

RFB NO. 317049



CONSTRUCTION DOCUMENTS PROJECT MANUAL

DANE COUNTY DEPARTMENT OF PUBLIC WORKS,
HIGHWAY AND TRANSPORTATION

PUBLIC WORKS SOLID WASTE DIVISION
1919 ALLIANT ENERGY CENTER WAY
MADISON, WISCONSIN 53713

REQUEST FOR BIDS NO. 317049 BIOGAS FACILITY CONSTRUCTION DANE COUNTY LANDFILL SITE NO. 2 7102 U.S. HIGHWAY 12 & 18 MADISON, WISCONSIN

Due Date / Time: **TUESDAY, APRIL 24, 2018 / 2:00 P.M.**

Location: **PUBLIC WORKS OFFICE**

Performance / Payment Bond: **100% OF CONTRACT AMOUNT**

Bid Deposit: **5% OF BID AMOUNT**

FOR INFORMATION ON THIS REQUEST FOR BIDS, PLEASE CONTACT:

JOHN WELCH, SOLID WASTE MANAGER
TELEPHONE NO.: 608/516 -4154
FAX NO.: 608/267-1533
E-MAIL: WELCH@COUNTYOFDANE.COM

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Drawings for RFB are a separate document entitled “Dane County No. 2 (Rodefled) Landfill Bioas Facility Construction”, March 2018, prepared by Cornerstone Environmental Group, LLC, a Tetra Tech Company.

Plot drawings on 22“ X 34” (ANSI D) paper for correct scale.

LEGAL NOTICE

INVITATION TO BID

Dane County Public Works, Highway & Transportation Dept., 1919 Alliant Energy Center Way, Madison, WI 53713, will receive sealed Bids until:

2:00 P.M., TUESDAY, APRIL 24, 2018

REQUEST FOR BIDS NO. 317049
BIOGAS FACILITY CONSTRUCTION
DANE COUNTY LANDFILL SITE NO. 2
7102 U.S. HIGHWAY 12 & 18
MADISON, WISCONSIN

Dane County is inviting Bids for construction services to develop approximately 5 acres into a biogas processing facility located on Dane County property. Work will include all civil site work, building construction, and all associated equipment procurement and installation. Only firms with capabilities, experience & expertise with similar projects should obtain this Request for Bids document & submit Bids.

Request for Bids document may be obtained after **2:00 p.m. on Tuesday, March 27, 2018** by downloading it from bids-pwht.countyofdane.com. Please call John Welch, Solid Waste Manager, at 608/516-4154, or our office at 608/266-4018, for any questions or additional information.

All Bidders must be a registered vendor with Dane County & pay an annual registration fee & must be pre-qualified as a Best Value Contractor before award of Contract. Complete Vendor Registration Form at danepurchasing.com/Account/Login? or obtain one by calling 608/266-4131. Complete Pre-qualification Application for Contractors at countyofdane.com/pwht/BVC_Application.aspx or obtain one by calling 608/266-4029.

A pre-bid site tour will be held Thursday, April 12, 2018 at 10:00 a.m. at Dane County Landfill Site No. 2, starting at the Scale House. Bidders are encouraged to attend this optional tour.

PUBLISH: TUESDAY, MARCH 27 & APRIL 3, 2018 - WISCONSIN STATE JOURNAL
TUESDAY, MARCH 27 & APRIL 3, 2018 - THE DAILY REPORTER



DANE COUNTY DEPARTMENT of PUBLIC WORKS, HIGHWAY and TRANSPORTATION

County Executive
Joseph T. Parisi

1919 Alliant Energy Center Way • Madison, Wisconsin 53713
Phone: (608) 266-4018 • FAX: (608) 267-1533

Commissioner / Director
Gerald J. Mandli

BEST VALUE CONTRACTING APPLICATION

CONTRACTORS / LICENSURE APPLICANTS

The Dane County Department of Public Works requires all contractors to be pre-qualified as a best value contractor with the County prior to being awarded a contract. In addition, the County pre-qualifies potential contractors and sub-contractors who wish to work on County contracts. Subcontractors must become pre-qualified ten (10) days prior to commencing work under any Dane County Public Works Contract. Potential subcontractors are urged to become pre-qualified as early as possible. This document shall be completed, properly executed, along with the necessary attachments and additional information that the County requires for the protection and welfare of the public in the performance of a County contract.

Contractors or subcontractors of any tier who attain pre-qualification status will retain that status for a period of two (2) years from the date of qualification. Contractors shall notify the Dane County Department of Public Works, Highway & Transportation within fifteen (15) days of any changes to its business or operations that are relevant to the pre-qualification application. Failure to do so could result in suspension, revocation of the contractor's pre-qualification, debarment from County contracts for up to three (3) years and / or other sanctions available under the law.

No contracts will be awarded for construction work performed on Dane County projects unless the contractor is currently approved as a Wisconsin Trade Trainer or has applied for approval as an Apprenticeship Trade Trainer to the Wisconsin Department of Workforce Development and agrees to an acceptable apprenticeship program. If you are not currently approved as a Wisconsin Trade Trainer, or have not applied for approval as an Apprenticeship Trade Trainer, please contact the Department of Workforce Development - Bureau of Apprenticeship Standards at 608/266-3133 or visit their web site at: dwd.wisconsin.gov/apprenticeship/.

EXEMPTIONS

- Contractors who employ less than five (5) apprenticeable trade workers are not required to pre-qualify.
- Contractors performing work that does not apply to an apprenticeable trade, as outlined in Appendix A.
- The contractor / subcontractor provides sufficient documentation to demonstrate one or more of the following:
 - apprentices are not available in a specific geographic area;
 - the applicable apprenticeship program is unsuitable or unavailable; or
 - there is a documented depression of the local construction market which prevents compliance.

SEC.	PROOF OF RESPONSIBILITY	CHECK IF APPLICABLE
1	Does your firm possess all technical qualifications and resources, including equipment, personnel and financial resources, necessary to perform the work required for any project or obtain the same through the use of responsible, pre-qualified subcontractors?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
2	Will your firm possess all valid, effective licenses, registrations or certificates required by federal, state, county, or local law, which are necessary for the type of work to be performed including, but not limited to, those for any type of trade work or specialty work?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
3	Will your firm meet all bonding requirements as required by applicable law or contract specifications?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
4	Will your firm meet all insurance requirements as required by applicable law or specifications, including general liability insurance, workers compensation insurance and unemployment insurance requirements?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
5	Will your firm maintain a substance abuse policy for employees hired for public works contracts that comply with Wis. Stats. Sec. 103.503?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
6	Does your firm acknowledge that it must pay all craft employees on public works projects the wage rates and benefits required under Section 66.0903 of the Wisconsin Statutes?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
7	Will your firm fully abide by the equal opportunity and affirmative action requirements of all applicable laws, including County ordinances?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
8	In the past three (3) years, has your firm had control or has another corporation, partnership or other business entity operating in the construction industry controlled it? If so, please attach a statement explaining the nature of the firm relationship?	Yes: <input type="checkbox"/> No: <input type="checkbox"/> If Yes, attach details.
9	In the past three (3) years, has your firm had any type of business, contracting or trade license, certification or registration revoked or suspended?	Yes: <input type="checkbox"/> No: <input type="checkbox"/> If Yes, attach details.
10	In the past three (3) years, has your firm been debarred by any federal, state or local government agency?	Yes: <input type="checkbox"/> No: <input type="checkbox"/> If Yes, attach details.
11	In the past three (3) years, has your firm defaulted or failed to complete any contract?	Yes: <input type="checkbox"/> No: <input type="checkbox"/> If Yes, attach details.
12	In the past three (3) years, has your firm committed a willful violation of federal, state or local government safety laws as determined by a final decision of a court or government agency authority.	Yes: <input type="checkbox"/> No: <input type="checkbox"/> If Yes, attach details.
13	In the past three (3) years, has your firm been in violation of any law relating to your contracting business where the penalty for such violation resulted in the imposition of a penalty greater than \$10,000?	Yes: <input type="checkbox"/> No: <input type="checkbox"/> If Yes, attach details.
14	Is your firm Executive Order 108 precertified with the State of Wisconsin?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
15	Is your firm an active Wisconsin Trade Trainer as determined by the Wisconsin Bureau of Apprenticeship Standards?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
16	Is your firm exempt from being pre-qualified with Dane County?	Yes: <input type="checkbox"/> No: <input type="checkbox"/> If Yes, attach reason for exemption.
17	Does your firm acknowledge that in doing work under any County Public Works Contract, it will be required to use as subcontractors only those contractors that are also pre-qualified with the County or become so ten days prior to commencing work?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
18	Contractor has been in business less than one year?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
19	Is your firm a first time Contractor requesting a one time exemption, but, intend to comply on all future contracts and are taking steps typical of a "good faith" effort?	Yes: <input type="checkbox"/> No: <input type="checkbox"/>
20	Not applicable. My firm does not intend to work on Best Value Contracts. Note: Best Value Contracting is required to bid on most Public Works Contracts (if unclear, please call Jan Neitzel Knox 608-266-4029).	Yes: <input type="checkbox"/> No: <input type="checkbox"/>

SIGNATURE SECTION

Your firm's Officer, or the individual who would sign a bid and / or contract documents must sign this document.

I do hereby certify that all statements herein contained are true and correct to the best of my knowledge:

Signature

Date

Printed or Typed Name and Title

NAME AND ADDRESS OF CONTRACTOR	
Name of Firm:	
Address:	
City, State, Zip:	
Telephone Number:	
Fax Number:	
E-mail Address:	

REMEMBER!

Return all to forms and attachments, or questions to:

JAN NEITZEL KNOX
EMAIL: NEITZEL-KNOX@COUNTYOFDANE.COM
OFFICE: (608)266-4029, FAX: (608)267-1533

**DANE COUNTY DEPARTMENT OF PUBLIC WORKS,
HIGHWAY & TRANSPORTATION
1919 ALLIANT ENERGY CENTER WAY
MADISON, WI 53713**

APPENDIX A

APPRENTICEABLE TRADES

Bricklayer
Carpenter
Cement Mason (Concrete Finisher)
Cement Mason (Heavy Highway)
Construction Craft Laborer
Data Communications Installer
Electrician
Elevator Mechanic / Technician
Environmental Systems Technician / HVAC Service Technician / HVAC Install & Service
Glazier
Heavy Equipment Operator / Operating Engineer
Insulation Worker (Heat & Frost)
Iron Worker (Assembler, Metal Buildings)
Painter / Decorator
Plasterer
Plumber
Roofer / Waterproofer
Sheet Metal Worker
Sprinkler Fitter
Steamfitter (Service & Refrigeration)
Taper & Finisher
Telecommunications (Voice, Data & Video) Installer / Technician
Tile Setter

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1. GENERAL

- A. Before submitting Bid, bidder shall thoroughly examine all Construction Documents. Successful Bidder shall be required to provide all the Work that is shown on Drawings, set forth in Specifications, or reasonably implied as necessary to complete Contract for this project.
- B. Bidder shall visit site to become acquainted with adjacent areas, means of approach to site, conditions of actual site and facilities for delivering, storing, placing, and handling of materials and equipment.
- C. Pre-bid meeting is scheduled on Thursday, April 12, 2018 at 10:00 a.m. at Dane County Landfill Site No. 2 starting at the Scale House. Attendance by all bidders is optional, however bidders and subcontractors are strongly encouraged to attend.
- D. Visits at other times can also be arranged. Coordinate site access activities with Solid Waste Manager, John Welch, 608/516-4154.
- E. Failure to visit site or failure to examine any and all Construction Documents will in no way relieve successful Bidder from necessity of furnishing any necessary materials or equipment, or performing any work, that may be required to complete the Work in accordance with Drawings and Specifications. Neglect of above requirements will not be accepted as reason for delay in the Work or additional compensation.

2. DRAWINGS AND SPECIFICATIONS

- A. Drawings and Specifications that form part of this Contract, as stated in Article 1 of General Conditions of Contract, are enumerated in Document Index of these Construction Documents.
- B. Complete sets of Drawings and Specifications for all trades will be available to all Bidders, irrespective of category of work to be bid on, in order that all Bidders may be familiar with work of other trades as they affect their bid.

3. INTERPRETATION

- A. No verbal explanation or instructions will be given in regard to meaning of Drawings or Specifications before Bid Due Date. Bidders shall bring inadequacies, omissions or conflicts to Owner or Architect / Engineer's attention at least ten (10) calendar days before Bid Due Date. Prompt clarification will be available to all bidders by Addendum.
- B. Failure to so request clarification or interpretation of Drawings and Specifications will not relieve successful Bidder of responsibility. Signing of Contract will be considered as implicitly denoting that Contractor has thorough understanding of scope of the Work and comprehension of Construction Documents.
- C. Owner or Architect / Engineer will not be responsible for verbal instructions.

4. QUALIFICATIONS OF BIDDER (CONTRACTOR AND SUBCONTRACTOR)

- A. Before award of Contract can be approved, Owner shall be satisfied that Bidder involved meets following requirements:
 - 1. Has completed at least one (1) project of at least fifty percent (50%) of size or value of Division of work being bid and type of work completed is similar to that being bid. If greater magnitude of experience is deemed necessary, other than size or value of work, such requirements will be described in appropriate section of Specifications.
 - 2. Maintains permanent place of business.
 - 3. Can be bonded for terms of proposed Contract.
 - 4. Has record of satisfactorily completing similar past projects. Contractor shall submit a list of three (3) most recent, similar projects of at least 50% value of this project, with architect or engineer's and owner's names, addresses and telephone numbers for each project. Submit to Public Works Project Manager with Bid. Criteria which will be considered in determining satisfactory completion of projects by bidder will include:
 - a. Completed contracts in accordance with drawings and specifications.
 - b. Diligently pursued execution of work and completed contracts according to established time schedule unless Owner grants extensions.
 - c. Fulfilled guarantee requirements of construction documents.
 - d. Is not presently on ineligible list maintained by County's Department of Administration for noncompliance with equal employment opportunities and affirmative action requirements.
 - e. Authorized to conduct business in Wisconsin. By submitting Bid, bidder warrants that it has: complied with all necessary requirements to do business in State of Wisconsin; that persons executing contract on its behalf are authorized to do so; and, if corporation, that name and address of bidder's registered agent are as set forth in Contract. Bidder shall notify Owner immediately, in writing, of any change in its registered agent, their address, and bidder's legal status. For partnership, term "registered agent" shall mean general partner.

- B. County's Public Works Project Manager will make such investigations as are deemed necessary to determine ability of bidder to perform the Work, and bidder shall furnish to County's Public Works Project Manager or designee all such information and data for this purpose as County's Public Works Project Manager may request. Owner reserves right to reject Bid if evidence submitted by, or investigation of, bidder fails to satisfy Owner that bidder is responsible and qualified to carry out obligations of Contract and to complete the Work contemplated therein.

5. BID GUARANTEE

- A. Bank certified check, cashier's check or Bid Bond, payable to County in amount not less than five percent (5%) of maximum bid, shall accompany each Bid as guarantee that if Bid is accepted, Bidder will execute and return proposed Contract and Performance and Payment Bonds within ten (10) business days after being notified of acceptance of Bid. Company issuing bonds must be licensed to do business in Wisconsin.
- B. Any bid, which is not accompanied by bid guarantee, will be considered "No Bid" and will not be read at Bid Due Date.
- C. If successful Bidder so delivers Contract, Certificate of Insurance, and Performance and Payment Bonds, check will be returned to Bidder. In case Bidder fails to deliver such Contract, insurance, and bond, amount of bid guarantee will be forfeited to County as liquidated damages.
- D. All checks tendered as bid guarantee, except those of three (3) lowest qualified, responsible bidders, will be returned to their makers within three (3) business days after Bid Due Date. All such retained checks will be returned immediately upon signing of Contract and Performance and Payment Bonds by successful Bidder.

6. WITHDRAWAL OF BIDS

- A. Bids may be withdrawn by written request received from bidder or authorized representative thereof prior to time fixed for Bid Due Date, without prejudice to right of bidder to file new Bid. Withdrawn Bids will be returned unopened. Negligence on part of bidder in preparing their Bid confers no right for withdrawal of Bid after it has been opened.
- B. No Bid may be withdrawn for period of sixty (60) calendar days after Bid Due Date.
- C. If Bid contains error, omission or mistake, bidder may limit liability to amount of bidder's guarantee by giving written Notice of Intent not to execute Contract to Owner within seventy-two (72) hours of Bid Due Date.

7. CONTRACT FORM

- A. Sample copy of contract that successful Bidder will be required to enter into is included in these Construction Documents and bidders are required to familiarize themselves with all conditions contained therein.

8. CONTRACT INTERESTS BY COUNTY PUBLIC OFFICIALS

- A. In accordance with Wisconsin Statute 946.13, county official may not bid for or enter into any contract involving receipts or disbursements of more than \$15,000.00 in a year, in which they have private pecuniary interest, direct or indirect if at same time they are authorized to take official action with respect to making of this Contract. Any contract entered into in

violation of this Statute is void and County incurs no liability thereon. This subsection does not affect application and enforcement of Wisconsin Statute 946.13 by state prosecutors in criminal courts of this state.

9. EMERGING SMALL BUSINESS PROVISIONS

A. **Emerging Small Business Definition.** For purposes of this provision, ESB is defined as:

1. Independent business concern that has been in business minimum of one year;
2. Business located in State of Wisconsin;
3. Business comprised of less than twenty-five (25) employees;
4. Business must not have gross sales in excess of three million dollars (\$3,000,000.00) over past three years; and
5. Business does not have history of failing to complete projects.

B. **Emerging Small Business (ESB) Involvement.** Bidder shall make good faith effort to award minimum of ten percent (10%) of the Work to ESBs. Bidder shall submit report to Dane County Contract Compliance Officer within ten (10) business days of Bid Due Date demonstrating such efforts. Good faith efforts means significant contact with ESBs for purposes of soliciting bids from them. Failure to make or demonstrate good faith efforts will be grounds for disqualification.

C. **Emerging Small Business Report.** Emerging Small Business Enterprise Report is to be submitted by Bidder in separate envelope marked "Emerging Small Business Report". This report is due by 2:00 p.m. following specified ten (10) business days after Bid Due Date. Bidder who fails to submit Emerging Small Business Report shall be deemed not responsive.

D. **ESB Goal.** Goal of this project is ten percent (10%) ESB participation. ESB utilizations are shown as percentage of total Bid. If Bidder meets or exceeds specified goal, Bidder is only required to submit Form A - Certification, and Form B - Involvement. Goal shall be met if Bidder qualifies as ESB.

E. **Report Contents.** Following award of Contract, Bidder shall submit copies of executed contracts for all Emerging Small Businesses. Emerging Small Business Report shall consist of these:

1. Form A - Certification;
2. Form B - Involvement;
3. Form C - Contacts;
4. Form D - Certification Statement (if appropriate); and
5. Supportive documentation (i.e., copies of correspondence, telephone logs, copies of advertisements).

F. **ESB Listing.** Bidders may solicit bids from this ESB listing:
pdf.countyofdane.com/commissions/2013-2015_Targeted_Business_Directory.pdf.

- G. **ESB Certification.** All contractors, subcontractors and suppliers seeking ESB certification must complete and submit Emerging Small Business Report to Dane County Contract Compliance Program.
- H. **Certification Statement.** If ESB firm has not been certified by County as ESB prior to submittal of this Bid, ESB Report cannot be used to fulfill ESB goal for this project unless firm provides “Form D - Certification Statement”. Certification statement must be completed and signed by ESB firm.
- I. **Questions.** Questions concerning Emerging Small Business provisions shall be directed to:
- Dane County Contract Compliance Officer
City-County Building, Room 421
210 Martin Luther King, Jr. Blvd.
Madison, WI 53703
608/266-5623
- J. **Substituting ESBs.** In event of any significant changes in subcontract arrangements or if need arises to substitute ESBs, Bidder shall report such proposed changes to Contract Compliance Officer to making any official changes and request authorization to substitute ESB firm. Bidder further agrees to make every possible effort to replace ESB firm with another qualified ESB firm.
- K. **Good Faith Efforts.** Good faith efforts can be demonstrated by meeting all of these obligations:
1. Selecting portions of the Work to be performed by ESBs in order to increase likelihood of meeting ESB goal including, where appropriate, breaking down Contract into smaller units to facilitate ESB participation.
 2. Advertising in general circulation, trade associations and women / minority focus media concerning subcontracting opportunities.
 3. Providing written notices to reasonable number of specific ESBs that their interest in Contract was being solicited in sufficient time to allow ESBs to participate effectively.
 4. Following up on initial solicitations of interest by contacting ESBs within five (5) business days prior to Bid Due Date to determine with certainty whether ESB were interested, to allow ESBs to prepare bids.
 5. Providing interested ESB with adequate information about Drawings, Specifications and requirements of Contract.
 6. Using services of available minority, women and small business organizations and other organizations that provide assistance in recruitment of MBEs / WBEs / ESBs.
 7. Negotiating in good faith with interested ESBs, not rejecting ESBs as unqualified without sound reason based on thorough investigation of their capabilities.
 8. Submitting required project reports and accompanying documents to County’s Contract Compliance Officer within twenty-four (24) hours after Bid Due Date.
- L. **Appeals Disqualification of Bid.** Bidder who is disqualified may appeal to Public Works & Transportation Committee and Equal Opportunity Commission.

10. METHOD OF AWARD - RESERVATIONS

- A. Following will be basis of award of Contract, providing cost does not exceed amount of funds then estimated by County as available to finance Contract(s):
 - 1. Lowest dollar amount submitted by qualified responsible bidder on Base Bid for all work comprising project, combined with such additive Owner accepted alternates.
 - 2. Owner reserves right to reject all bids or any bid, to waive any informality in any bid, and to accept any bid that will best serve interests of County.
 - 3. Unit Prices and Informational Bids will not be considered in establishing low bidder.

11. SECURITY FOR PERFORMANCE AND PAYMENTS

- A. Simultaneous with delivery of signed Contract, Bidder shall be required to furnish Performance and Payment Bonds as specified in Article 29 of General Conditions of Contract, "Contract Security". Surety Company shall be licensed to do business in Wisconsin. Performance and Payment Bonds must be dated same date or subsequent to date of Contract. Performance and Payment Bonds must emulate information in Sample Performance and Payment Bonds in Construction Documents.
- B. Provide certified copy of power of attorney from Surety Company showing that agent who signs Bond has power of attorney to sign for Surety Company. Secretary or Assistant Secretary of company must sign this certification, not attorney-in-fact. Certification must bear same or later date as Bond. Power of Attorney must emulate model power of attorney information detailed in Sample Performance and Payment Bonds.
- C. If Bidder is partnership or joint venture, State certified list, providing names of individuals constituting partnership or joint venture must be furnished. Contract itself may be signed by one partner of partnership, or one partner of each firm comprising joint venture, but Performance and Payment Bonds must be signed by all partners.
- D. If Bidder is corporation, it is necessary that current certified copy of resolution or other official act of directors of corporation be submitted showing that person who signs Contract is authorized to sign contracts for corporation. It is also necessary that corporate seal be affixed to resolution, contract, and performance and payment bonds. If your corporation has no seal, it is required that above documents include statement or notation to effect that corporation has no seal.

12. TAXES

- A. Wisconsin Statute 77.54 (9m) allows building materials that become part of local unit government facilities to be exempt from sales & use tax. Vendors & materials suppliers may not charge Bidders sales & use tax on these purchases. This does not include highways, streets or roads. Any other Sales, Consumer, Use & other similar taxes or fees required by law shall be included in Bid.
- B. In accordance with Wisconsin Statute 71.80(16)(a), successful nonresident bidder, whether incorporated or not, and not otherwise regularly engaged in business in this state, shall file surety bond with State of Wisconsin Department of Revenue payable to Department of Revenue, to guarantee payment of income taxes, required unemployment compensation contributions, sales and use taxes and income taxes withheld from wages of employees, together with any penalties and interest thereon. Amount of bond shall be three percent (3%) of Contract or subcontract price on all contracts of \$50,000 or more.

13. SUBMISSION OF BIDS

- A. All Bids shall be submitted on standard Bid Form bound herein and only Bids that are made on this Bid Form will be considered. Entire Bid Form and other supporting documents, if any, shall be removed or copied from Construction Documents, filled out, and submitted in manner specified hereinafter. Submit completed Bid Bond with Bid as well.
- B. No bids for any subdivision or any sub-classification of this Work, except as indicated, will be accepted. Any conditional Bid, amendment to Bid Form or appended item thereto, or inclusion of any correspondence, written or printed matter, or details of any nature other than that specifically called for, which would alter any essential provision of Construction Documents, or require consideration of unsolicited material or data in determining award of Contract, will disqualify Bid. Telecommunication alterations to Bid will not be accepted.
- C. Bidders must submit single Bid for all the Work.
- D. Bid amounts shall be inserted in words and in figures in spaces provided on Bid Form; in case of conflict, written word amounts will govern.
- E. Addenda issued after Bid Letting shall become part of Construction Documents. Bidders shall acknowledge receipt of such addenda in appropriate space provided on Bid Form. Bid may be rejected if receipt of any particular addendum applicable to award of Contract has not been acknowledged on Bid Form.
- F. Bids shall be signed, placed in envelope, sealed and delivered before due time to place designated in Invitation to Bid, and identified with project name, bid number, location, category of work being bid upon, Bid Due Date, name and address of bidder.
- G. Bidder shall be responsible for sealed Bid being delivered to place designated for Bid Due Date on or before date and time specified. Bids received after time of closing will be rejected and returned to bidder unopened.
- H. Bid will be considered invalid and will be rejected if bidder has not signed it.
- I. Faxed or emailed Bids will not be accepted.
- J. Bidder's organization shall submit completed with Bid, Fair Labor Practices Certification form, included in these Construction Documents.

14. SUBCONTRACTOR LISTING

- A. Bidders shall be required to submit list of major subcontractors for General Construction, Plumbing, HVAC, and Electrical work proposed for this project to include committed prices for each subcontractor. List shall be placed in separate sealed envelope that must be clearly identified as "Major Subcontractor List", for named project and name of Bidder submitting it. County must receive envelope no later than date by which successful Bidder is required to submit his or her signed Contract, as established in Construction Documents.

15. ALTERNATE BIDS

- A. Bidder shall carefully read requests for Alternate Bids, and thoroughly examine Drawings and Specifications to determine extent various changes and conditions will affect Bid.
- B. Space is provided in Bid Form for requested Alternate Bids. Failure to submit bid for any requested Alternate Bids may result in rejection of entire Bid.

- C. Bidder shall state amount to be added / subtracted to Base Bid for providing alternates, including all incidentals, omissions, additions, and adjustments as may be necessary or required by such changes. If there is no difference in price, Bidder shall state, "No Change".
- D. Descriptions of requested Alternate Bids are as set forth in Construction Documents.

16. INFORMATIONAL BIDS

- A. Not Applicable.

17. UNIT PRICES

- A. Not Applicable.

18. COMMENCEMENT AND COMPLETION

- A. Successful Bidder shall commence work when schedule and weather permit, but no later than stated in Bid Form. Contractor shall pursue the Work regularly and continuously at reasonable rate to insure completion of the Work within time stated in Bid.
- B. Should it be found impossible to complete the Work on or before time specified for completion, written request may be submitted for extension of time setting forth reasons believed to justify granting of such request. Refer to Article 20 of General Conditions of Contract, titled "Time for Completion".

19. WORK BY OWNER

- A. See Section 01 11 00 titled "Summary of Work" for Work by Owner.

20. SPECIAL HAZARDS COVERAGE

- A. Not Applicable.

FORM A

**DANE COUNTY
EMERGING SMALL BUSINESS REPORT - CERTIFICATION**

In accordance with General Conditions of Contract, submit this Emerging Small Business Report within ten (10) days after Bid Due Date.

PROJECT NAME: _____

BID NO.: _____ BID DUE DATE: _____

BIDDER INFORMATION

COMPANY NAME: _____

ADDRESS: _____

TELEPHONE NO.: _____

CONTACT PERSON: _____

EMAIL ADDRESS: _____

FORM B

Page ___ of ___

DANE COUNTY

(Copy this Form as necessary to provide complete information)

EMERGING SMALL BUSINESS REPORT - INVOLVEMENT

COMPANY NAME: _____

PROJECT NAME: _____

BID NO.: _____ BID DUE DATE: _____

ESB NAME: _____

CONTACT PERSON: _____

ADDRESS: _____

PHONE NO & EMAIL.: _____

Indicate percentage of financial commitment to this ESB: _____ % Amount: \$ _____

ESB NAME: _____

CONTACT PERSON: _____

ADDRESS: _____

PHONE NO & EMAIL.: _____

Indicate percentage of financial commitment to this ESB: _____ % Amount: \$ _____

FORM C

Page ___ of ___

**DANE COUNTY
EMERGING SMALL BUSINESS REPORT - CONTACTS**

(Copy this Form as necessary to provide complete information)

COMPANY NAME: _____

PROJECT NAME: _____

BID NO.: _____ BID DUE DATE: _____

	<u>ESB FIRM NAME CONTACTED</u>	<u>DATE</u>	<u>PERSON CONTACTED</u>	<u>DID ESB BID?</u>	<u>ACC- EPT BID?</u>	<u>REASON FOR REJECTION</u>
1)	_____	_____	_____	_____	_____	_____
2)	_____	_____	_____	_____	_____	_____
3)	_____	_____	_____	_____	_____	_____
4)	_____	_____	_____	_____	_____	_____
5)	_____	_____	_____	_____	_____	_____
6)	_____	_____	_____	_____	_____	_____
7)	_____	_____	_____	_____	_____	_____
8)	_____	_____	_____	_____	_____	_____

FORM D

**DANE COUNTY
EMERGING SMALL BUSINESS REPORT - CERTIFICATION STATEMENT**

I, _____, _____ of
Name Title

_____ certify to best of my knowledge and
Company

belief that this business meets Emerging Small Business definition as indicated in Article 9 and
that information contained in this Emerging Small Business Report is true and correct.

Bidder's Signature

Date

Name of Bidding Firm: _____

BID FORM

BID NO. 317049

**PROJECT: BIOGAS FACILITY CONSTRUCTION
DANE COUNTY LANDFILL SITE NO. 2**

**TO: DANE COUNTY DEPARTMENT OF PUBLIC WORKS, HIGHWAY &
TRANSPORTATION PROJECT MANAGER
1919 ALLIANT ENERGY CENTER WAY
MADISON, WISCONSIN 53713**

**NOTE: WISCONSIN STATUTE 77.54 (9M) ALLOWS FOR NO SALES & USE TAX ON
THE PURCHASE OF MATERIALS FOR COUNTY PUBLIC WORKS PROJECTS.**

BASE BID - LUMP SUM:

Dane County is inviting Bids for construction services to develop approximately 5 acres into a biogas processing facility located on Dane County property. Work will include all civil site work, building construction, and all associated equipment procurement and installation. The undersigned, having examined the site where the Work is to be executed and having become familiar with local conditions affecting the cost of the Work and having carefully examined the Drawings and Specifications, all other Construction Documents and Addenda thereto prepared by Dane County Department of Public Works, Highway & Transportation hereby agrees to provide all labor, materials, equipment and services necessary for the complete and satisfactory execution of the entire Work, as specified in the Construction Documents, for the Base Bid stipulated sum of:

_____ and _____ /100 Dollars
Written Price

\$ _____
Numeric Price

For the following price(s) in accordance with the Contract Documents:

Item Number	Description	Unit	Quantity	Unit Price	Total Price
101	Mobilization and General Conditions	LS	1		
102	Site Preparation – General	LS	1		
103	Silt Fence	EA	2,638		
104	Silt Logs	EA	8		
105	Temporary Erosion Control Matting	SF	242,950		
106	Temporary Seeding	SF	242,950		
107	Excavation	CY	3,000		
108	Undercut and Backfill with General Fill	CY	2,000		
109	Undercut and Backfill with Special Fill	CY	2,000		
110	Structural Fill	CY	4,000		

111	RNG Area Finish Grading	LS	1		
112	Facility Concrete Pads	LS	1		
113	Fixed Bollards	EA	75		
114	Removable Bollards	EA	14		
115	Aggregate Base for Paved / Parking Areas	SF	57,080		
116	Asphalt Pavement Placement	SF	55,280		
117	Concrete Pavement Placement	SF	1,800		
118	Aggregate Pad	SF	3,150		
119	Blower Building and Office Building	LS	1		
120	Compression Building	LS	1		
121	Boiler Building	LS	1		
122	Metering Skid Not in Contract	NA	NA		
123	RNG Offload Facility Installation	LS	1		
124	Metering Skid Installation	Each	3		
125	Condensate Management	LS	1		
126	Blower and Flare Facility Installation	LS	1		
127	Below Ground Gas Piping	LS	1		
128	Above Ground Gas Piping	LS	1		
129	Above Ground Gas Piping Tie-Ins	LS	1		
130	GCCS Header Installation	LS	1		
131	Supply and Install Flow Meters, Gas Valves, and Pressure Regulators	LS	1		
132	Electrical Lines	LS	1		
133	Communication Lines	LS	1		
134	Mechanical	LS	1		
135	Surface Water Drainage Features	LS	1		
136	Fire Protection	LS	1		
137	Supply and Install Fence	LS	1		
138	Supply and Install Security Devices	LS	1		
139	Traffic Signage and Pavement Markings	LS	1		
140	Site Restoration	LS	1		
				Grand Total	

***Quantities shown are Project Engineer's best estimate. Bid will be awarded based on the Grand Total Bid. Unit prices are reflective of estimated quantities to establish a Base Bid. Payment on unit rate items will be based on actual quantities installed by the selected Contractor.**

ALTERNATE BID 1 - LUMP SUM:

Add price for providing a 62'-8" by 48'-4" maintenance building per drawings and specifications.

_____ and _____ /100 Dollars
Written Price

\$ _____
Numeric Price (circle: Add or Deduct)

ALTERNATE BID 2 - LUMP SUM:

Add price for providing approximately 2,400 linear feet of transmission pipeline per drawings and specifications.

_____ and _____ /100 Dollars
Written Price

\$ _____
Numeric Price (circle: Add or Deduct)

Receipt of the following addenda and inclusion of their provisions in this Bid is hereby acknowledged:

Addendum No(s). _____ through _____

Dated _____

Dane County Public Works – Solid Waste Division must have this project completed by November 23, 2018. Assuming this Work can be started by June 18, 2018, what dates can you commence and complete this job?

Commencement Date: _____ Completion Date: _____
(final, not substantial)

I hereby certify that all statements herein are made on behalf of:

(Name of Corporation, Partnership or Person submitting Bid)

Select one of the following:

- 1. A corporation organized and existing under the laws of the State of _____, or
- 2. A partnership consisting of _____, or
- 3. A person conducting business as _____;

Of the City, Village, or Town of _____ of the State of _____.

I have examined and carefully prepared this Bid from the associated Construction Documents and have checked the same in detail before submitting this Bid; that I have full authority to make such statements and submit this Bid in (its) (their) (my) behalf; and that the said statements are true and correct. In signing this Bid, we also certify that we have not, either directly or indirectly, entered into any agreement or participated in any collusion or otherwise taken any action in restraint of free competition; that no attempt has been made to induce any other person or firm to submit or not to submit a Bid; that this Bid has been independently arrived at without collusion with any other bidder, competitor, or potential competitor; that this Bid has not been knowingly disclosed prior to the Bids Due Date to another bidder or competitor; that the above statement is accurate under penalty of perjury.

The undersigned further agrees to honor the Base Bid and the Alternate Bid(s) for sixty (60) calendar days from date of Award of Contract.

SIGNATURE: _____
(Bid is invalid without signature)

Print Name: _____ Date: _____

Title: _____

Address: _____

Telephone No.: _____ Fax No.: _____

Email Address: _____

Contact Person: _____

THIS PAGE IS FOR BIDDERS' REFERENCE AND NEED NOT BE SUBMITTED WITH BID FORM.

BID CHECK LIST:

These items **must** be included with Bid:

- Bid Form Bid Bond Fair Labor Practices Certification
 Project Experience / Reference Summary

BIDDERS SHOULD BE AWARE OF THE FOLLOWING:

DANE COUNTY VENDOR REGISTRATION PROGRAM

Any person bidding on any County contract must be registered with the Dane County Purchasing Division & pay an annual registration fee. A contract will not be awarded to an unregistered vendor. Obtain a *Vendor Registration Form* by calling 608/266-4131 or complete a new form or renewal online at:

www.danepurchasing.com/registration

DANE COUNTY BEST VALUE CONTRACTING PRE-QUALIFICATION

Contractors must be pre-qualified as a Best Value Contractor with the Dane County Public Works Engineering Division before the award of contract. Obtain a *Best Value Contracting Application* by calling 608/266-4018 or complete one online at:

www.countyofdane.com/pwht/BVC_Application.aspx

EQUAL BENEFITS REQUIREMENT

By submitting a Bid, the contractor acknowledges that a condition of this contract is to provide equal benefits as required by Dane County Code of Ordinances Chapter 25.13. Contractor shall provide equal benefits as required by that Ordinance to all required employees during the term of the contract. Equal Benefits Compliance Payment Certification shall be submitted with final pay request. For more information:

www.danepurchasing.com/partner_benefit.aspx

FAIR LABOR PRACTICES CERTIFICATION

The undersigned, for and on behalf of the BIDDER, APPLICANT or PROPOSER named herein, certifies as follows:

- A. That he or she is an officer or duly authorized agent of the above-referenced BIDDER, APPLICANT or PROPOSER, which has submitted a bid, application or proposal for a contract or agreement with the county of Dane.

- B. That BIDDER, APPLICANT or PROPOSER has (check one):

_____ not been found by the National Labor Relations Board (“NLRB”) or the Wisconsin Employment Relations Commission (“WERC”) to have violated any statute or regulation regarding labor standards or relations in the seven years prior to the signature date of this Certification.

_____ been found by the National Labor Relations Board (“NLRB”) or the Wisconsin Employment Relations Commission (“WERC”) to have violated any statute or regulation regarding labor standards or relations in the seven years prior to the signature date of this Certification.

Officer or Authorized Agent Signature Date

Printed or Typed Name and Title

Printed or Typed Business Name

NOTE: You can find information regarding the violations described above at: www.nlrb.gov and werc.wi.gov.

For reference, Dane County Ordinance 25.11(28)(a) is as follows:
(28) BIDDER RESPONSIBILITY. (a) Any bid, application or proposal for any contract with the county, including public works contracts regulated under chapter 40, shall include a certification indicating whether the bidder has been found by the National Labor Relations Board (NLRB) or the Wisconsin Employment Relations Committee (WERC) to have violated any statute or regulation regarding labor standards or relations within the last seven years. The purchasing manager shall investigate any such finding and make a recommendation to the committee, which shall determine whether the conduct resulting in the finding affects the bidder’s responsibility to perform the contract.

If you indicated that the NLRB or WERC have found you to have such a violation, you must include copies of any relevant information regarding such violation with your proposal, bid or application.

Include this completed Certification with your bid, application or proposal.

COUNTY OF DANE

PUBLIC WORKS CONSTRUCTION CONTRACT

Contract No. _____ Bid No. 317049

Authority: 2017 RES - _____

THIS CONTRACT, made and entered into as of the date by which authorized representatives of both parties have affixed their signatures, by and between the County of Dane (hereafter referred to as "COUNTY") and _____ (hereafter, "CONTRACTOR"), and

WITNESSETH:

WHEREAS, COUNTY, whose address is c/o Assistant Public Works Director, 1919 Alliant Energy Center Way, Madison, WI 53713, desires to have CONTRACTOR provide Biogas Facility Construction ("the Project"); and

WHEREAS, CONTRACTOR, whose address is _____ is able and willing to construct the Project, in accordance with the Construction Documents;

NOW, THEREFORE, in consideration of the above premises and the mutual covenants of the parties hereinafter set forth, the receipt and sufficiency of which is acknowledged by each party for itself, COUNTY and CONTRACTOR do agree as follows:

1. CONTRACTOR agrees to construct, for the price of \$ _____ the Project and at the CONTRACTOR'S own proper cost and expense to furnish all materials, supplies, machinery, equipment, tools, superintendence labor, insurance, and other accessories and services necessary to complete the Project in accordance with the conditions and prices stated in the Bid Form, General Conditions of Contract, the drawings which include all maps, plats, plans, and other drawings and printed or written explanatory matter thereof, and the specifications therefore as prepared by Cornerstone Environmental Group LLC (hereinafter referred to as "the Architect / Engineer"), and as enumerated in the Project Manual Table of Contents, all of which are made a part hereof and collectively evidence and constitute the Contract.

2. COUNTY agrees to pay the CONTRACTOR in current funds for the performance of the Contract subject to additions and deductions, as provided in the General Conditions of Contract, and to make payments on account thereof as provided in Article entitled, "Payments to Contractor" of the General Conditions of Contract.

3. Contract Times

Time of the Essence

- A. All time limits for Substantial Completion and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

Contract Times: Dates

- B. The Work shall be substantially completed on or before the following date: November 16, 2018.

Substantially complete means the following Work shall be completed:

1. Any start-up or commissioning required for operation,
 2. Final walk through completed,
 3. Development of punch-list, and
 4. Final planting, seeding and mulching.
- C. Work shall be completed and ready for final payment on or before the following date: November 23, 2018.

Liquidated Damages

D. Contractor and Owner recognize that time is of the essence as stated above and that Owner will suffer financial and other losses if the Work is not completed within the times specified above, plus any extensions thereof allowed in accordance with the Contract. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):

1. Substantial Completion: Contractor shall pay Owner \$10,000 for each day that expires after the time (as duly adjusted pursuant to the Contract) specified above for Substantial Completion until the Work is substantially complete.
2. Completion of Remaining Work: After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner \$5,000 for each day that expires after such time until the Work is completed and ready for final payment.
3. Liquidated damages for failing to timely attain Substantial Completion and final completion are not additive and will not be imposed concurrently.
4. There shall be no delays or adjustment to the dates for weather delays.

Bonus

E. Contractor and Owner recognize that time is of the essence as stated above and that Owner will suffer financial and other losses if the Work is not completed within the times specified above.

Contractor and Owner further recognize the Owner will realize financial and other benefits if the Work is completed by the time specified for Substantial Completion. Accordingly, Owner and Contractor agree that as a bonus for timely completion, Owner shall pay Contractor \$50,000 if the Work is substantially complete by the time specified in Paragraph 3B for Substantial Completion. When determining the final deadline for Bonus payment, there shall be no delays or adjustment to the dates for weather delays.

4. During the term of this Contract, CONTRACTOR agrees to take affirmative action to ensure equal employment opportunities. The CONTRACTOR agrees in accordance with Wisconsin Statute 111.321 and Chapter 19 of the Dane County Code of Ordinances not to discriminate on the basis of age, race, ethnicity, religion, color, gender, disability, marital status, sexual orientation, national origin, cultural differences, ancestry, physical appearance, arrest record or

conviction record, military participation or membership in the national guard, state defense force or any other reserve component of the military forces of the United States, or political beliefs. Such equal opportunity shall include, but not be limited to, the following: employment, upgrading, demotion, transfer, recruitment, advertising, layoff, termination, training, rates of pay, and any other form of compensation. CONTRACTOR agrees to post in conspicuous places, available to all employees and applicants for employment, notices setting forth the provisions of this paragraph.

5. CONTRACTOR shall file an Affirmative Action Plan with the Dane County Contract Compliance Officer in accord with Chapter 19 of the Dane County Code of Ordinances. CONTRACTOR must file such plan within fifteen (15) business days of the effective date of this Contract. During the term of this Contract CONTRACTOR shall also provide copies of all announcements of employment opportunities to COUNTY'S Contract Compliance Office, and shall report annually the number of persons, by race, ethnicity, gender, and disability status, which apply for employment and, similarly classified, the number hired and number rejected.

6. During the term of this Contract, all solicitations for employment placed on CONTRACTOR'S behalf shall include a statement to the effect that CONTRACTOR is an "Equal Opportunity Employer".

7. CONTRACTOR agrees to comply with provisions of Chapter 25.13 of the Dane County Code of Ordinances, which pertains to domestic partnership benefits.

8. CONTRACTOR agrees to furnish all information and reports required by COUNTY'S Contract Compliance Officer as the same relate to affirmative action and nondiscrimination, which may include any books, records, or accounts deemed appropriate to determine compliance with Chapter 19, Dane County Code of Ordinances, and the provisions of this Contract.

9. This Contract is intended to be a Contract solely between the parties hereto and for their benefit only. No part of this Contract shall be construed to add to, supplement, amend, abridge or repeal existing rights, benefits or privileges of any third party or parties including, but not limited to, employees of either of the parties.

10. The entire agreement of the parties is contained herein and this Contract supersedes any and all oral agreements and negotiations between the parties relating to the subject matter hereof. The parties expressly agree that the express terms of this Contract shall not be amended in any fashion except in writing, executed by both parties.

11. CONTRACTOR must be pre-qualified as a Best Value Contractor with Dane County Public Works Solid Waste Division before award of Contract. Subcontractors must be pre-qualified ten (10) business days prior to commencing Work under this Contract.

IN WITNESS WHEREOF, COUNTY and CONTRACTOR, by their respective authorized agents, have caused this Contract and its Schedules to be executed, effective as of the date by which all parties hereto have affixed their respective signatures, as indicated below.

* * * * *

FOR CONTRACTOR:

Signature Date

Printed or Typed Name and Title

Signature Date

Printed or Typed Name and Title

NOTE: If CONTRACTOR is a corporation, Secretary should attest. In accordance with IRS Regulations, unincorporated entities are required to provide either their Social Security or Employer Number in order to receive payment for services rendered.

* * * * *

This Contract is not valid or effectual for any purpose until approved by the appropriate authority designated below, and no work is authorized until the CONTRACTOR has been given notice to proceed by COUNTY'S Assistant Public Works Director.

FOR COUNTY:

Joseph T. Parisi, County Executive Date

Scott McDonell, County Clerk Date

AIA[®] Document A310[™] – 2010

Bid Bond

CONTRACTOR:

(Name, legal status and address)

SURETY:

(Name, legal status and principal place of business)

OWNER:

(Name, legal status and address)

BOND AMOUNT:**PROJECT:**

(Name, location or address, and Project number, if any)

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

The Contractor and Surety are bound to the Owner in the amount set forth above, for the payment of which the Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, as provided herein. The conditions of this Bond are such that if the Owner accepts the bid of the Contractor within the time specified in the bid documents, or within such time period as may be agreed to by the Owner and Contractor, and the Contractor either (1) enters into a contract with the Owner in accordance with the terms of such bid, and gives such bond or bonds as may be specified in the bidding or Contract Documents, with a surety admitted in the jurisdiction of the Project and otherwise acceptable to the Owner, for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof; or (2) pays to the Owner the difference, not to exceed the amount of this Bond, between the amount specified in said bid and such larger amount for which the Owner may in good faith contract with another party to perform the work covered by said bid, then this obligation shall be null and void, otherwise to remain in full force and effect. The Surety hereby waives any notice of an agreement between the Owner and Contractor to extend the time in which the Owner may accept the bid. Waiver of notice by the Surety shall not apply to any extension exceeding sixty (60) days in the aggregate beyond the time for acceptance of bids specified in the bid documents, and the Owner and Contractor shall obtain the Surety's consent for an extension beyond sixty (60) days.

If this Bond is issued in connection with a subcontractor's bid to a Contractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

When this Bond has been furnished to comply with a statutory or other legal requirement in the location of the Project, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

Signed and sealed this _____ day of _____

_____	(Contractor as Principal)	_____	(Seal)
(Witness)		_____	(Title)
		_____	(Surety)
_____		_____	(Seal)
(Witness)		_____	(Title)

CAUTION: You should sign an original AIA Contract Document, on which this text appears in RED. An original assures that changes will not be obscured.

AIA[®] Document A312[™] – 2010

Performance Bond

CONTRACTOR:

(Name, legal status and address)

SURETY:

(Name, legal status and principal place of business)

OWNER:

(Name, legal status and address)

CONSTRUCTION CONTRACT

Date:

Amount:

Description:

(Name and location)

BOND

Date:

(Not earlier than Construction Contract Date)

Amount:

Modifications to this Bond: None See Section 16

CONTRACTOR AS PRINCIPAL

Company: *(Corporate Seal)*

SURETY

Company: *(Corporate Seal)*

Signature: _____

Name _____
and Title: _____

(Any additional signatures appear on the last page of this Performance Bond.)

Signature: _____

Name _____
and Title: _____

(FOR INFORMATION ONLY — Name, address and telephone)

AGENT or BROKER:

OWNER'S REPRESENTATIVE:

(Architect, Engineer or other party:)

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

AIA Document A312–2010 combines two separate bonds, a Performance Bond and a Payment Bond, into one form. This is not a single combined Performance and Payment Bond.

§ 1 The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.

§ 2 If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Section 3.

§ 3 If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond shall arise after

- .1 the Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice shall indicate whether the Owner is requesting a conference among the Owner, Contractor and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Section 3.1 shall be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement shall not waive the Owner's right, if any, subsequently to declare a Contractor Default;
- .2 the Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and
- .3 the Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.

§ 4 Failure on the part of the Owner to comply with the notice requirement in Section 3.1 shall not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.

§ 5 When the Owner has satisfied the conditions of Section 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

§ 5.1 Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;

§ 5.2 Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;

§ 5.3 Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Section 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or

§ 5.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances:

- .1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or
- .2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.

§ 6 If the Surety does not proceed as provided in Section 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Section 5.4, and the Owner refuses the payment or the Surety has denied liability, in whole or in part, without further notice the Owner shall be entitled to enforce any remedy available to the Owner.

§ 7 If the Surety elects to act under Section 5.1, 5.2 or 5.3, then the responsibilities of the Surety to the Owner shall not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety shall not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication, for

- .1 the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
- .2 additional legal, design professional and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Section 5; and
- .3 liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

§ 8 If the Surety elects to act under Section 5.1, 5.3 or 5.4, the Surety's liability is limited to the amount of this Bond.

§ 9 The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors and assigns.

§ 10 The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders and other obligations.

§ 11 Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and shall be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

§ 12 Notice to the Surety, the Owner or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears.

§ 13 When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

§ 14 Definitions

§ 14.1 **Balance of the Contract Price.** The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made, including allowance to the Contractor of any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

§ 14.2 **Construction Contract.** The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.

§ 14.3 **Contractor Default.** Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.

§ 14.4 **Owner Default.** Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

§ 14.5 **Contract Documents.** All the documents that comprise the agreement between the Owner and Contractor.

§ 15 If this Bond is issued for an agreement between a Contractor and subcontractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

§ 16 Modifications to this bond are as follows:

Sample

(Space is provided below for additional signatures of added parties, other than those appearing on the cover page.)

CONTRACTOR AS PRINCIPAL

SURETY

Company: _____

(Corporate Seal)

Company: _____

(Corporate Seal)

Signature: _____
Name and Title: _____
Address _____

Signature: _____
Name and Title: _____
Address _____

CAUTION: You should sign an original AIA Contract Document, on which this text appears in RED. An original assures that changes will not be obscured.



AIA® Document A312™ – 2010

Payment Bond

CONTRACTOR:

(Name, legal status and address)

SURETY:

(Name, legal status and principal place of business)

OWNER:

(Name, legal status and address)

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

AIA Document A312-2010 combines two separate bonds, a Performance Bond and a Payment Bond, into one form. This is not a single combined Performance and Payment Bond.

CONSTRUCTION CONTRACT

Date:

Amount:

Description:

(Name and location)

BOND

Date:

(Not earlier than Construction Contract Date)

Amount:

Modifications to this Bond: None See Section 18

CONTRACTOR AS PRINCIPAL

Company: *(Corporate Seal)*

SURETY

Company: *(Corporate Seal)*

Signature: _____

Name _____
and Title: _____

Signature: _____

Name _____
and Title: _____

(Any additional signatures appear on the last page of this Payment Bond.)

(FOR INFORMATION ONLY — Name, address and telephone)

AGENT or BROKER:**OWNER'S REPRESENTATIVE:**

(Architect, Engineer or other party:)

§ 1 The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner to pay for labor, materials and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.

§ 2 If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies and holds harmless the Owner from claims, demands, liens or suits by any person or entity seeking payment for labor, materials or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.

§ 3 If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond shall arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Section 13) of claims, demands, liens or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials or equipment furnished for use in the performance of the Construction Contract and tendered defense of such claims, demands, liens or suits to the Contractor and the Surety.

§ 4 When the Owner has satisfied the conditions in Section 3, the Surety shall promptly and at the Surety's expense defend, indemnify and hold harmless the Owner against a duly tendered claim, demand, lien or suit.

§ 5 The Surety's obligations to a Claimant under this Bond shall arise after the following:

§ 5.1 Claimants, who do not have a direct contract with the Contractor,

- .1 have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and
- .2 have sent a Claim to the Surety (at the address described in Section 13).

§ 5.2 Claimants, who are employed by or have a direct contract with the Contractor, have sent a Claim to the Surety (at the address described in Section 13).

§ 6 If a notice of non-payment required by Section 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Section 5.1.1.

§ 7 When a Claimant has satisfied the conditions of Sections 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:

§ 7.1 Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and

§ 7.2 Pay or arrange for payment of any undisputed amounts.

§ 7.3 The Surety's failure to discharge its obligations under Section 7.1 or Section 7.2 shall not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Section 7.1 or Section 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

§ 8 The Surety's total obligation shall not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Section 7.3, and the amount of this Bond shall be credited for any payments made in good faith by the Surety.

§ 9 Amounts owed by the Owner to the Contractor under the Construction Contract shall be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfy obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

§ 10 The Surety shall not be liable to the Owner, Claimants or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to, or give notice on behalf of, Claimants or otherwise have any obligations to Claimants under this Bond.

§ 11 The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders and other obligations.

§ 12 No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Section 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

§ 13 Notice and Claims to the Surety, the Owner or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, shall be sufficient compliance as of the date received.

§ 14 When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

§ 15 Upon request by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.

§ 16 Definitions

§ 16.1 Claim. A written statement by the Claimant including at a minimum:

- .1 the name of the Claimant;
- .2 the name of the person for whom the labor was done, or materials or equipment furnished;
- .3 a copy of the agreement or purchase order pursuant to which labor, materials or equipment was furnished for use in the performance of the Construction Contract;
- .4 a brief description of the labor, materials or equipment furnished;
- .5 the date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
- .6 the total amount earned by the Claimant for labor, materials or equipment furnished as of the date of the Claim;
- .7 the total amount of previous payments received by the Claimant; and
- .8 the total amount due and unpaid to the Claimant for labor, materials or equipment furnished as of the date of the Claim.

§ 16.2 Claimant. An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials or equipment were furnished.

§ 16.3 Construction Contract. The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.

§ 16.4 **Owner Default.** Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

§ 16.5 **Contract Documents.** All the documents that comprise the agreement between the Owner and Contractor.

§ 17 If this Bond is issued for an agreement between a Contractor and subcontractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

§ 18 Modifications to this bond are as follows:

(Space is provided below for additional signatures of added parties, other than those appearing on the cover page.)

CONTRACTOR AS PRINCIPAL

Company: _____

(Corporate Seal)

SURETY

Company: _____

(Corporate Seal)

Signature: _____

Name and Title: _____

Address _____

Signature: _____

Name and Title: _____

Address _____

CAUTION: You should sign an original AIA Contract Document, on which this text appears in RED. An original assures that changes will not be obscured.

EQUAL BENEFITS COMPLIANCE PAYMENT CERTIFICATION FORM

PURPOSE

25.13 of the Dane County Ordinance requires that each contractor receiving payment for contracted services must certify that he or she has complied fully with the requirements of Chapter 25.13 "Equal Benefits Requirement" of the Dane County Ordinances. Such certification must be submitted prior to the final payment on the contract.

This form should be included with a copy of the final contract invoice forwarded to your contract representative at Dane County.

CERTIFICATION

I, _____ certify that
Printed or Typed Name and Title

Printed or Typed Name of Contractor

has complied fully with the requirements of Chapter 25.13 of the Dane County Ordinances "Equal Benefits Requirements".

Signed _____

Date _____

For questions on this form, please contact Chuck Hicklin at 608-266-4109 or your contract representative at Dane County.

GENERAL CONDITIONS OF CONTRACT

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1. CONSTRUCTION DOCUMENTS

- A. Construction Documents, listed in Table of Contents of this Specification volume shall form part of this Contract and provisions of Construction Documents shall be as binding upon parties as if they were fully set forth in Contract itself.
- B. These shall also be considered as part of Construction Documents: Addenda, including additions and modifications incorporated in such addenda before execution of Contract; requests for information; construction bulletins; change orders; and written interpretations by Architect / Engineer or Public Works Project Manager that are made after execution of Contract.
- C. Construction Documents are complementary, and what is required by one shall be as binding as if required by all. Intent of Construction Documents is to include all labor, materials and equipment necessary for proper execution of the Work.

2. DEFINITIONS

- A. These terms as used in this Contract are respectively defined as follows:
 - 1. All uses of term “County” in Construction Documents shall mean Dane County.
 - 2. All uses of term “Department” in Construction Documents shall mean Department of Public Works, Highway & Transportation, which is a unit of Dane County government. Department is County agency overseeing Contract with Contractor.
 - 3. Public Works Project Manager is appointed by and responsible to Department. Public Works Project Manager has authority to act on behalf of Department and will sign change orders, payment requests and other administrative matters related to projects.
 - 4. Public Works Project Manager is responsible for supervision, administration and management of field operations involved in construction phase of this Work.
 - 5. Term “Work” includes all labor, equipment and materials necessary to produce project required by Construction Documents.
 - 6. Term “Substantial Completion” is date when project or specified area of project is certified by Architect / Engineer that construction is sufficiently completed, in accordance with Construction Documents, and as modified by any subsequent changes agreed to by parties, so that County may occupy project or specified area of project for use for which it was intended subject to permit approval for occupancy.
 - 7. Contractor is person, firm, or corporation with whom County makes Contract. Though multiple contracts may be involved, Construction Documents treat them throughout as if each were of singular number.

3. ADDITIONAL INSTRUCTIONS AND DRAWINGS

- A. Contractor may be furnished additional instructions and detail drawings as necessary to carry out the Work included in Contract. Additional drawings and instructions thus supplied to Contractor will coordinate with Construction Documents and will be so prepared that they can be reasonably interpreted as part thereof. Contractor shall carry out the Work in accordance with additional detail drawings and instructions.

4. SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- A. Unless otherwise specified, Contractor shall submit three (3) copies of all Shop Drawings for each submission, until receiving final approval. After final approval, provide five (5) additional copies for distribution and such other copies as may be required.

- B. Contractor shall submit, on an on-going basis and as directed, Product Data such as brochures that shall contain catalog cuts and specifications of all furnished mechanical and electrical equipment. After Architect / Engineer's approval, one (1) copy shall remain in Architect / Engineer's file, one (1) kept at Department's office and one (1) kept at job site by Contractor for reference purposes.
- C. Samples shall consist of physical examples furnished by Contractor in sufficient size and quantity to illustrate materials, equipment or workmanship, and to establish standards to compare the Work.
 - 1. Submit Samples in sufficient quantity (minimum of two (2)) to permit Architect / Engineer to make all necessary tests and of adequate size showing quality, type, color range, finish, and texture. Label each Sample stating material, type, color, thickness, size, project name, and Contractor's name.
 - 2. Submit transmittal letter requesting approval, and prepay transportation charges to Architect / Engineer's office on samples forwarded.
 - 3. Materials installed shall match approved Samples.
- D. Contractor shall review Shop Drawings and place their dated stamp thereon to evidence their review and approval and shall submit with reasonable promptness and in orderly sequence to cause no delay in the Work or in work of any other contractor. At time of submission, Contractor shall inform Architect / Engineer in writing of any deviation in Shop Drawings or Samples from requirements of Construction Documents. Architect / Engineer will not consider partial lists.
- E. Architect / Engineer will review and approve or reject Shop Drawings with reasonable promptness to cause no delay. Architect / Engineer's approval shall not relieve Contractor from responsibility for errors or omissions in Shop Drawings.
- F. Contractor shall not commence any work requiring Shop Drawing, Product Data or Sample submission until Architect / Engineer has approved submission. All such work shall be in accordance with approved Shop Drawings, Product Data and Samples.
- G. Contractor shall keep on site of the Work, approved or conformed copy of Shop Drawings and shall at all times give Department access thereto.
- H. By stamping and submitting Shop Drawings, Product Data and Samples, Contractor thereby represents that he or she has or will determine and verify all field measurements, field construction criteria, materials, catalog numbers, and similar data and that he or she has checked and coordinated each Shop Drawing, Product Data and Sample with requirements of the Work and of Construction Documents. Architect / Engineer shall return without examination, Shop Drawings, Product Data and Samples not so noted.
- I. All Shop Drawings from any one Contractor should be numbered consecutively and on cover sheet shall bear name and location of project, name of Contractor, date of submittal and date of each correction or revision and associated Specification section and page number.

5. CUTTING AND PATCHING

- A. Contractor shall be responsible for all cutting, fitting or patching required to complete the Work or to make its parts fit together properly.

- B. Contractor shall not damage or endanger portion of the Work or fully or partially completed construction of County or separate contractors by cutting, patching or otherwise altering such construction, or by excavation. Contractor shall not cut or otherwise alter such construction by County or separate contractor except with written consent of County and of such separate contractor; such consent shall not be unreasonably withheld. Contractor shall not withhold unreasonably from County or separate contractor, Contractor's consent to cutting or otherwise altering the Work.

6. CLEANING UP

- A. Contractor shall keep premises and surrounding area free from accumulation of waste materials or rubbish caused by operations under Contract. Contractor shall remove from and about the Work waste materials, rubbish, Contractor's tools, construction equipment, machinery, and surplus materials at completion of the Work. Contractor shall maintain streets and sidewalks around the Work site in clean condition. Contractor shall remove all spillage and prevent tracking of spillage arising from performance of the Work, into, out of, and within the Work site. Contractor shall establish regular maintenance program of sweeping, vacuuming and / or hosing to minimize accumulation of dirt and dust upon such areas.
- B. If Contractor fails to clean up as directed in Construction Documents, County may do so and shall charge Contractor cost thereof.
- C. Contractor shall be responsible for broken windows and glass, and at completion of the Work shall replace such damaged or broken windows and glass. After replacing damaged or broken windows and glass, Contractor shall remove all labels, wash and polish both sides of all windows and glass.
- D. In addition to general cleaning (sweeping, vacuuming and / or hosing, as is appropriate to work surface), Contractor shall perform following final cleaning for all trades at completion of the Work:
 - 1. Remove temporary protections;
 - 2. Remove marks, stains, fingerprints and other soil or dirt from painted, decorated and finished woodwork and wall surfaces;
 - 3. Remove spots, plaster, soil and paint from ceramic tile, marble and other finished materials, and wash or wipe clean;
 - 4. Clean fixtures, cabinet work and equipment, removing stains, paint, dirt and dust, and leave same in undamaged, new condition;
 - 5. Clean aluminum in accordance with recommendations of manufacturer; and
 - 6. Clean resilient floors thoroughly with well-rinsed mop containing only enough moisture to clean off any surface dirt or dust and buff dry by machine to bring surfaces to sheen.

7. USE OF SITE

- A. Contractor shall provide County and Architect / Engineer access to the Work under all circumstances.
- B. Contractor shall confine operations at site to areas permitted by County, law, ordinance, permits and Construction Documents and shall not unreasonably encumber site with materials or equipment. Contractor shall assure free, convenient, unencumbered, direct and safe access to all properties adjacent to the Work for County, its employees, invitees and guests.

8. MATERIALS AND WORKMANSHIP

- A. Contractor shall perform all work and furnish all supplies and materials, machinery, equipment, facilities and means, necessary to complete the Work required by this Contract, within time specified, in accordance with provisions of Construction Documents.
- B. All equipment and materials incorporated in the Work covered by this Contract are to be new; use recycled and / or recovered materials to extent that such use is technically and economically feasible. Recovered materials are products recovered from solid waste in form identical to original form for use that is same as, or similar to original use. Recycled materials are products manufactured from solid waste.
- C. If requested, Contractor shall furnish satisfactory evidence as to kind and quality of construction materials proposed or used. Contractor shall furnish to Architect / Engineer, for approval, manufacturer name and model, performance capacities and other pertinent information of machinery, mechanical, electrical or other types of equipment, which Contractor plans to install.
- D. If not otherwise provided, materials and labor called for in this Contract shall be provided and performed in accordance with established practice and standards recognized by Architects, Engineers, Department, and construction industry.
- E. Reference to “Standard” specifications of any association or manufacturer, or codes of County authorities, intends most recent printed edition or catalog in effect on date that corresponds with date of Construction Documents.
- F. Whenever reference is made in Specifications that work shall be “performed”, “applied”, in accordance with “manufacturer’s directions or instructions”, Contractor to whom those instructions are directed shall furnish three (3) printed copies of such instructions to Architect / Engineer before execution of the Work.

9. CONTRACTOR’S TITLE TO MATERIALS

- A. Contractor or any subcontractor shall not purchase materials or supplies for the Work subject to any chattel mortgage or under conditional sale contract or other agreement by which seller retains interest. Contractor warrants that all materials and supplies used in the Work are free from all liens, claims or encumbrances and Contractor has good title to them.

10. “OR EQUAL” CLAUSE

- A. Whenever equipment or materials are identified on Drawings or in Specifications by reference to manufacturer’s or vendor’s name, trade name, catalog number, and other identifying information, it is intended to establish standards; and any equipment or material of other manufacturers and vendors which will perform adequately duties imposed by general design will be considered equally accepted provided equipment or material so proposed is, in opinion of Architect / Engineer, of equal substance and function. Architect / Engineer and Department shall provide written approval before Contractor may purchase or install it.
- B. Equipment or materials of manufacturers, other than those named, may be used only upon following conditions:
 - 1. That, in opinion of Architect / Engineer and Department, proposed material or equipment item is fully equal or superior (in design, materials, construction, workmanship,

- performance, finish, etc.) to named item. No compromise in quality level, however small, is acceptable.
2. That, in substituting materials or equipment, Contractor assumes responsibility for any changes in system or for modifications required in adjacent or related work to accommodate such substitution despite Architect / Engineer's and Department's approval, and all costs growing out of approval of "or equal" items shall be responsibility of Contractor. No extra costs resulting from such approval shall become responsibility of Department, Architect / Engineer or any other separate Contractor.
 3. It shall be understood that use of materials or equipment other than those specified, or approved equal by Architect / Engineer and Department, shall constitute violation of Contract, and that Architect / Engineer and Department shall have right to require removal of such materials or equipment and their replacement with specified materials or equipment at Contractor's expense.
 4. Product and manufacturer named first in Specifications or on information shown on Drawings is basis of selection of manufactured items and equipment, particularly mechanical equipment. In using other than first named products or manufacturers, including those specified as additionally approved or acceptable, Contractor assumes responsibility for any changes in system and for modifications in any work required to accommodate them. Architect / Engineer's approval of such additionally acceptable products or manufacturers, either in Specifications or in Addendum, does not relieve Contractor from obligation to coordinate such optional products with other Contractors, whose work may be affected by them, and to pay all additional costs resulting from their inclusion into the Work. Contractor's liability shall include payment of Architect / Engineer's fees for any additional services made necessary by or directly connected to such product changes. No extra costs resulting from such changes shall become responsibility of Department, Architect / Engineer or any other separate Contractor.
- C. No request for approval of "or equal" materials will be entertained except from Contractor. Identify any request for substitution as substitution on Contractor's letter of transmittal and give reasons for substitution. Department may in its sole discretion allow substitutions of materials.

11. PATENTS AND ROYALTIES

- A. If Contractor uses any design, device or material covered by letters, patent or copyright, it is mutually agreed and understood, that, without exception, contract prices shall include all royalties or costs arising from use of such design, device or materials, in any way involved in the Work.
- B. Contractor shall indemnify and save harmless County from any and all claims for infringement by reason of use of such patent or copyright in connection with the Work agreed to be performed under this Contract, and shall indemnify County for any cost, expense or damage which it may be obliged to pay by reason of such infringement at any time during prosecution of the Work or after completion of the Work.

12. SURVEYS, PERMITS, REGULATIONS AND TAXES

- A. Department will furnish to Contractor all site, topography and property surveys necessary for execution of the Work.
- B. Contractor shall procure all permits, licenses and approvals necessary for execution of this Contract.

- C. Contractor shall give all notices and comply with all State of Wisconsin, Federal and local laws, codes, rules and regulations relating to performance of the Work, protection of adjacent property, and maintenance of passageways, guard fences or other protective facilities.
- D. Contractor shall pay all Sales, Consumer, Use and other similar taxes required by law.
- E. Contractor shall promptly notify Architect / Engineer of any variances of Drawings or Specifications with that of any State of Wisconsin, federal or local law, code, rule or regulation. Upon such notification, Architect / Engineer will require correction of variance to comply with applicable law, code, rule or regulation at no additional cost to Contractor.
- F. Work under this Contract shall comply with all applicable State of Wisconsin, Federal and local laws, codes and regulations.
- G. Contractor shall pay charges for water, sewer and other utility connections made by municipalities where required by Specifications.

13. CONTRACTOR'S OBLIGATIONS AND SUPERINTENDENCE

- A. Contractor shall provide and pay for all materials, labor, tools, equipment, transportation and superintendence necessary to execute, complete and deliver the Work within specified time. Contractor agrees to secure at their own expense all personnel necessary to carry out the Work. Such personnel shall not be deemed County employees nor shall they have or be deemed to have any direct contractual relationship with County.
- B. Performance of any work necessary after regular working hours, on Sundays or Legal Holidays shall be without additional expense to County. Performance of any work at site at other than normal working hours must be coordinated with Public Works Project Manager.
- C. Contractor shall furnish, erect, maintain and remove such temporary works as may be required.
- D. Contractor shall observe, comply with, and be subject to all terms, conditions, requirements and limitations of Construction Documents.
- E. At the Work site, Contractor shall give personal superintendence to the Work or shall employ construction superintendent or foreman, experienced in character of work covered by Contract, who shall have full authority to act for Contractor. Understand that such superintendent or foreman shall be acceptable to Architect / Engineer and Department.
- F. Remove from project or take other corrective action upon notice from Architect / Engineer or Department for Contractor's employees whose work is considered by Architect / Engineer or Department to be unsatisfactory, careless, incompetent, unskilled or otherwise objectionable.
- G. Contractor and subcontractors shall be required to conform to Labor Laws of State of Wisconsin and various acts amendatory and supplementary thereto and to other laws, ordinances and legal requirements applicable to the Work.
- H. Presence and observation of the Work by Architect / Engineer or Public Works Project Manager shall not relieve Contractor of any obligations.

14. WEATHER CONDITIONS

- A. In event of temporary suspension of work, or during inclement weather, or whenever Architect / Engineer shall direct, Contractor shall, and shall cause subcontractors to protect carefully all work and materials against damage or injury from weather. If, in opinion of Architect / Engineer or Department, any work or materials that have been damaged or injured due to failure on part of Contractor or any subcontractors so to protect the Work, such materials shall be removed and replaced at expense of Contractor.

15. PROTECTION OF WORK AND PROPERTY

- A. Contractor shall at all times safely guard County's property from injury or loss in connection with this Contract. Contractor shall at all times safely guard and protect the Work, and adjacent property, from damage. Contractor shall replace or make good any such damage, loss or injury unless such is caused directly by errors contained in Contract, or by County, or County's duly authorized representative.
- B. Contractor may act diligently, without previous instructions from Architect / Engineer and / or Department, in emergency that threatens loss or injury of property, or safety of life. Contractor shall notify Architect / Engineer and / or Department immediately thereafter. Promptly submit any claim for compensation by Contractor due to such extra work to Architect / Engineer and / or Department for approval as provided for in Article 18 herein.

16. INSPECTION AND TESTING OF MATERIALS

- A. Authorized representatives and agents of County government shall have access at all times to the Work wherever it is in preparation or progress and Contractor shall provide facilities for such access and for inspection.
- B. Should it be considered necessary or advisable at any time before final acceptance of the Work to make examination of work already completed, by removing or tearing out same, Contractor shall upon request, promptly furnish all necessary facilities, labor and materials. If such work is found to be defective in any aspect, due to fault of Contractor or subcontractors thereof, Contractor shall assume all expenses of such examination and of satisfactory reconstruction. Contractor will be reimbursed for such examination and replacement in accordance with Article 18 - A.3., of these General Conditions of Contract if such work is found to meet requirements of Contract.
- C. If Specifications, Architect / Engineer's, or Public Works Project Manager's instructions require any work to be specially tested or approved, Contractor shall give Architect / Engineer and Public Works Project Manager timely notice of its readiness for testing or inspection. Test all materials and equipment requiring testing in accordance with accepted or specified standards, as applicable. Architect / Engineer shall recommend laboratory or inspection agency and Department will select and pay for all initial laboratory inspection services. Should retesting be required, due to failure of initial testing, cost of such retesting shall be borne by Contractor.
- D. Cost of any testing performed by manufacturers or Contractor for substantiating acceptability of proposed substitution of materials and equipment, or necessary conformance testing in conjunction with manufacturing processes or factory assemblage, shall be borne by Contractor or manufacturer responsible.

17. REPORTS, RECORDS AND DATA

- A. Contractor shall submit to Architect / Engineer and Public Works Project Manager such schedule of quantities and costs, progress schedules, payrolls, reports, estimates, invoices, records and other data as either may request concerning work performed or to be performed under this Contract.

18. CHANGES IN THE WORK

- A. Make no changes, except in cases of emergency, in the Work covered by approved Construction Documents without having prior written approval of Department. Charges or credits for the Work covered by approved change shall be determined by one of these methods:
1. Unit bid prices previously approved.
 2. Agreed lump sum based on actual cost of:
 - a) Labor, including foremen, and all fringe benefits that are associated with their wages.
 - b) Materials entering permanently into the Work.
 - c) Ownership or rental cost of construction tools and equipment during time of use on extra work.
 - d) Power and consumable supplies for operation of power equipment.
 - e) Workmen's Compensation Insurance, Contractor's Public Liability and Property Damage Insurance, and Comprehensive Automobile Liability Insurance.
 - f) Social Security and old age and unemployment contributions.
 - g) Add to cost under (2), fixed fee to be agreed upon, but not to exceed fifteen percent (15%) of actual cost of work performed with their own labor force. Fee shall be compensation to cover cost of supervision, overhead, bond, profit and any other general expense.
 - h) On that portion of the Work under (2) done under subcontract, Contractor may include not over seven and one-half percent (7½%) for supervision, overhead, bond, profit and any other general expense.
 - i) Department may require correct amount of costs with supporting vouchers; Contractor shall keep and present in such form as directed.
 3. Cost-plus work, with not-to-exceed dollar limit, based on actual cost of:
 - a) Labor, including foremen, and all fringe benefits that are associated with their wages.
 - b) Materials entering permanently into the Work.
 - c) Ownership or rental cost of construction tools and equipment during time of use on extra work. Rental cost cannot exceed fifty percent (50%) replacement value of rented equipment.
 - d) Power and consumable supplies for operation of power equipment.
 - e) Workmen's Compensation Insurance, Contractor's Public Liability and Property Damage Insurance, and Comprehensive Automobile Liability Insurance.
 - f) Social Security and old age and unemployment contributions.
 - g) To cost under (3), there shall be added fixed fee to be agreed upon but not to exceed fifteen percent (15%) of actual cost of work performed with their own labor force. Fee shall be compensation to cover cost of supervision, overhead, bond, profit, and any other general expense.
 - h) On that portion of the Work under (3) done under subcontract, Contractor may include not over seven and one-half percent (7½%) for supervision, overhead, bond, profit, and any other general expense.
 - i) Contractor shall keep and present, in such form as directed, correct amount of cost together with such supporting vouchers as may be required by Department.

- B. If Contractor claims that by any instructions given by Architect / Engineer, Department, by drawings or otherwise, regarding performance of the Work or furnishing of material under Contract, involves extra cost, Contractor shall give Department written notice of cost thereof within two (2) weeks after receipt of such instructions and in any event before proceeding to execute work, unless delay in executing work would endanger life or property.
- C. No claim for extra work or cost shall be allowed unless it was done in pursuance of written Change Order from Architect / Engineer and approved by Department, as previously mentioned, and claim presented with payment request submitted after changed or extra work is completed.
- D. Negotiation of cost for change in the Work shall not be cause for Contractor to delay prosecution of the Work if Contractor has been authorized in writing by Public Works Project Manager to proceed.

19. EXTRAS

- A. Without invalidating Contract, Department may order extra work or make changes by altering, adding to or deducting from the Work, contract sum being adjusted in accordance with Article 18 herein.

20. TIME FOR COMPLETION

- A. Contractor agrees that the Work shall be prosecuted regularly and diligently and complete the Work as stated in Construction Documents.

21. CORRECTION OF WORK

- A. All work, all materials whether incorporated in the Work or not, and all processes of manufacture shall at all times and places be subject to inspection of Architect / Engineer and Public Works Project Manager who shall be judge of quality and suitability of the Work, materials, and processes of manufacture for purposes for which they are used. Should they fail to meet Architect / Engineer's and Public Works Project Manager's approval they shall be reconstructed, made good, replaced or corrected, by Contractor at Contractor's expense. Immediately remove all rejected material from site.
- B. If Contractor defaults or neglects to carry out the Work in accordance with Construction Documents or fails to perform any provision of Contract, Department may, after ten (10) business days' written notice to Contractor and without prejudice to any other remedy County may have, make good such deficiencies. In such case, appropriate Change Order shall be issued deducting from Contractor's payments then or thereafter, cost of correcting such deficiencies, including cost of Architect / Engineer's additional services made necessary by such default, neglect or failure.

22. SUBSURFACE CONDITIONS FOUND DIFFERENT

- A. If Contractor encounters subsurface or latent conditions at site materially differing from those shown on Drawings or indicated in Specifications, Contractor shall immediately give notice to Architect / Engineer and Public Works Project Manager of such conditions before they are disturbed. Architect / Engineer will thereupon promptly investigate conditions, and if Architect / Engineer finds that they materially differ from those shown on Drawings or indicated in Specifications, Architect / Engineer will at once make such changes as necessary,

any increase or decrease of cost resulting from such changes to be adjusted in manner provided in above Article 18 entitled "Changes in the Work".

23. RIGHT OF DEPARTMENT TO TERMINATE CONTRACT

- A. In event that any provisions of this Contract are violated by Contractor or by any subcontractors, County may serve written notice upon Contractor and Surety of its intention to terminate Contract, such notice to contain reasons for such intention to terminate Contract, and unless within ten (10) business days after serving of such notice upon Contractor, such violation or delay shall cease and satisfactory arrangement or correction be made, Contract shall, upon expiration of said ten (10) business days, cease and terminate.
- B. In event of any such termination, County shall immediately serve notice thereof upon Surety and Contractor, and Surety shall have right to take over and perform Contract subject to County's approval; provided, however, that if Surety does not commence performance thereof within ten (10) business days from date of mailing to such Surety of notice of termination, County may take over the Work and prosecute same to completion by contract, or by force account, at expense of Contractor; Contractor and Surety shall be liable to County for any excess cost occasioned County thereby, and in such event County may take possession of and utilize in completing the Work, such materials and equipment as may be on the Work site and therefore necessary.

24. CONSTRUCTION SCHEDULE AND PERIODIC ESTIMATES

- A. Contractor shall be responsible for Construction Schedule and coordination. Immediately after execution and delivery of Contract and before making first payment, Contractor shall notify all subcontractors to furnish all required information to develop Construction Schedule. Contractor and all subcontractors associated with the Work shall furnish following information from each Division of Specifications:
 - 1. List of construction activities;
 - 2. Start, finish and time required for completion of each activity;
 - 3. Sequential relationships between activities;
 - 4. Identify all long lead-time items, key events, meetings or activities such as required submittals, fabrication and delivery, procurement of materials, installation and testing;
 - 5. Weekly definition of extent of work and areas of activity for each trade or Subcontract; and
 - 6. Other information as determined by Public Works Project Manager.
- B. In addition to above requested items, Contractor shall request delivery dates for all County-furnished equipment, materials or labor. This shall include any work handled by Department under separate contracts such as asbestos abatement, air and water balancing, etc. Indicate on Construction Schedule these associated delivery and installation dates.
- C. Progress Reporting:
 - 1. Contractor shall update and publish Construction Schedule on monthly basis. Revisions to Schedule shall be by Contractor and made in same detail as original Schedule and accompanied by explanation of reasons for revision; and shall be subject to approval by Department.
 - 2. Failure of Contractor to keep Schedule in updated format shall result in County hiring firm specializing in construction schedule development and deducting those costs associated with updating process from payments due Contractor.
 - 3. Contractor shall submit show actual percentage of each activity completed, estimated future progress, and anticipated completion time.

- D. Responsibility for timely completion requires:
1. Contractor and subcontractors understand that performance of each is interdependent upon performance of others.
 2. Whenever it becomes apparent from current schedule, that phasing or progress completion dates will not be met, Contractor must take some or all following actions at no additional cost to County:
 - a) Increase construction labor in such quantities and crafts as will eliminate backlog of work.
 - b) Increase number of working hours per shift, shifts per working day, working days per week, amount of construction equipment, or any combination of foregoing to eliminate backlog of work.
 - c) Reschedule work (yet remain in conformance with Drawings and Specifications).
 3. Prior to proceeding with any of above actions, Contractor shall notify Public Works Project Manager.
- E. Maintain current Construction Schedule at all times. Revise Construction Schedule in same detail as original and accompany with explanation of reasons for revision. Schedule shall be subject to approval by Architect / Engineer and Public Works Project Manager.

25. PAYMENTS TO CONTRACTOR

- A. Contractor shall provide:
1. Detailed estimate giving complete breakdown of contract price by Specification Division; and
 2. Periodic itemized estimates of work done for purpose of making partial payments thereon.
- B. Submit these estimates for approval first to Architect / Engineer, then to Public Works Project Manager. Costs employed in making up any of these schedules are for determining basis of partial payments and not considered as fixing basis for additions to or deductions from Contract price.
- C. County will make partial payments to Contractor for value, proportionate to amount of Contract, of all labor and material incorporated in the Work during preceding calendar month upon receipt of Application and Certificate for Payment form from Architect / Engineer and approval of Department.
- D. Contractor shall submit for approval first to Architect / Engineer, and then to Public Works Project Manager all Application and Certificate for Payment forms. If requested, Application and Certificate for Payment shall be supported by such additional evidence as may be required, showing Contractor's right to payment claimed.
- E. Application and Certificate for Payment for preparatory work and materials delivered and suitably stored at site to be incorporated into the Work at some future period, will be given due consideration. Requesting payment for materials stored off site, may be rejected, however, if deemed essential for reasons of job progress, protection, or other sufficient cause, requests will be considered, conditional upon submission by Contractor of bills of sale, photographs and such other procedures as will adequately protect County's interest such as storage in bonded warehouse with adequate coverage. If there is any error in payment, Contractor is obligated to notify Department immediately, but no longer than ten (10) business days from receipt of payment.

- F. Payments by County will be due within forty-five (45) business days after receipt by Department of Application and Certificate for Payment.
- G. County will retain five percent (5%) of each Application and Certificate for Payment until final completion and acceptance of all the Work covered by Contract. However, anytime after fifty percent (50%) of the Work has been furnished and installed at site, County will make remaining payments in full if Architect / Engineer and Public Works Project Manager find that progress of the Work corresponds with Construction Schedule. If Architect / Engineer and Public Works Project Manager find that progress of the Work does not correspond with Construction Schedule, County may retain up to ten percent (10%) of each Application and Certificate for Payment for the Work completed.
- H. All material and work covered by partial payments made shall become sole property of County, but this provision shall not be construed as relieving Contractor from sole responsibility for care and protection of materials and work upon which payments have been made, or restoration of any damaged work, or as waiver of right of County to require fulfillment of all of terms of Contract.
- I. County will make final payment within sixty (60) calendar days after final completion of the Work, and will constitute acceptance thereof. Submit Equal Benefits Compliance Payment Certification with final pay request. Payment may be denied if Certification is not included.
- J. County may make payment in full, including retained percentages and less authorized deductions, upon completion and acceptance of each Division where price is stated separately in Contract.
- K. Every contractor engaged in performance of any contract for Department of Public Works, Highway & Transportation shall submit to this Department, as requested and with final application for payment for work under said contract, affidavit(s) as required to prove that all debts and claims against this Work are paid in full or otherwise satisfied, and give final evidence of release of all liens against the Work and County. Use "Dane County, Wisconsin Contractor Wage Affidavit" form included in Supplementary Conditions.

26. WITHHOLDING OF PAYMENTS

- A. County, after having served written notice on said Contractor, may either pay directly any unpaid bills of which Department has written notice, or withhold from Contractor's unpaid compensation sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged; whereupon, payment to Contractor shall be resumed in accordance with terms of this Contract, but in no event shall these provisions be construed to impose any obligations upon County to either Contractor or Contractor's Surety.
- B. In paying any unpaid bills of Contractor, County shall be deemed agent of Contractor, and any payment so made by County, shall be considered as payment made under Contract by County to Contractor and County shall not be liable to Contractor for any such payment made in good faith.
- C. Contractor shall indemnify, hold harmless and defend Dane County, its boards, commissions, agencies, officers, employees and representatives from all claims growing out of lawful demands of subcontractors, laborers, workers, mechanics, material men, and furnishers of machinery and parts thereof, equipment, power tools, and all supplies, including commissary, incurred in performance of this Contract.

- D. At Department's request, Contractor shall furnish satisfactory evidence that all obligations of nature designated above have been paid, discharged or waived.

27. ACCEPTANCE OF FINAL PAYMENT AS RELEASE

- A. Making of final payment shall constitute waiver of all claims by County except those arising from:
1. Unsettled lien;
 2. Faulty or defective work appearing after substantial completion;
 3. Failure of the Work to comply with requirements of Construction Documents; or
 4. Terms of any special guarantees required by Construction Documents.
- B. Acceptance of final payment shall constitute waiver of all claims by Contractor.

28. PAYMENTS BY CONTRACTOR

- A. Contractor shall pay following not later than fifth (5th) business day following each payment received from County:
1. All transportation and utility services rendered;
 2. All materials, tools, and other expendable equipment that have been delivered at site of the Work to extent of ninety percent (90%) of cost thereof, and balance of cost thereof when said balance is paid to Contractor; and
 3. Each subcontractor, respective amount allowed Contractor because of work performed by subcontractor to extent of subcontractor's interest therein.

29. CONTRACT SECURITY

- A. Contractor shall furnish Performance and Payment Bonds in amount at least equal to one hundred percent (100%) of Contract price as security for faithful performance of this Contract and payment of all persons performing labor on project under this Contract and furnishing materials in connection with this Contract.
- B. Sample Performance and Payment Bonds that Contractor will be required to execute is bound into these Construction Documents. Before construction Contract is consummated, completed Performance and Payment Bonds must be approved by Department.

30. ASSIGNMENTS

- A. Contractor shall not assign whole or any part of this Contract or any moneys due or to become due hereunder without written consent of Department. In case Contractor assigns all or any part of any moneys due or to become due under this Contract, instrument of assignment shall contain clause substantially to effect that it is agreed that right of assignee in and to any moneys due or to become due to Contractor shall be subject to prior claims of all persons, firms and corporations for services rendered or materials supplied for performance of the Work called for in this Contract.

31. MUTUAL RESPONSIBILITY OF CONTRACTORS

- A. If, through acts of neglect on part of Contractor or any subcontractor shall suffer loss or damage on the Work, Contractor agrees to settle with such subcontractor by agreement or arbitration if such other subcontractor will so settle. If such subcontractor shall assert any claim against County on account of any damage alleged to have been sustained, Department shall notify Contractor, who shall indemnify, hold harmless and defend Dane County, its boards, commissions, agencies, officers, employees and representatives against any such claim.

32. SEPARATE CONTRACTS

- A. Department may award other contracts for the Work and all Contractors shall fully cooperate with each other and carefully adjust their work to that provided under other contracts as may be directed by Department. No Contractor shall commit or permit any act that will interfere with performance of the Work by any other Contractor.
- B. Contractor shall coordinate the Work with those of other Contractors. Cooperation will be required in arrangement for storage of materials and in detailed execution of the Work. Contractor, including subcontractors, shall keep informed of progress and detail work of others and shall notify Architect / Engineer or Department immediately of lack of progress or defective workmanship on part of others. Failure of Contractor to keep informed of the Work progressing on site and failure to give notice of lack of progress or defective workmanship by others shall be construed as acceptance by Contractor of status of the Work as being satisfactory for proper coordination with Contractor's own work.

33. SUBCONTRACTS

- A. Contractor may use services of specialty subcontractors on those parts of the Work that, under normal contracting practices, are performed by specialty subcontractors.
- B. Contractor shall not award any work to any subcontractor without prior approval of Department. Qualifications of subcontractors shall be same as qualifications of Contractor. Request for subcontractor approval shall be submitted to Department fifteen (15) business days before start of subcontractor's work. If subcontractors are changed or added, Contractor shall notify Department in writing.
- C. Contractor shall be as fully responsible to County for acts and omissions of subcontractors, and of persons either directly or indirectly employed by them, as Contractor is for acts and omissions of persons directly employed by Contractor.
- D. Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the Work to bind subcontractors to Contractor by terms of General Conditions of Contract and other Construction Documents insofar as applicable to work of subcontractors and to give Contractor same power as regards terminating any subcontract that Department may exercise over Contractor under any provision of Construction Documents.
- E. Nothing contained in this Contract shall create any contractual relation between any subcontractor and County.
- F. Contractor shall insert in all subcontracts, Articles 26, 33, 43 and 45, respectively entitled: "Withholding of Payments", "Subcontracts", "Affirmative Action Provision and Minority /

Women / Disadvantaged Business Enterprises”, and “Minimum Wages”, and shall further require all subcontractors to incorporate physically these same Articles in all subcontracts.

34. PUBLIC WORKS PROJECT MANAGER’S AUTHORITY

- A. Public Works Project Manager shall:
 - 1. Administer and ensure compliance with Construction Documents;
 - 2. Provide responsible on-site observations of construction and have authority to request work and to stop work whenever necessary to insure proper enforcement of Construction Documents;
 - 3. Convene and chair project meetings and foreman’s coordination meetings when necessary to coordinate resolution of conflicts between Contractors, Architects, Engineers, Consultants, and Department; and
 - 4. Check and inspect material, equipment and installation procedures of all trades for proper workmanship and for compliance with Drawings, Specifications and Shop Drawings, permit no material on project site that is not satisfactory and reject work not in compliance with Construction Documents.

35. ARCHITECT / ENGINEER’S AUTHORITY

- A. Architect / Engineer is retained by, and is responsible to Department acting for County.
- B. Architect / Engineer shall determine amount, quality, acceptability, and fitness of several kinds of work and materials that are provided under this Contract and shall decide all questions that may arise in relation to said work and construction thereof.
- C. Architect / Engineer shall decide meaning and intent of any portion of Specifications and of any Drawings where they may be found obscure or be in dispute.
- D. Architect / Engineer shall provide responsible observation of construction. Architect / Engineer has authority to stop the Work whenever such stoppage may be necessary to insure proper execution of Construction Documents.
- E. Architect / Engineer shall be interpreter of conditions of Construction Documents and judge of its performance.
- F. Within reasonable time, Architect / Engineer shall make decisions on all matters relating to progress of the Work or interpretation of Construction Documents.
- G. Architect / Engineer’s decisions are subject to review by Public Works Project Manager.

36. STATED ALLOWANCES

- A. Stated allowances enumerated in Instructions to Bidders shall cover net cost of materials or equipment, and all applicable taxes. Contractor’s cost of delivery and unloading at site, handling costs on site, labor, installation costs, overhead, profit and any other incidental costs shall be included in Contractor’s bid, but not as part of cash allowance.
- B. Department will solicit at least two (2) bids on materials or equipment for which allowance is stated and select on basis of lowest qualified responsible bid. Contractor will then be instructed to purchase “Allowed Materials”. If actual price for purchasing “Allowed Materials”, including taxes, is more or less than “Cash Allowance”, Contract price shall be

adjusted accordingly. Adjustment in Contract price shall not contain any cost items excluded from cash allowance.

37. ESTIMATES OF QUANTITIES

- A. Whenever estimated quantities of work to be done and materials to be furnished under this Contract are shown in any of Construction Documents, they are given for use in comparing bids and right is especially reserved to increase or diminish them as they may be deemed reasonably necessary or desirable by Department to complete the Work included in this Contract, and cost for such increase or diminution shall be adjusted in manner provided for in General Conditions of Contract Article 18 entitled "Changes in the Work".

38. LANDS AND RIGHTS-OF-WAY

- A. Prior to start of construction, County shall furnish all land and rights-of-way necessary for carrying out and completion of the Work to be performed under this Contract.

39. GENERAL GUARANTEE

- A. Neither final certificate of payment nor any provision in Construction Documents nor partial or entire occupancy of premises by County shall constitute acceptance of work not done in accordance with Construction Documents or relieve Contractor of liability in respect to any expressed warranties or responsibility for faulty materials or workmanship.
 - 1. In no event shall making of any payment required by Contract constitute or be construed as waiver by County of any breach of covenants of Contract or waiver of any default of Contractor and making of any such payment by County while any such default or breach shall exist shall in no way impair or prejudice right of County with respect to recovery of damages or other remedy as result of such breach or default.
- B. Contractor shall remedy and make good all defective workmanship and materials and pay for any damage to other work resulting there from, which appear within period of one (1) year from date of substantial completion, providing such defects are not clearly due to abuse or misuse by County. Department will give notice of observed defects with reasonable promptness.
- C. Guarantee on work executed after certified date of substantial completion will begin on date when such work is inspected and approved by Architect / Engineer and Public Works Project Manager.
- D. Where guarantees or warranties are required in sections of Specifications for periods in excess of one (1) year, such longer terms shall apply; however, Contractor's Performance and Payment Bonds shall not apply to any guarantee or warranty period in excess of one (1) year.

40. CONFLICTING CONDITIONS

- A. Any provision in any of Construction Documents which may be in conflict or inconsistent with any Articles in these General Conditions of Contract or Supplementary Conditions shall be void to extent of such conflict or inconsistency.
- B. In case of ambiguity or conflict between Drawings and Specifications, Specifications shall govern.

- C. Printed dimensions shall be followed in preference to measurements by scale. Large-scale drawings take precedence over small-scale drawings. Dimensions on Drawings and details are subject to field measurements of adjacent work.

41. NOTICE AND SERVICE THEREOF

- A. Any notice to Contractor from Department relative to any part of this Contract shall be in writing and considered delivered and service thereof completed, when said notice is posted, by certified or registered mail, to Contractor at Contractor's last given address, or delivered in person to said Contractor, or Contractor's authorized representative on the Work.

42. PROTECTION OF LIVES AND HEALTH

- A. In order to protect lives and health of Contractor's employees under Contract, Contractor shall comply with all pertinent provisions of Wisconsin Administrative Code, Rules of Department of Commerce, relating to Safety and Health.
- B. Contractor alone shall be responsible for safety, efficiency and adequacy of Contractor's tools, equipment and methods, and for any damage that may result from their failure or their improper construction, maintenance or operation.

43. AFFIRMATIVE ACTION PROVISION AND MINORITY / WOMEN / DISADVANTAGED BUSINESS ENTERPRISES

- A. Affirmative Action Provisions.
 - 1. During term of their Contract, Contractor agrees not to discriminate on basis of race, religion, color, sex, handicap, age, sexual preference, marital status, physical appearance, or national origin against any person, whether recipient of services (actual or potential), employee, or applicant for employment. Such equal opportunity shall include but not be limited to following: employment, upgrading, demotion, transfer, recruitment, advertising, layoff, termination, training, rates of pay, and any other form of compensation or level of service(s). Contractor agrees to post in conspicuous places, these affirmative action standards so as to be visible to all employees, service recipients and applicants for this paragraph. Listing of prohibited bases for discrimination shall not be construed to amend in any fashion state or federal law setting forth additional bases and exceptions shall be permitted only to extent allowable in state or federal law.
 - 2. Contractor is subject to this Article only if Contractor has ten (10) or more employees and receives \$10,000.00 or more in annual aggregate contracts with County. Contractor shall file and Affirmative Action Plan with Dane County Contract Compliance Officer in accord with Chapter 19 of Dane County Code of Ordinances. Such plan must be filed within fifteen (15) business days of effective date of this Contract and failure to do so by said date shall constitute ground for immediate termination of Contract by County. Contractor shall also, during term of this Contract, provide copies of all announcements of employment opportunities to County's Contract Compliance Office, and shall report annually number of persons, by race, sex and handicap status, who apply for employment, and, similarly classified, number hired and number rejected.
 - 3. Contact Dane County Contract Compliance Officer at Dane County Contract Compliance Office, 210 Martin Luther King, Jr. Blvd., Room 421, Madison, WI 53703, 608/266-4114.
 - 4. In all solicitations for employment placed on Contractor's behalf during term of this Contract, Contractor shall include statement to affect Contractor is "Equal Opportunity Employer". Contractor agrees to furnish all information and reports required by

County's Contract Compliance Officer as same relate to affirmative action and nondiscrimination, which may include any books, records, or accounts deemed appropriate to determine compliance with Chapter 19, Dane County Code of Ordinances, and provision of this Contract.

- B. Minority / Women / Disadvantaged / Emerging Small Business Enterprises.
 - 1. Chapter 19.508 of Dane County Code of Ordinances is official policy of Dane County regarding utilization of, to fullest extent of, Minority Business Enterprises (MBEs), Women Business Enterprises (WBEs) Disadvantage Business Enterprises (DBEs) and Emerging Small Business Enterprises (ESBEs).
 - 2. Contractor may utilize MBEs / WBEs / DBEs / ESBEs as subcontractors or suppliers. List of subcontractors will be required of low bidder as stated in this Contract. List shall indicate which are MBEs / WBEs / DBEs / ESBEs and percentage of subcontract awarded, shown as percentage of total dollar amount of bid.

44. COMPLIANCE WITH FAIR LABOR STANDARDS

- A. During term of this Contract, Contractor shall report to County Contract Compliance Officer, within ten (10) business days, any allegations to, or findings by National Labor Relations Board (NLRB) or Wisconsin Employment Relations Commission (WERC) that Contractor has violated statute or regulation regarding labor standards or relations. If investigation by Contract Compliance Officer results in final determination that matter adversely affects Contractor's responsibilities under this Contract, and which recommends termination, suspension or cancellation of this Contract, County may take such action.
- B. Contractor may appeal any adverse finding by Contract Compliance Officer as set forth in Dane County Ordinance 25.015(11)(c) through (e).
- C. Contractor shall post this statement in prominent place visible to employees: "As condition of receiving and maintaining contract with Dane County, this employer shall comply with federal, state and all other applicable laws prohibiting retaliation or union organizing."

45. DOMESTIC PARTNERSHIP BENEFITS

- A. Contractor agrees to provide same economic benefits to all of its employees with domestic partners as it does to employees with spouses, or cash equivalent if such benefit cannot reasonably be provided. Contractor agrees to make available for County inspection Contractor's payroll records relating to employees providing services on or under this Contract or subcontract. If any payroll records of Contractor contain any false, misleading or fraudulent information, or if Contractor fails to comply with provisions of Chapter 25.13, Dane County Ordinances, contract compliance officer may withhold payments on Contract; terminate, cancel or suspend Contract in whole or in part; or, after due process hearing, deny Contractor right to participate in bidding on future County contracts for period of one year after first violation is found and for period of three years after second or subsequent violation is found.

46. USE AND OCCUPANCY PRIOR TO ACCEPTANCE

- A. Contractor agrees to use and occupancy of portion or unit of the Work before formal acceptance by Department, provided Department:

1. Secures written consent of Contractor; except when in opinion of Public Works Project Manager, Contractor is chargeable with unwarranted delay in final cleanup of punch list items or other Contract requirements.
2. Secures endorsement from insurance carrier and consent of Surety permitting occupancy of building or use of the Work during remaining period of construction, or, secures consent of Surety.
3. Assumes all costs and maintenance of heat, electricity and water.
4. Accepts all work completed within that portion or unit of the Work to be occupied, at time of occupancy.

47. MINIMUM WAGES

- A. Contractor shall post, at appropriate conspicuous point on site of project, schedule showing all determined minimum wage rates for various classes of laborers and mechanics to be engaged in the Work under this Contract and all deductions, if any, required by law to be made from unpaid wages actually earned by laborers and mechanics so engaged.
- B. Supplementary Conditions section in Construction Documents lists wage determinations required by State Law.
- C. If, after award of Contract, it becomes necessary to employ any person in trade or occupation not classified in wage determinations, such person shall be paid at not less than such rate as shall be determined by Wisconsin Department of Workforce Development. Such approved minimum rate shall be retroactive to time of initial employment of such person in such trade or occupation. Contractor shall notify Department of Contractor's intention to employ persons in trades or occupations not so classified in sufficient time for Department to obtain approved rates for such trades or occupations.
- D. Specified wage rates are minimum rates only, and Department will not consider any claims for additional compensation made by Contractor because of payment by Contractor of any wage rate in excess of applicable rate contained in this Contract. Contractor shall adjust any disputes in regard to payment of wages in excess of those specified in this Contract.
- E. Submit required affidavit(s) to Department of Public Works, Highway & Transportation, as requested and with final application for payment for work under said contract. Affidavit(s) shall clearly indicate name, trade or occupation, and paid wages of every laborer, worker or mechanic employed by Contractor and all subcontractors during billing period including accurate record of number of hours worked by each employee and actual wages paid as stipulated in Wisconsin Statute 66.0903. Use "Dane County, Wisconsin Contractor Wage Affidavit" form included in Supplementary Conditions.

48. CLAIMS

- A. No claim may be made until Department's Assistant Public Works Director has reviewed Architect / Engineer's decision as provided for in Article 35 of General Conditions of Contract. If any claim remains unresolved after such review by Department's Assistant Public Works Director the claim may be filed under Wisconsin Statute 893.80. Work shall progress during period of any dispute or claim. Unless specifically agreed between parties, venue will be in Dane County, Wisconsin.

49. ANTITRUST AGREEMENT

- A. Contractor and County recognize that in actual economic practice, overcharges resulting from antitrust violations are in fact usually borne by County. Therefore, Contractor hereby assigns to County any and all claims for such overcharges as to goods and materials purchased in connection with this Contract, except as to overcharges which result from antitrust violations commencing after price is established under this Contract and any change order thereto.

50. INSURANCE

- A. Contractor Carried Insurance:
1. Contractor shall not commence work under this Contract until Contractor has obtained all insurance required under this Article and has provided evidence of such insurance to Risk Manager, 425 City-County Building, 210 Martin Luther King Jr. Blvd., Madison, WI 53703. Contractor shall not allow any subcontractor to commence work until insurance required of subcontractor has been so obtained and approved. Company providing insurance must be licensed to do business in Wisconsin.
 2. Worker's Compensation Insurance:
 - a) Contractor shall procure and shall maintain during life of this Contract, Worker's Compensation Insurance as required by statute for all of Contractor's employees engaged in work at site of project under this Contract and, in case of any such work sublet, Contractor shall require subcontractor similarly to provide Worker's Compensation Insurance for all of latter's employees to be engaged in such work unless such employees are covered by protection afforded by Contractor's Worker's Compensation Insurance.
 - b) If any claim of employees engaged in hazardous work on project under this Contract is not protected under Worker's Compensation Statute, Contractor shall provide and shall cause each subcontractor to provide adequate Employer's Liability Insurance for protection of such of Contractor's employees as are not otherwise protected.
 3. Contractor's Public Liability and Property Damage Insurance:
 - a) Contractor shall procure and maintain during life of this Contract, Contractor's Public Liability Insurance and Contractor's Property Damage Insurance in amount not less than \$1,000,000 bodily injury, including accidental death, to any one person, and subject to same limit for each person, in amount not less than \$1,000,000 on account of one accident, and Contractor's Property Damage Insurance in amount not less than \$1,000,000 or combined single limit of at least \$1,000,000 with excess coverage over and above general liability in amount not less than \$5,000,000. Contractor shall add "Dane County" as additional insured for each project.
 - b) Contractor's Public Liability and Property Damage Insurance shall include Products, Completed Operation, and Contractual Liability under Insurance Contract. "Contractor shall in all instances save, defend, indemnify and hold harmless County and Architect / Engineer against all claims, demands, liabilities, damages or any other costs which may accrue in prosecution of the Work and that Contractor will save, defend, indemnify and hold harmless County and Architect / Engineer from all damages caused by or as result of Contractor's operations" and each shall be listed as additional insured on Contractor's and sub-contractors' insurance policies.
 - c) Obligations of Contractor under Article 50.A.2.b) shall not extend to liability of Architect / Engineer, agents or employees thereof, arising out of:
 - 1) Preparation or approval of maps, drawings, opinions, reports, surveys, change orders, designs or specifications; or
 - 2) Giving of or failure to give directions or instructions by Architect / Engineer, agents or employees thereof provided such giving or failure to give is primary cause of injury or damage.

- d) Contractor shall procure and shall maintain during life of this Contract, Comprehensive Automobile Liability Insurance covering owned, non-owned and hired automobiles for limits of not less than \$1,000,000 each accident single limit, bodily injury and property damage combined with excess coverage over and above general liability in amount not less than \$5,000,000.
- e) Contractor shall either:
 - 1) Require each subcontractor to procure and to maintain during life of subcontract, subcontractor's Public Liability Property Damage Insurance, and Comprehensive Automobile Liability Insurance of type and in same amount specified in preceding paragraphs; or
 - 2) Insure activities of subcontractors in Contractor's own policy.
- 4. Scope of Insurance and Special Hazards: Insurance required under Article 50.A.2 & 50.A.3. hereof shall provide adequate protection for Contractor and subcontractors, respectively, against damage claims which may arise from operations under this Contract, whether such operation be by insured or by anyone directly or indirectly employed by insured and also against any of special hazards which may be encountered in performance of this Contract as enumerated in Supplementary Conditions.
- 5. Proof of Carriage of Insurance: Contractor shall furnish Risk Manager with certificates showing type, amount, class of operations covered, effective dates, dates of expiration of policies and "Dane County" listed as additional insured. Such certificates shall also contain (substantially) following statement: "Insurance covered by this certificate will not be canceled or materially altered, except after ten (10) business days written notice has been received by Risk Manager."

B. Builder's Risk:

- 1. County shall provide Builder's Risk insurance coverage for its insurable interests in construction or renovation projects with completed value of \$1,000,000 or less. Therefore, if project completed value is more than \$1,000,000, Contractor shall obtain and maintain in force, at its own expense, Builder's Risk Insurance on all risks for amount equal to full completed value of covered structure or replacement value of alterations or additions. Any deductible shall not exceed \$25,000 for each loss. Policy shall include occupancy clause and list Dane County as loss payee.

C. Indemnification / Hold Harmless:

- 1. Contractor shall indemnify, hold harmless and defend Dane County, its boards, commissions, agencies, officers, employees and representatives from and against all claims, damages, losses and expenses including attorneys' fees arising out of or resulting from performance of the Work, provided that any such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself) including loss of use resulting therefrom, and is caused in whole or in part by any act or omission of Contractor, any subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, regardless of whether or not it is caused in part by part indemnified hereunder.
- 2. In any and all claims against Dane County, its boards, commissions, agencies, officers, employees and representatives or by any employee of Contractor, any subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, indemnification obligation under this Contract shall not be limited in any way by any limitation on amount or type of damages, compensation or benefits payable by or for Contractor or any subcontractor under worker's compensation acts, disability benefits or other employee benefit acts.
- 3. Obligations of Contractor under this Contract shall not extend to liability of Architect / Engineer, its agents or employees arising out of:

- a) Preparation or approval of maps, drawings, opinion, reports, surveys, change orders, designs or specifications; or
 - b) Giving of or failure to give directions or instruction by Architect / Engineer, its agents or employees provided such giving or failure to give is primary cause of injury or damage.
4. Dane County shall not be liable to Contractor for damages or delays resulting from work by third parties or by injunctions or other restraining orders obtained by third parties.


51. WISCONSIN LAW CONTROLLING

- A. It is expressly understood and agreed to by parties hereto that in event of any disagreement or controversy between parties, Wisconsin law shall be controlling.

SUPPLEMENTARY CONDITIONS

1. APPLICATION & CERTIFICATE FOR PAYMENT

- A. Every contractor engaged in performance of any contract for Department of Public Works, Highway & Transportation shall submit partial and final Application & Certificate for Payment for work under said contract. Form shall provide similar information as shown on AIA G702™ and G703™ forms (samples shown below). Forms shall be submitted to [project Architect / Engineer, Public Works Project Manager] for approval.


AIA Document G702™ – 1992

Application and Certificate for Payment

TO OWNER:	PROJECT:	APPLICATION NO:	Distribution to:
FROM CONTRACTOR:	VIA ARCHITECT:	PERIOD TO:	OWNER <input type="checkbox"/>
		CONTRACT FOR:	ARCHITECT <input type="checkbox"/>
		CONTRACT DATE:	CONTRACTOR <input type="checkbox"/>
		PROJECT NOS:	FIELD <input type="checkbox"/>
			OTHER <input type="checkbox"/>

CONTRACTOR'S APPLICATION FOR PAYMENT

Application is made for payment, as shown below, in connection with the Contract. AIA Document G703™, Continuation Sheet, is attached.

1. ORIGINAL CONTRACT SUM \$ _____

2. NET CHANGE BY CHANGE ORDERS \$ _____

3. CONTRACT SUM TO DATE (Line 1 ± 2) \$ _____

4. TOTAL COMPLETED & STORED TO DATE (Column G on G703) \$ _____

5. RETAINAGE:

a. _____% of Completed Work
(Columns D + E on G703) \$ _____

b. _____% of Stored Material
(Column F on G703) \$ _____

Total Retainage (Lines 5a + 5b, or Total in Column I of G703) \$ _____

6. TOTAL EARNED LESS RETAINAGE \$ _____
(Line 4 minus Line 5 Total)

7. LESS PREVIOUS CERTIFICATES FOR PAYMENT \$ _____
(Line 6 from prior Certificate)

8. CURRENT PAYMENT DUE \$ _____

9. BALANCE TO FINISH, INCLUDING RETAINAGE \$ _____
(Line 3 minus Line 6)

CHANGE ORDER SUMMARY	ADDITIONS	DEDUCTIONS
Total changes approved in previous months by Owner	\$ _____	\$ _____
Total approved this month	\$ _____	\$ _____
TOTAL	\$ _____	\$ _____
NET CHANGES by Change Order	\$ _____	

The undersigned Contractor certifies that to the best of the Contractor's knowledge, information and belief the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, that all amounts have been paid by the Contractor for Work for which previous Certificates for Payment were issued and payments received from the Owner, and that current payment shown herein is now due.

CONTRACTOR: _____ Date: _____

By: _____ State of: _____

Country of: _____

Subscribed and sworn to before me this _____ day of _____

Notary Public: _____
My commission expires: _____

ARCHITECT'S CERTIFICATE FOR PAYMENT

In accordance with the Contract Documents, based on on-site observations and the data comprising this application, the Architect certifies to the Owner that to the best of the Architect's knowledge, information and belief the Work has progressed as indicated, the quality of the Work is in accordance with the Contract Documents, and the Contractor is entitled to payment of the AMOUNT CERTIFIED.

AMOUNT CERTIFIED \$ _____

(Attach explanation if amount certified differs from the amount applied. Initial all figures on this Application and on the Continuation Sheet that are changed to conform with the amount certified.)

ARCHITECT: _____ Date: _____

This Certificate is not negotiable. The AMOUNT CERTIFIED is payable only to the Contractor named herein. Issuance, payment and acceptance of payment are without prejudice to any rights of the Owner or Contractor under this Contract.

CAUTION: You should sign an original AIA Contract Document, on which this text appears in RED. An original assures that changes will not be obscured.
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Continuation Sheet

AIA Document G703™-1992, Application and Certificate for Payment, or G732™-2009, Application and Certificate for Payment, Construction Manager as Adviser Edition, containing Contractor's signed certification is attached. In tabulations below, amounts are in US dollars. Use Column I on Contracts where variable retainage for line items may apply.

APPLICATION NO:
APPLICATION DATE:
PERIOD TO:
ARCHITECT'S PROJECT NO:

A ITEM NO.	B DESCRIPTION OF WORK	C SCHEDULED VALUE	D WORK COMPLETED		F MATERIALS PRESENTLY STORED <i>(Not in D or E)</i>	G TOTAL COMPLETED AND STORED TO DATE <i>(D+E-F)</i>	H BALANCE TO FINISH <i>(C-G)</i>	I RETAINAGE <i>(if variable rate)</i>
			FROM PREVIOUS APPLICATION <i>(D - E)</i>	THIS PERIOD				
GRAND TOTAL								

CAUTION: You should sign an original AIA Contract Document, on which this text appears in RED. An original assures that changes will not be obscured.

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2. CONTRACTOR WAGE AFFIDAVIT

- A. Every contractor engaged in performance of any contract for Department of Public Works, Highway & Transportation shall submit to this Department, as requested and with final application for payment for work under said contract, affidavit in form as hereinafter set forth in this section. Affidavit affirms that all persons employed by contractor or by any of contractor's subcontractors on such contract have been paid no less than minimum wages established under Dane County Ordinances, Chapter 40, Subchapter II (Minimum Wage Ordinance) and in effect at date of execution of contract, that full payment of wages earned has been made, and that no rebates either directly or indirectly have been made. Form of such affidavit is included in this section.
- B. Form should be included with a copy of the final contract invoice forwarded to your contract representative at Dane County.

SECTION 01 00 00

BASIC REQUIREMENTS

PART 1 GENERAL

1.1 SECTION SUMMARY

- A. Section Includes:
1. Section Summary
 2. Summary of the Work
 3. Contractor Use of Premises
 4. Applications for Payment
 5. Change Procedures
 6. Alternates
 7. Lump Sum Allowances for Work
 8. Coordination
 9. Cutting and Patching
 10. Conferences
 11. Progress Meetings
 12. Job Site Administration
 13. Submittal Procedures
 14. Proposed Products List
 15. Shop Drawings
 16. Product Data
 17. Samples
 18. Manufacturers' Instructions
 19. Manufacturers' Certificates
 20. Quality Assurance / Quality Control of Installation
 21. References
 22. Interior Enclosures
 23. Protection of Installed Work
 24. Parking
 25. Staging Areas
 26. Occupancy During Construction and Conduct of Work
 27. Protection
 28. Progress Cleaning
 29. Products
 30. Transportation, Handling, Storage and Protection
 31. Product Options
 32. Substitutions
 33. Starting Systems
 34. Demonstration and Instructions
 35. Contract Closeout Procedures
 36. Final Cleaning
 37. Adjusting
 38. Operation and Maintenance Data
 39. Spare Parts and Maintenance Materials
 40. As-Built and Record Drawings and Specifications

1.2 SUMMARY OF THE WORK

- A. Project Description: Perform the Work as specified and detailed in Construction Documents package. Contractor to provide all civil site work, building construction, and all associated equipment procurement and installation.
- B. Work by Owner: See Section 19 in Instructions to Bidders.
- C. Diggers Hotline:
 - 1. It is General Contractor's responsibility to contact Diggers Hotline to have all utility locations marked prior to excavation and planning an excavation in a timely manner so as not to delay the Work.
 - 2. Diggers Hotline shall also be used to obtain information on safe working clearances from overhead lines.
 - 3. Completely comply with all requirements of each affected utility company.
 - 4. It is General Contractor's responsibility to contact & hire private utility locating services if necessary.

1.3 CONTRACTOR USE OF PREMISES

- A. Limit use of premises to allow work by others and work by Owner.
- B. Coordinate utility outages and shutdowns with Owner.

1.4 APPLICATIONS FOR PAYMENT

- A. Submit one (1) original copies with "wet" signatures of each application on AIA G702™ and G703™ forms or approved contractors invoice form.
- B. Content and Format: Utilize Schedule of Values for listing items in Application for Payment.
- C. Payment Period: Monthly.
- D. Submit Applications for Payment to Architect / Engineer for initial approval. Architect / Engineer will forward approved copies to Owner who will also approve & process for payment.

1.5 CHANGE PROCEDURES

- A. Outlined in Section 18, "Change in the Work" of General Conditions of Contract.

1.6 ALTERNATES

- A. See Bid Form
- B. Alternates quoted on Bid Form shall be reviewed and accepted or rejected at Owner's option.
- C. Coordinate related work and modify surrounding work as required.

1.7 LUMP SUM ALLOWANCES FOR WORK

- A. As outlined in Section 01 22 00 titled "Measurement and Payment".

1.8 COORDINATION

- A. Coordinate scheduling, submittals, and work of various sections of Specifications to assure efficient and orderly sequence of installation of interdependent construction elements.
- B. Verify utility requirement characteristics of operating equipment are compatible with building utilities.
- C. Coordinate space requirements and installation of mechanical and electrical work that are indicated diagrammatically on Drawings.
- D. Contractor shall provide Public Works Project Engineer with work plan that ensures the Work will be completed within required time of completion.
- E. Public Works Project Manager may choose to photograph or videotape site or workers as the Work progresses.

1.9 CUTTING AND PATCHING

- A. Outlined in Section 5, "Cutting and Patching" of General Conditions of Contract.

1.10 CONFERENCES

- A. There will be pre-bid conference for this project; see Instructions to Bidders.
- B. Owner will schedule a preconstruction conference after Award of Contract for all affected parties.
- C. Contractor shall submit Construction Schedule at pre-construction conference.
- D. When required in individual Specification section, convene a pre-installation conference at project site prior to commencing work of Section.

1.11 PROGRESS MEETINGS

- A. Owner shall schedule and administer meetings throughout progress of the Work at minimum of two (2) per month.
- B. Architect / Engineer shall preside at meetings, record minutes, and distribute copies within two (2) business days to those affected by decisions made.
- C. Attendance at progress meetings by General Contractor, subcontractors, or their authorized representative, is mandatory.
- D. Contractors shall give verbal reports of progress on the Work, discuss schedule for upcoming period and present all conflicts, discrepancies or other difficulties for resolution.

E. Day & time of progress meetings to be determined at pre-construction meeting.

1.12 JOB SITE ADMINISTRATION

A. Architect / Engineer shall provide construction inspections (two inspections/week – minimum).

1.13 SUBMITTAL PROCEDURES

A. Submittal form to identify Project, Contractor, Subcontractor or supplier; and pertinent Construction Documents references.

B. Apply Contractor's stamp, signed or initialed, certifying that review, verification of Products required, field dimensions, adjacent construction work, and coordination of information is in accordance with requirements of the Work and Construction Documents.

C. Identify variations from Construction Documents and Product or system limitations that may be detrimental to successful performance of completing the Work.

D. Revise and resubmit submittals as required; identify all changes made since previous submittal.

1.14 PROPOSED PRODUCTS LIST

A. Within fifteen (15) business days after date of Award of Contract, submit complete list of major Products proposed for use, with name of manufacturer, trade name, and model number of each Product.

1.15 SHOP DRAWINGS

A. Outlined in Section 4, “Shop Drawings, Product Data and Samples” of General Conditions of Contract.

1.16 PRODUCT DATA

A. Outlined in Section 4, “Shop Drawings, Product Data and Samples” of General Conditions of Contract.

1.17 SAMPLES

A. Outlined in Section 4, “Shop Drawings, Product Data and Samples” of General Conditions of Contract.

1.18 MANUFACTURERS' INSTRUCTIONS

A. When specified in individual Specification sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Product Data.

1.19 MANUFACTURERS' CERTIFICATES

- A. When specified in individual Specification sections, submit manufacturers' certificate to Public Works Project Manager for review, in quantities specified for Product Data.
- B. Indicate material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

1.20 QUALITY ASSURANCE / QUALITY CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce work of specified quality.
- B. Comply fully with manufacturers' instructions.
- C. Comply with specified standards as minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

1.21 REFERENCES

- A. Conform to reference standard by date of issue current as of date for receiving bids.
- B. Should specified reference standard conflict with Construction Documents, request clarification from Public Works Project Manager before proceeding.

1.22 INTERIOR ENCLOSURES

- A. Not Applicable.

1.23 PROTECTION OF INSTALLED WORK

- A. Outlined in Section 15, "Protection of Work and Property" of General Conditions of Contract.

1.24 PARKING

- A. Arrange for temporary parking areas to accommodate construction personnel. Parking shall be available at the Work site.
- B. All contractors and their employees shall cooperate with General Contractor and others in parking of vehicles to avoid interference with normal operations and construction activities.
- C. Do not obstruct existing service drives and parking lots with equipment, materials and / or vehicles. Keep accessible for Owner's use at all times.

1.25 STAGING AREAS

- A. Coordinate staging areas with Public Works Project Manager prior to starting the Work.

- B. On-site space for use as staging areas and storage of materials is limited and will be apportioned among various Contractors as their needs dictate with due regard for storage requirements of each Contractor. Each Contractor shall be responsible for safety of equipment and materials that are stored on site.

1.26 OCCUPANCY DURING CONSTRUCTION AND CONDUCT OF WORK

- A. Owner shall not be held liable for any lost time, wages, or impacts to construction schedule by any Contractor or construction personnel dismissed for failure to uphold requirements of this Section.
- B. Areas of existing facility will be occupied during period when the Work is in progress. Work may be done during normal business hours (8:00 am to 4:30 pm), but confer with Owner, schedule work and store materials so as to interfere as little as possible with normal use of premises. Notify Owner when coring or similar noise making work is to be done and obtain Owner's written approval of schedule. If schedule is not convenient for Owner, reschedule and resubmit new times for Owner approval. Coring of floor along with other noisy work may have to be done on second and third shifts.
- C. Areas of existing facility will be occupied during period when the Work is in progress. Work may be done during normal business hours (8:00 am to 4:30 pm), but confer with Owner, schedule work and store materials so as to interfere as little as possible with normal use of premises. Work performed on Saturday shall be by permission of Owner. Notify Owner when coring or similar noise making work is to be done and obtain Owner's written approval of schedule. If schedule is not convenient for Owner, reschedule and resubmit new times for Owner approval. Coring of floor along with other noisy work may have to be done on second and third shifts.
- D. Contractor shall provide adequate protection for all parts of facility, its contents and occupants wherever the Work under this Contract is to be performed.
- E. Each Contractor shall arrange with Owner to make necessary alterations, do new work, make connections to all utilities, etc., at such times as will not cause interruption of utility services to facility. Contractor doing this work shall protect, cap, cut off and / or replace and relocate existing pipes, electrical work and other active utilities encountered which may interfere with new construction work.
- F. New work in extension of existing work shall correspond in all respects with that to which it connects or similar existing work unless otherwise indicated or specified.
 - 1. Existing work shall be cut, altered, removed or replaced as necessary for performance of Contract obligations.
 - 2. Work remaining in place, damaged or defaced by reason of work done under this Contract shall be restored equal to its condition at time of Award of Contract.
 - 3. If removal of work exposes discolored or unfinished surfaces or work out of alignment, such surfaces shall be refinished or materials replaced as necessary to make continuous work uniform and harmonious.
- G. Contractor is responsible for providing & maintaining temporary toilet facilities.

1.27 PROTECTION

- A. Contractor shall protect from damage / injury all trees, shrubs, hedges, plantings, grass, mechanical, electrical & plumbing equipment, walks and driveways and pay for any damage to same resulting from insufficient or improper protection.
- B. Contractor shall provide and maintain barricades & signage to prohibit public access to construction site.

1.28 PROGRESS CLEANING

- A. Outlined in Section 6, "Cleaning Up" of General Conditions of Contract.

1.29 PRODUCTS

- A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work, but does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components specifically identified for reuse.
- B. Do not use materials and equipment removed from existing premises, except as specifically identified or allowed by Construction Documents.

1.30 TRANSPORTATION, HANDLING, STORAGE AND PROTECTION

- A. Transport, handle, store and protect Products in accordance with manufacturer's instructions.

1.31 PRODUCT OPTIONS

- A. Where definite material is specified, it is not intentional to discriminate against "equal" product made by another manufacturer. Intention is to set definite standard of material quality. Should bidder choose to bid materials other than those specified, bidder shall submit said materials specifications to Public Works Project Manager for approval at least seven (7) business days prior to Bid Due Date.
- B. Products and materials that are not specified, but have been approved for use by Public Works Project Manager shall be identified in addenda to all bidding contractors.
- C. Requests for material or product substitutions submitted after Bid Due Date shall not be considered. Owner reserves right to approve or reject substitutions based on Specification requirements and intended use.

1.32 SUBSTITUTIONS

- A. Public Works Project Manager shall consider requests for Substitutions only up to seven (7) business days prior to date of Bid Due Date.
- B. Document each request with complete data substantiating compliance of proposed Substitution with Construction Documents.

- C. Submit three (3) copies of requests for Substitution for consideration. Limit each request to one (1) proposed Substitution.
- D. Substitutions shall not change contract price established at Bid Due Date.

1.33 STARTING SYSTEMS

- A. Provide written notification prior to start-up of each equipment item or system.
- B. Ensure that each piece of equipment or system is ready for operation.
- C. Execute start-up under supervision of responsible persons in accordance with manufacturers' instructions.
- D. Submit written report that equipment or system has been properly installed and is functioning correctly.

1.34 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of Products to Owner's personnel prior to date of final inspection.
- B. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at designated location.
- C. Owner may choose to photograph or videotape demonstration session; demonstration and demonstrator shall be to level of satisfaction of Owner.

1.35 CONTRACT CLOSEOUT PROCEDURES

- A. Submit final Application for Payment identifying total adjusted Contract Sum / Price, previous payments, and amount remaining due.

1.36 FINAL CLEANING

- A. Outlined in Section 6, "Cleaning Up" of General Conditions of Contract.

1.37 ADJUSTING

- A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

1.38 OPERATION AND MAINTENANCE MANUAL

- A. Provide two (2) bound, hard-copy operation and maintenance manuals that include all systems, materials, products, equipment, mechanical and electrical equipment and systems supplied and installed in the Work. Provide electronic version of operation and maintenance manual also.

1.39 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide Products, spare parts, maintenance and extra materials in quantities specified in individual Specification Sections.
- B. Deliver to the Work site and place in location as directed.

1.40 AS-BUILT AND RECORD DRAWINGS AND SPECIFICATIONS

- A. Contractor shall furnish with original marked up redlines of Construction Documents' drawings and specifications that shall include all Addendums, Change Orders, Construction Bulletins, on-site changes, field corrections, etc. These are project As-Built Drawings & Specifications.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 11 00

SUMMARY OF WORK

PART 1 - GENERAL

1.1 Section Includes

- A. Project Description
- B. Work Covered by Contract Documents
- C. Related Work Performed by OWNER or Under Separate Contract.
- D. Commencement of the Work
- E. Project Schedule and Hours of Work
- F. Work Sequence.
- G. Communications during Construction
- H. CONTRACTOR Use of Premises.
- I. Site Health and Safety Issues
- J. Quality Assurance / Coordination
- K. Warranties
- L. Defect Assessment
- M. Project Meetings
- N. Submittals
- O. Schedule of Values
- P. Measurement and Payment
- Q. Application for Payment
- R. Union Issues

1.2 Project Description

- A. Construction of a Renewable Natural Gas (RNG) facility that integrates with a Biogas Cleaning Facility (by others). In addition to all connections to the Biogas Cleaning Facility, major components to be constructed are a landfill gas (LFG) blower and flare facility, RNG trailer offload facility, metering facility, gas pipeline and a maintenance building. Work includes but is not necessarily limited to site preparation, stormwater management, excavation and grading, concrete foundation and concrete pad construction, asphalt and concrete pavement, fire protection, fencing, housing structure construction, service connections, RNG handling equipment installation, tie-in to existing LFG infrastructure, and all associated structures, fittings, valves and appurtenances as shown on the Construction Drawings and Described in the Project Specifications.

Connections to the Biogas Cleaning Facility – Includes the supply of biogas, natural gas, and fresh water and the offtake of RNG, off-spec gas, condensate, effluent and stormwater.

LFG Blower and Flare Facility – Includes the installation of LFG blowers, utility flare, heat exchanger and ancillary piping and valves, and the construction of a building to house the blowers. This building will include a small office separated by a firewall that will house site electronics and a facility monitoring workstation.

RNG Trailer Offload Facility – Includes the installation of trailer defueling equipment, decant panel, natural gas fired boilers and booster compressors, and the construction of two buildings to house the boilers and compressors.

Metering Facility – Includes the installation of three RNG metering skids, each containing equipment to monitor gas quality from the Biogas Cleaning Facility, the Trailer Offload Facility, and the blended streams.

Gas Pipeline (alternate bid item) – Includes the installation of an approximately 2,000 ft. high pressure pipeline connecting the RNG facility to the utility pipeline interconnection.

Maintenance Building (alternate bid item) – Includes the construction of a general use maintenance building that will primarily be used for landfill compactor maintenance.

1.3 Work Covered by Contract Documents

- A. Base Bid: Work of this Contract under the Base Bid includes, but is not necessarily limited to, the following major elements:
1. General Conditions
 2. Mobilization and demobilization.
 3. Site preparation including installation and maintenance of temporary erosion control devices (if required).
 4. Site preparations including clearing and debris removal within proposed limits of construction (if required).
 5. Site preparation include topsoil stripping and stockpiling for use (if required).
 6. Site grading including but not limited to construction of ditches, roadway subgrades, foundation subgrades (if required).
 7. Site grading to bring the site to proposed subgrade through structural filling and /or utilizing engineered fill (if required).
 8. Stormwater Management including miscellaneous drainage structures such as culverts, piping and storm sewer to convey stormwater.
 9. Installation of a landfill gas collection and conveyance system including pipe bedding, backfill, and associated appurtenances.
 10. Installation of force main piping including pipe bedding, backfill, manholes/vaults and associated appurtenances
 11. Construction of a non-potable water service for fire protection activities.
 12. Construction of facility concrete pads for the filtration separator vessel, transformers, knockout vessel, metering buildings, water tank, decant, and flare skid.
 13. Construction of a Blower and Office Building, Compression Building, Boiler Building, and Metering Skid Buildings.
 14. Offload RNG facility equipment.

15. Construction of asphalt and concrete pavement areas including stone base and asphalt / concrete surfaces.
16. Construction of an aggregate parking area and road entrance to the proposed Maintenance Building.
17. Restoration including final grading of disturbed areas and seeding/fertilizing mulching disturbed areas.
18. Other related work described in the Contract Documents such as submittals, quality control, temporary construction facilities and controls, cleaning, protection, etc., necessary and incidental to fully execute the Work.
19. Alternates:
 - a. There are Alternates Bid Items on the Bid Form. OWNER reserves the right to select none or any combination of the Alternates.
 - i. Construction of the maintenance building.
 - ii. 2,000 feet of transmission pipeline from the compression building to the ANR gas pipeline interconnection.

1.4 Related Work Performed by OWNER or Under Separate Contract

- A. OWNER will furnish the following materials for installation by CONTRACTOR. CONTRACTOR will assist OWNER in obtaining OWNER-furnished materials to ensure that delivery dates of OWNER furnished materials do not delay the CONTRACTOR's construction schedule.
 1. Water, as available on site. CONTRACTOR responsible for located off-site source if needed.
 2. On-site soils consisting of clay, general/structural fill and top soil.
- B. OWNER will perform the following items:
 1. Initial Surface Preparation.
 2. Erosion control measures and construction of the stormwater detention basin and all necessary outlet controls, as needed.
 3. All earthwork associated with the RNG facility within 18-inches of final grade prior to final subgrade completion and aggregate placement and compaction. Does not include restoration work (i.e. top soil placement, seeding, and vegetation establishment).
- C. OWNER will provide the following items:
 1. All Biogas Cleaning Equipment including concrete slabs for both the Gas Cleaning Equipment and Electrical Transformers, RNG Handling Equipment (i.e. boiler, blowers, decant, RNG metering skids, electronic control devices and flare)
 2. OWNER will arrange for installation of the Biogas Cleaning Equipment and Electrical Transformers. CONTRACTOR to provide all service connections to and from the Biogas Cleaning Equipment. CONTRACTOR to install all RNG Handling Equipment supplied by the OWNER. CONTRACTOR to work with OWNER or OWNERs representative to coordinate delivery and installation of all equipment.

3. Electrical from main to transformer (distribution from transformer CONTRACTOR's responsibility)
4. Natural gas from main to meter (distribution from meter is CONTRACTOR's responsibility)
5. Landfill gas collection and Control system (GCCS) tie-in (including manhole)
6. Two (2) computers for reporting and monitoring purposes
7. SCADA system
8. Construction Quality Assurance Services
9. Construction documentation and Measurements and Payments surveying (CONTRACTOR responsible for all construction layout and staking required)
10. Concrete Strength Testing
11. Asphalt Strength Testing
12. Soil Testing
13. Monitoring Well abandonment and replacement
14. Communication splice and tie-in (distribution from hand hole is CONTRACTOR's responsibility)

1.5 Commencement of the Work

- A. The CONTRACTOR shall not commence the Work nor allow any subcontractor or sub-subcontractor to commence the Work until:
 1. The Contract has been fully executed or a Notice to Proceed has been issued.
 2. The OWNER has approved the CONTRACTOR's performance and payment bonds, if required.
 3. The OWNER has approved evidence of the CONTRACTOR's liability insurance and any other insurance required to be purchased by the CONTRACTOR.
 4. The CONTRACTOR has obtained any necessary construction permits.

1.6 Project Schedule and Hours of Work

- A. Anticipated Contract start date is June 18, 2018. Work shall be Substantially Complete by October 25, 2018. Final Completion of remaining items shall be completed by November 23, 2018.
- B. The operation of heavy equipment and machinery shall be limited. If extended hours are necessary it should be discussed with the site operator should work start or continue outside of the normal working hours for the landfill operations. Heavy equipment may operate at the facility between 6:30 AM and 6:00 PM Monday through Friday and 6:30 AM and 12:00 PM on Saturday. Work shall not be conducted on Sunday unless an extension is approved by the OWNER. Waste hauled to active area as part of project shall be between 6:30 AM and 3:30 PM Monday through Friday only no waste can be taken to active areas on Saturday unless the OWNER has manpower available to get it covered or the CONTRACTOR covers the waste at their expense. Extensions may be granted if requested and approved by OWNER.

- C. Prior to starting Work submit project schedule. Revise and resubmit to reflect actual progress relative to the proposed schedule every two weeks.
- D. Project schedule shall be a comprehensive horizontal bar chart with separate bar for each major trade, subcontractor, or operation, identifying first Work day of each week. Show projected production rates and number of operating equipment on-site. Arrange schedule to indicate required sequencing of activities and to show allowances for submittals, inspections, and similar time margins.
- E. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Show projected percentage of completion of each item of Work at each Application for Progress Payment.
- F. Show submittal dates required for shop drawings, product data, samples, and product delivery dates, including those furnished by OWNER.

1.7 Work Sequence

- A. Coordinate work with OWNER to ensure work done will not interfere with general landfill operations.
- B. Samples of off-site materials supplied by CONTRACTOR shall be tested and approved by OWNER prior to delivery to site.
- C. Project shall be completed under the general sequence shown below:
 1. Install erosion control and storm water management control devices prior to beginning major construction.
 2. Excavate and complete undercuts/backfilling to achieve desired subbase grades.
 3. Place and compact structural / engineer fill to desired subgrades.
 4. Install storm sewer and culvert piping.
 5. Install all below ground piping.
 6. Place and compact base course at road and pads.
 7. Construct building structures.
 8. Place asphalt / concrete in road and parking areas.
 9. Install RNG offload facility.
 10. Install metering skids.
 11. Install above ground piping.
 12. Install leachate/condensate collection and landfill gas piping; tie-in to existing infrastructure.
 13. Install surface water drainage features.
 14. Install fencing.
 15. Install security devices.
 16. Complete site restoration.

1.8 Communications during Construction

- A. Inquiries, information and coordination relating to scheduling of work, use of site, interruption of utility services, and similar matters shall be directed to the OWNER.
- B. Inquiries regarding interpretation of the Contract Documents and authorization of additional work shall be directed to the OWNER.

1.9 CONTRACTOR Use of Premises

- A. Refer to Section 01 00 00 Basic Requirements

1.10 Site Health and Safety Issues

- A. The Work of this Contract will be performed on or adjacent to a site which may contain hazardous substances on the surface and/or subsurface. Therefore, as a minimum, satisfy applicable federal, state, and local statutes, regulations, health and safety, including but not limited to OSHA 29-CFR 1910.120, Hazardous Waste Operations and Emergency Response.
- B. A site specific Health and Safety Plan shall be developed and implemented by CONTRACTOR. The CONTRACTOR shall be and remain liable for compliance with the CONTRACTOR's Health and Safety Plan by its employees, agents, and subcontractors, and shall hold ENGINEER and OWNER harmless from claims, damages, suits, expenses, and losses in any way arising from non-compliance with the CONTRACTOR's Health and Safety Plan prepared for this project site.
 - 1.
- C. The OWNER will make available to CONTRACTOR documents and information available that relate to the identity, location, quantity, nature, or characteristics of hazardous substances near the work site. The OWNER, however, assumes no responsibility or liability for the accuracy or completeness of such documents or information, and such documents and information shall remain the property of the OWNER.

1.11 Quality Assurance / Coordination

- A. CONTRACTOR is solely responsible for conformance of the Work with the Contract Documents. Review and testing by the ENGINEER or OWNER's Testing Laboratories in no way relieves the CONTRACTOR of sole responsibility for the Work and maintaining a quality assurance program.
- B. Use adequate numbers of skilled workmen who are thoroughly trained, qualified, and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the Work.
- C. Provide necessary supervision, planning, scheduling, coordination, and control to perform the Work and meet the requirements of the Contract Documents.
- D. Coordinate and integrate elements of Work of the various Sections of Specifications to ensure efficient and orderly sequence of installation with provisions for accommodating items installed later.
- E. Verify that characteristics of elements of interrelated operating equipment are compatible; coordinate Work of various Specification Sections having interdependent responsibilities for installing, connecting to, and placing in service such equipment.
- F. Key members of the CONTRACTOR's staff shall not be changed without the consent of the OWNER, unless such members cease to be employed by the CONTRACTOR in a similar capacity. Prior to commencement of the Work, select a Project Manager who shall have full

Summary of Work

responsibility for the prosecution of the Work, with full authority to act in matters as necessary for the proper coordination, direction, and administration of the Work.

- G. Refer to Section 01 00 00 Basic Requirements

1.12 Warranties

- A. Provide written warranties as required by respective sections of the Contract Documents.
- B. Warranties shall be submitted to the OWNER and approved prior to final payment.
- C. Warranties shall be in writing and shall be signed by an authorized agent for the CONTRACTOR and the Manufacturer where required.
- D. Warranty periods shall start from the Substantial Completion Date of the Work as certified by the ENGINEER. In multi-year projects, warranty periods shall start from the Substantial Completion Date of each phase of the Work, as certified by the ENGINEER.
- E. Within the specified warranty period, if repairs are required in connection with warranted Work as a result of materials, equipment, or workmanship, which are inferior, defective, or not in accordance with the terms of the Contract, the CONTRACTOR shall promptly upon receipt of notice from the OWNER, perform the following:

Place in satisfactory condition warranted Work, and thus correct defects therein.

Place in satisfactory condition other elements of the building or site which are damaged or disturbed in performance of warranty Work.

1.13 Defect Assessment

- A. Replace the Work, or portions of the Work, not conforming to specified requirements.
- B. If in the opinion of the ENGINEER the defective Work is repairable, and it is not practical to remove and replace the Work, the ENGINEER will elect one of the following remedies:
 - 1. The defective Work may remain, but the unit sum/price shall be adjusted.
 - 2. The defective Work shall be repaired as instructed by the ENGINEER and the unit sum/price shall be adjusted to a new sum/price at the discretion of the ENGINEER.
- C. The individual specification sections may modify these options or may identify a specific formula or percentage sum/price adjustment.

1.14 Project Meetings

- A. Refer to Section 01 00 00 Basic Requirements

1.15 Submittal Procedures

- A. Refer to Section 01 00 00 Basic Requirements
- B. Make submittals of project schedules, survey and layout data, product data, shop drawings, samples, color charts, quality control test results, photographs, warranties, etc. required by these Specifications. Submit to OWNER. Revise and resubmit as required to establish compliance with specified requirements. Mix designs shall be no more than 6 months old.
- C. Prior to each submittal, verify that each item and the submittal for it conform with the specified requirements. If a submittal contains deviations from Contract Document requirements, such deviations shall be clearly noted on the submittal.

- D. Submit one copy of each requested submittal. Submittals shall bear the CONTRACTOR's stamp of review and approval.
- E. No portion of the Work requiring a shop drawing, sample, certification, or product data submission shall be commenced until the submission has been reviewed by the OWNER for conformity with the design intent of the Project Plans and Specifications.
- F. Consecutively number submittals and indicate the applicable specification section. On resubmittals, cite the original submittal number for reference.
- G. Make submittals far enough in advance of scheduled dates for installation to provide time for reviews, secure necessary approvals, revisions, resubmittals, and for placing orders and securing delivery. Allow five days for OWNER's review of submittals.
- H. Review by the OWNER does not relieve the CONTRACTOR from responsibility for errors which may exist in the submitted data, including non-compliance with the Contract Documents, unless the CONTRACTOR has indicated in writing such deviation at the time of submission and written approval has been given to the specific deviation.
- I. Maintain a submittal log for the duration of the Work, showing current status of submittals. Make available to OWNER upon request.

1.16 Schedule of Values

- A. Submit Schedule of Values to OWNER prior to submitting first payment request. Schedule of Values shall provide a detailed breakdown of the agreed upon Contract Sum showing values allocated to each of the various parts of the Work and shall be based on the unit prices on the Contract Bid Form. Total costs of items listed in schedule shall equal the total Contract Sum. Revise and resubmit as required by OWNER.
- B. Schedule of Values shall be used as a basis for CONTRACTORS's Payment Request.
- C. Revise Schedule of Values to list approved Change Orders with each Application for Payment.
- D. Upon request from OWNER, submit data on cost of materials, labor, equipment, overhead, and profit that will substantiate magnitude of values.

1.17 Measurement and Payment

- A. Payment for lump sum work items will be based on percentage of work completed and accepted through the end of the billing period. Percentage complete will be mutually agreed upon prior to submittal of request. Lump sum payment includes full compensation for required labor, tools, products, equipment, transportation, services, and incidentals required for complete and proper erection, application, or installation of an item of the Work, including overhead and profit.
- B. Lump sum payment includes full compensation for required labor, tools, products, equipment, transportation, services, and incidentals required for complete and proper erection, application, or installation of an item of the Work, including overhead and profit.
- C. Payment for unit price work items shall be based on the actual quantities and measurements accepted and defined in Section 01 22 00, multiplied by the unit price of each item incorporated in the Work. Unit quantities shall be agreed upon prior to submittal of payment request.

- D. Unit price payment includes full compensation for required labor, tools, products, equipment, transportation, services, and incidentals required for complete and proper erection, application, or installation of an item of the Work, including overhead and profit.
- E. Estimated quantities provided on the Bid Form are for bidding purposes only. Actual quantities may and will likely vary from those estimated. If the actual Work requires more or fewer quantities than those estimated, provide the required quantities at the unit sum/prices contracted. OWNER reserves the right to reduce or increase quantities from the Bid Form.

1.18 Application for Payment

- A. Refer to Section 01 00 00 Basic Requirements

1.19 Union Issues

- A. Dane County Landfill is a non-union site.

*** END SECTION***

SECTION 01 22 00

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 Section Includes

Procedures for measurement and payment for the Work to be done under the respective items listed in the itemized quantity listing for this project.

1.2 General

- A. The following paragraphs describe measurement of and payment for the Work included under the respective items listed in the itemized bid for this contract.
- B. Each lump sum and unit price stated in the itemized bid shall constitute full compensation for not only all labor, equipment and materials necessary and required to complete all work specified under that particular item including cleaning up, but also all costs for doing related work as set forth in these Specifications and/or on the Contract Drawings or implied in carrying out their intent.
- C. It is anticipated that all work satisfactorily completed will be processed under monthly Payment Requests, each dated on the 30th day of each month during the construction period.
- D. OWNER will provide initial topographic survey and final as-built survey in areas being constructed. All other construction staking and lay-out is the responsibility of the CONTRACTOR.

1.3 Quantities

- A. Quantities indicated in the Bid Form are for bidding and contract purposes only. Actual payment quantities will be determined by measured quantities supplied or constructed and verified by OWNER.
- B. If the actual Work requires quantities less than or greater than those quantities indicated in the Bid Form, CONTRACTOR will provide the required quantities at the unit prices contracted.
- C. The quantities given in the Contract Documents are approximate only, and are given as a basis for the uniform comparison of bids. OWNER does not expressly or by implication agree that the actual amount of work will correspond therewith.
- D. The CONTRACTOR must provide, for Unit Price Work, a proposed contract price determined on the basis of estimated quantities required for each item. The estimated quantities of items are not guaranteed and are solely for the purpose of comparing bids. Each such unit price will be deemed to include an amount for overhead, profit and indirect costs for each separately defined item.
- E. An increase or decrease in the quantity for any unit price item shall not be regarded as sufficient grounds for an increase or decrease in the price of the items.

1.4 Measurement and Computation of Quantities

- A. Measurement of quantities expressed as area shall be based upon a horizontal, planimetric projection to the Work limits as determined by survey Record Drawings for each item with no additional allowances for slopes.
- B. Measurement of quantities expressed as volume shall be based upon comparison of survey Record Drawings performed both prior to and upon completion of each item.
- C. Computation of the volume of prisms shall be by the method of average end areas of surveyed cross sections recorded at 50 foot stations at the same locations both prior to construction and upon completion of construction of these items. Measurement of length for these items shall be recorded along the top centerline for purposes of volume computations.
- D. Measurement of linear items such as piping, drainage swales, and access roads will be for quantities actually installed to the specified work limits, based upon minimum 50 foot surveyed stations (planimetric horizontal distance) recorded along the straight or curved centerline of each respective item with no additional allowances for slope.
- E. No partial payments shall be made for items which have not been tested and approved.
- F. Payment will be made to the limits as specified in the Contract Documents. If the constructed limits are less than the specified limit, payment will be made to the actual limits of construction as shown on the Record Drawings. Payment for quantities that exceed the specified contract limits will only be made with the approval of the OWNER/ENGINEER. The payment for quantities that exceed the contract quantities can only be obtained through an approved change order before contract quantities are exceeded.

1.5 Schedule of Contract Payment Items

- A. Bid Item 101 – Mobilization and General Conditions
 - 1. The lump sum price for this item shall be payment in full for supervision and management, ongoing project related expenses such as site health and safety, utilities, dust control, bonds, and insurances, etc., and compliance with the requirements of regulatory agencies and utilities, as well as mobilization and demobilization of all parts, material, and equipment to and from the site.
 - 2. The price shall include, but not be limited to, the following:
 - a. Supervision and management expenses such as:
 - 1) The salaries of Project Manager, Engineer, Superintendent, QA/QC Specialist, etc.
 - 2) Management travel, etc.
 - b. Ongoing project related expenses such as:
 - 1) Transportation or delivery of all parts, material, and equipment necessary for the work to and/or from the site.
 - 2) Dust control.
 - 3) Master mechanic services.
 - 4) Contractor's facilities, office trailers, and their related expenses.
 - 5) Vehicles and related maintenance including supplies such as fuel.

- 6) Sanitary facilities and related maintenance.
 - 7) Contractor provided utilities.
 - 8) Dewatering.
 - 9) Preparation and submission of submittals, shop drawings, Operations and Maintenance Manual, etc.
 - 10) Landfill gas control measures during construction, if necessary.
 - 11) Soil erosion and sediment control during construction.
 - 12) Protection of existing facilities to remain and protection of completed work.
 - 13) All other related costs to complete the Project not specifically referenced in the bid tabulation.
3. Executing any and all the requirements of utility companies and regulatory agencies as pertaining to the Work.
 4. Carrying out the work in compliance with the requirements set forth in the General Conditions, Supplementary Conditions, and the General Requirements.
 5. Unloading and suitably storing all Owner provided materials.
 6. Measurement: Lump Sum
 7. Payment: This item will be payable in partial payments made monthly based on the percent complete status of the Contract as determined by the ENGINEER.
- B. Bid Item 102 – Site Preparation -General
1. The lump sum payment for this item includes but is not limited to all necessary equipment, materials, and labor required for , installation and maintenance of temporary storm water control systems, construction and management of stockpiles, construction and maintenance of haul roads to and from areas under construction, borrow areas and stockpiles.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- C. Bid Item 103 - Silt Fence
1. Work includes, procurement and installation the Silt Fence required to be installed in all locations identified or described in the DRAWINGS and SPECIFICATIONS.
 2. Measurement: Liner Feet
 3. Payment: Payment for this item will be made monthly, until the completion of the item, based on the Linear Feet installed of the Silt Fence and approved by the ENGINEER.
- D. Bid Item 104 - Silt Logs
1. Work includes, procurement and installation Silt Logs required to be installed in all locations identified or described in the DRAWINGS and SPECIFICATIONS during construction. This is for temporary erosion control and not Site Restoration which is to be performed under a separate line item.
 2. Measurement: Each

Measurement and Payment

3. Payment: Payment for this item will be made monthly, until the completion of the item, based on the number of completed installations of each silt log and approved by the ENGINEER.
- E. Bid Item 105 – Temporary Erosion Control Matting
1. Work includes, procurement and installation of temporary erosion control matting required to be installed in all areas identified or described in the DRAWINGS and SPECIFICATIONS during construction. This is for temporary erosion control and not Site Restoration which is to be performed under a separate line item.
 2. Measurement: Surveyed Square Feet of Erosion Control Mat Installed.
 3. Payment: Payable based on the Square Feet of Erosion Control Mat appropriately installed per the specification.
- F. Bid Item 106 - Temporary Seeding
1. Work includes, procurement and installation of temporary seeding required to be installed in all areas identified or described in the DRAWINGS and SPECIFICATIONS during construction. This is for temporary seeding and not final vegetation seeding which is to be performed under a separate line item.
 2. Measurement: Surveyed Square Feet of Temporary Seeding Installed.
 3. Payment: Payable based on the Square Feet of Temporary Seeding installed per the specification and approved by the ENGINEER.
- G. Bid Item 107 – Excavation
1. The unit price per cubic yard (CY) for this item includes but is not limited to the excavation, hauling, stockpiling of overburden soil material, and final subbase grading to reach subbase grades as shown on the Drawings.
 2. Measurement for this bid item shall be determined in-place based on actual excavated “cut” amounts by comparing a beginning surface to an ending surface over the same undercut area. Units will be in CY and quantity survey will be by or under the direction of a RLS or PE.
 3. Payment for this item will be based on the actual CY quantity excavated, stockpiled, graded and as approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents .
- H. Bid Item 108 – Undercut and Backfill with General Fill
1. The unit price per cubic yard (CY) for this item includes but is not necessarily limited to the removal of organic or unstable soils from within the limits of grading and refilling these areas with compacted general fill as necessary.
 2. Measurement for this bid item shall be determined in-place based on actual excavated “cut” amounts by comparing a beginning surface to an ending surface over the same undercut area. Units will be in CY and quantity survey will be completed by or under the direction of a RLS or PE.
 3. Payment for this item will be based on the actual CY quantity excavated, graded and as approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- I. Bid Item 109 – Undercut and Backfill with Special Fill

1. The unit price per cubic yard (CY) for this item includes but is not necessarily limited to the removal of organic or unstable soils from within the limits of grading and refilling these areas with compacted special fill as necessary.
 2. Measurement for this bid item shall be determined in-place based on actual excavated "cut" amounts by comparing a beginning surface to an ending surface over the same undercut area. Units will be in CY and quantity survey will be completed by or under the direction of a RLS or PE.
 3. Payment for this item will be based on the actual CY quantity excavated, graded and as approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- J. Bid Item 110 - Structural Fill
1. The unit price per cubic yard for this item shall be payment in full for transporting, placement, moisture conditioning, compaction, grading, and proof-rolling in accordance with the Plans and Specifications and in conformance with the lines, grades, details, and cross-sections shown on the Drawings.
 2. Measurement for this bid item shall be determined in-place based on actual in place "fill" amounts by comparing a beginning surface to an ending surface over the same area. Units will be in CY and quantity survey will be completed by or under the direction of a RLS or PE.
 3. The structural fill volume placed and within the limits specified shall be determined by surveys performed by the OWNER before and after placement is complete. Payment for this item shall be made after the placement is complete and approved by the ENGINEER based on the record drawings.
- K. Bid Item 111 – RNG Area Finish Grading
1. The lump sum payment for this item includes but is not necessarily limited to preparation and finish grading of the subbase to final foot of the finished top of the aggregate layer for the RNG Gas Cleaning Area. The area designated for the Biogas Cleaning Equipment is not included in this contract.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- L. Bid Item 112 - Facility Concrete Pads
1. The lump sum payment for this item includes but is not necessarily limited to the concrete pads for the RNG Handling Equipment including the blower building, compression building, maintenance building, metering buildings, water tank decant panel, and flare skid. CONTRACTOR shall procure and install all, concrete, and other materials as necessary to complete the concrete pads for the equipment in accordance with project Drawings and Specifications.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

M. Bid Item 113 – Fixed Bollards

1. The unit price payment for this item includes but is not necessarily limited to the concrete bollards. CONTRACTOR shall procure and install all aggregate, concrete, and other materials as necessary to complete the concrete bollards in accordance with project Drawings and Specifications.
2. Measurement: Each
3. Payment: Payment for this item will be made monthly based on the number of bollards installed and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

N. Bid Item 114 – Removable Bollards

1. The unit price payment for this item includes but not necessarily limits to the removable bollards. Contractor shall procure all materials as necessary to complete the removable bollards in accordance to the project Drawings and Specifications.
2. Measurement: Each
3. Payment: Payable based on the number of bollards installed and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

O. Bid Item 115 – Aggregate Base for Paved / Parking Areas

1. The unit price per square foot (SF) for this item includes but is not necessarily limited to providing all necessary materials and labor required to procure and install the crushed stone base for pavement / parking areas in accordance with the project Drawings and Specifications.
2. Measurement for this bid item shall be determined in-place based on actual aggregate surface area as measured by a survey performed by or under the direction of a RLS or PE.
3. Payment for this item will be based on the actual SF quantity installed and as approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

P. Bid Item 116 – Asphalt Pavement Placement

1. The unit price per square foot (SF) for this item includes but is not necessarily limited to providing all necessary materials and labor required to procure and install bituminous asphaltic pavement in accordance with the project Drawings and Specifications.
2. Measurement for this bid item shall be determined in-place based on actual paved surface area as measured by a survey performed by or under the direction of a RLS or PE.
3. Payment for this item will be based on the actual SF quantity installed and as approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

Q. Bid Item 117 – Concrete Pavement Placement

1. The unit price per square foot (SF) for this item includes but is not necessarily limited to providing all necessary materials and labor required to procure and install concrete pavement in accordance with the project Drawings and Specifications.
2. Measurement for this bid item shall be determined in-place based on actual paved surface area as measured by a survey performed by a RLS or PE.

3. Payment for this item will be based on the actual SF quantity installed and as approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- R. Bid Item 118 - Aggregate Pad
1. The unit price per square foot (SF) for this item includes but is not necessarily limited to providing all necessary materials and labor required to procure and install the crushed aggregate parking area and road entrance to the Maintenance Building in accordance with the project Drawings and Specifications.
 2. Measurement for this bid item shall be determined in-place based on actual aggregate surface area as measured by a survey performed by or under the direction of a RLS or PE.
 3. Payment for this item will be based on the actual SF quantity installed and as approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- S. Bid Item 119 – Blower Building and Office Building
1. The lump sum payment for this item includes but is not necessarily limited to providing all necessary materials and labor required to construct and install the Blower/Office Building in accordance with the project Drawings and Specifications. RNG equipment installation to be performed under Bid Item 123. Electrical, Communication and Mechanical work to be performed under separate Bid Items.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- T. Bid Item 120 - Compression Building
1. The lump sum payment for this item includes but is not necessarily limited to providing all necessary materials and labor required to construct and install the Compression Building in accordance with the project Drawings and Specifications. RNG equipment installation to be performed under Bid Item 123. Electrical, Communication and Mechanical work to be performed under separate Bid Items.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- U. Bid Item 121- Boiler Building
1. The lump sum payment for this item includes but is not necessarily limited to providing all necessary materials and labor required to construct and install Boiler Building in accordance with the project Drawings and Specifications. RNG equipment installation to be performed under Bid Item 123. Electrical, Communication and mechanical work to be performed under separate Bid Items.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

- V. Bid Item 122 - Metering Skids **(to be supplied by OWNER, Not on Contract)**
1. The unit price payment for each metering skid building includes but is not necessarily limited to providing all necessary materials and labor required to construct the metering skid buildings in accordance with the project Drawings and Specifications. Metering Skid Installations to be performed under Bid Item 12419 and the Concrete Pad construction to be performed under Bid Item 11308. Electrical, Communication and mechanical work to be performed under separate Bid Items.
 2. Measurement: Each Metering Skid
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- W. Bid Item 123 – RNG Offload Facility Installation
1. The lump sum payment for this item includes but is not necessarily limited to providing all necessary materials and labor required to install the RNG processing equipment provided by the OWNER. RNG Offload Equipment shall be installed on concrete pads or in the housing buildings at locations shown in accordance with the Drawings and Specifications.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- X. Bid Item 124 – Metering Skids Installation
1. The unit price payment for this item includes but is not necessarily limited to providing all necessary materials and labor required to make necessary connections to each of the three (3) RNG metering skids. Metering skids shall be installed on the concrete pad(s) at the locations shown on the Drawings and in accordance with the Specifications.
 2. Measurement: Each Metering Skid Building
- Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- Y. Bid Item 125 – Condensate Management
1. The lump sum payment for this item includes but is not necessarily limited to procurement and installation of all leachate force main piping, manholes and condensate structures, connection to the existing force main piping, and air pressure testing of the force main in accordance with the Drawings and Specifications.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- Z. Bid Item 126 – Blower/Flare Facility Installation
1. The lump sum payment for this item includes but is not limited to providing all materials and labor required to install the landfill gas blower(s), flare and associated piping and

pipe connections at the locations shown in accordance with the Drawings and Specifications.

2. Measurement: Lump Sum
3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

AA. Bid Item 127 – Below Ground Gas Piping

1. The lump sum payment for this item includes but is not limited to the installation of all below ground ancillary piping runs between the RNG offload facility, blower/flare facility, and metering skids as shown in the Drawings. CONTRACTOR shall be responsible for interconnecting with BioFERM equipment tie-in locations in accordance with the Drawings and Specifications.
2. Measurement: Lump Sum
3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

BB. Bid Item 128 - Aboveground Gas Piping

1. The lump sum payment for this item includes but is not limited to the installation of all above ground ancillary piping runs between the Biogas Cleaning Equipment and RNG Handling Equipment including but not limited to the: offload facility, blower/flare facility, and metering skids as shown in accordance with the Drawings and Specifications.
2. Measurement: Lump Sum
3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

CC. Bid Item 129 - Aboveground Gas Piping Tie-ins

1. The lump sum payment for this item includes but is not limited to the installation of all above ground ancillary piping interconnecting between the RNG Handling Equipment, including but not limited to the: RNG offload facility, blower/flare facility, and metering skids as shown in the Drawings. CONTRACTOR shall be responsible for interconnecting with Biogas Cleaning Equipment tie-in locations, in accordance with the Drawings and Specifications.
2. Measurement: Lump Sum
3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

DD. Bid Item 130 - GCCS Header Installation

1. The lump sum payment for this item includes but is not necessarily limited to procurement and installation of pipe and fittings to complete the Landfill Gas header piping as shown on the Drawings. Piping will be terminated with (3) blind flanges on a cross as shown on the drawings. CONTRACTOR is responsible for all trenching as necessary to complete installation.

2. MEASUREMENT: LUMP SUM

3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

EE. Bid Item 131 - Supply and Install Flow Meters, Valves, and Pressure Regulators,

1. The lump sum payment for this item includes but is not necessarily limited to procurement and installation of all flow meters, gas valves, pressure regulators and check valves along the aboveground and below ground gas piping under Bid Items 127 and 128 in accordance with the Drawings and Specifications

2. MEASUREMENT: LUMP SUM

3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

FF. Bid Item 132 - Electrical Lines

1. The lump sum payment for this item includes but is not limited to the supply and installation of all conduit, electrical wiring and fixtures between the Biogas Cleaning Equipment and the various components of the RNG Handling Equipment including all buildings and interconnections between the RNG offload facility, blower/flare facility, metering skids, in accordance with the Drawings and Specifications.

2. Measurement: Lump Sum

3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

GG. Bid Item 133 – Communication Lines

1. The lump sum payment for this item includes but is not limited to the supply and installation of all conduit and communication wiring between Biogas Cleaning Equipment and the various components of the RNG Handling Equipment within the RNG facility, including all the buildings and interconnections offload facility, blower/flare facility, metering skids, in accordance with the Drawings and Specifications.

2. Measurement: Lump Sum

3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

HH. Bid Item 134 – Mechanical

1. The lump sum payment for this item includes but is not limited to the supply and installation of all mechanical components except of those specified in Bid Item 131 between Biogas Cleaning Equipment and the various components of the RNG Handling Equipment within the RNG facility, including but not limited to the blower building, compression building, boiler building, and maintenance building in accordance with the Drawings and Specifications.

2. Measurement: Lump Sum

3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- II. Bid Item 135 – Surface Water Drainage Features
1. The lump sum payment for this item includes but is not limited to construction/installation of ditches, infiltration trenches, the supply and installation of culverts, storm sewer, storm manhole, inlet and outlet structures in accordance with the Drawings and Specifications.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- JJ. Bid Item 136 - Fire Protection
1. The lump sum payment for this item includes but is not limited to construction/installation of a non-potable water well up to 250 feet deep, pump, piping, valves, 10,000 gallon above ground water storage tank, and fire hydrant as shown in the Drawings and Specifications.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- KK. Bid Item 137 – Supply and Install Fence
1. The lump sum payment for this item includes but is not necessarily limited to procurement and installation of perimeter fencing in accordance with the Drawings and Specifications.
 2. Measurement: Lump Sum
 3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- LL. Bid Item 138 – Supply and Install Security Devices
1. The lump sum price for this item includes but is not necessarily limited to procurement and installation of security cameras and secure facility access points as shown in the Drawings.
 2. Measurement: Lump Sum
 3. Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.
- MM. Bid Item 139 – Traffic Signage and Pavement Markings
1. The lump sum price for this item includes but is not necessarily limited to procurement and installation of all traffic signage and pavement marking as shown on the Drawings.
 2. Measurement: Lump Sum

3. Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

NN. Bid Item 140 – Site Restoration

1. The lump sum price for this item includes but is not necessarily limited to all necessary equipment, materials, and labor required to restore surfaces disturbed during construction to pre-construction conditions or better to the satisfaction of OWNER. This includes top soiling, seeding and establishing permanent vegetation.
2. Measurement: Lump Sum
3. Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER, and as determined by the Record Documents.

Alternate Bid Items

Alternate Bid Item 1 – Maintenance Building

1. The lump sum payment for this item includes but is not necessarily limited to providing all necessary materials and labor required to construct and install the Maintenance Building in accordance with the project Drawings and Specifications.
2. Measurement: Lump Sum
3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

Alternate Bid Item 2 - 4-inch Diameter Steel Process Gas Piping

1. The lump sum payment for this item includes but is not limited to the installation of the processed gas pipe line from the ANR Gas Pipeline interconnection to the compression building in accordance with the Drawings and Specifications.
2. Measurement: Lump Sum
3. Payment: Payment for this item will be made monthly based on the percentage of the work related to this item that is complete and approved by the ENGINEER at the time of the pay request, and as determined by the Record Documents.

PART 2 - PRODUCTS

(Not used)

PART 3 - EXECUTION

(Not used)

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT, DISPOSAL & RECYCLING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Summary
 - 2. Waste Management Goals
 - 3. Construction and / or Demolition Waste Management
 - 4. Waste Management Plan
 - 5. Reuse
 - 6. Recycling
 - 7. Materials Sorting and Storage On Site
 - 8. Lists of Recycling Facilities Processors and Haulers
 - 9. Waste Management Plan Form

- B. Related Sections:
 - 1. Section 01 00 00 - Basic Requirements

1.2 WASTE MANAGEMENT GOALS

- A. Dane County requires that as many waste materials as possible produced as result of this project be salvaged, reused or recycled in order to minimize impact of construction waste on landfills and to minimize expenditure of energy and cost in fabricating new materials. Additional information may be found in Dane County Green Building Policy, Resolution 299, 1999-2000.

1.3 CONSTRUCTION AND / OR DEMOLITION WASTE MANAGEMENT

- A. All construction and demolition waste suitable for recycling must go to Dane County Construction & Demolition Recycling Facility located at 7102 US Hwy 12, Madison, located across from Yahara Hills Golf Course. This facility can receive mixed loads of construction and demolition waste. For complete list of acceptable materials see www.countyofdane.com/pwht/recycle/CD_Recycle.aspx.
- B. Dane County Landfill, also at 7102 US Hwy 12, Madison, must receive all other waste from this project. www.countyofdane.com/pwht/recycle/landfill.aspx.

1.4 WASTE MANAGEMENT PLAN

- A. Contractor shall develop Waste Management Plan (WMP) for this project. Dane County's Special Projects & Materials Manager may be contacted with questions. Outlined in RECYCLING section of this specification are examples of materials that can be recycled or reused as well as recommendations for waste sorting methods.

B. Contractor shall complete WMP and include cost of recycling / reuse in Bid. WMP will be submitted to Public Works Project Manager within fifteen (15) business days of Bid Due date. Copy of blank WMP form is in this Section. Submittal shall include cover letter and WMP form with:

1. Information on:
 - a. Types of waste materials produced as result of work performed on site;
 - b. Estimated quantities of waste produced;
 - c. Identification of materials with potential to be recycled or reused;
 - d. How materials will be recycled or reused;
 - e. On-site storage and separation requirements (on site containers);
 - f. Transportation methods; and
 - g. Destinations.

1.5 REUSE

A. Contractors and subcontractors are encouraged to reuse as many waste materials as possible. Salvage should be investigated for materials not reusable on site.

1.6 RECYCLING

A. These materials must be recycled at Dane County Construction & Demolition Recycling Facility:

1. Wood.
2. Wood Pallets.
3. PVC Plastic (pipe, siding, etc.).
4. Asphalt & Concrete.
5. Bricks & Masonry.
6. Vinyl Siding.
7. Cardboard.
8. Metal.
9. Unpainted Gypsum Drywall.
10. Shingles.

B. These materials can be recycled elsewhere in Dane County area:

1. Fluorescent Lamps.
2. Foam Insulation & Packaging (extruded and expanded).
3. Carpet Padding.
4. Barrels & Drums.

C. All materials must be recycled at WDNR permitted waste processing facilities that adhere to all State Statutes.

1.7 MATERIALS SORTING AND STORAGE ON SITE

A. Contractor shall provide separate containers for recyclable materials. Number of containers will be dependent upon project and site conditions.

B. Contractor shall provide on-site locations for subcontractors supplied recycling containers to help facilitate recycling.

- C. Mixed loads of recycled materials are allowed only per instructions at www.countyofdane.com/pwht/recycle/CD_Recycle.aspx.

1.8 LISTS OF RECYCLING FACILITIES PROCESSORS AND HAULERS

- A. Refer to www.countyofdane.com/pwht/recycle/CD_Recycle.aspx for information on Dane County Construction & Demolition Recycling Facility.
- B. Web site www.countyofdane.com/pwht/recycle/categories.aspx lists current information for Dane County Recycling Markets. Contractors can also contact Allison Rathack at 608/266-4990, or local city, village, town recycling staff listed at site www.countyofdane.com/pwht/recycle/contacts.aspx. Statewide listings of recycling / reuse markets are available from UW Extension at <https://www.uwgb.edu/shwec/>.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

WASTE MANAGEMENT PLAN FORM



Contractor Name: _____

Address: _____

Phone No.: _____ Recycling Coordinator: _____

MATERIAL	ESTIMATED QUANTITY	DISPOSAL METHOD (CHECK ONE)		RECYCLING / REUSE COMPANY OR DISPOSAL SITE
Salvaged & reused building materials	_____ cu. yds. _____ tons	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Wood	_____ cu. yds. _____ tons	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Wood Pallets	_____ units	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
PVC Plastic	_____ cu. ft. _____ lbs.	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Asphalt & Concrete	_____ cu. ft. _____ lbs.	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Bricks & Masonry	_____ cu. ft. _____ lbs.	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Vinyl Siding	_____ cu. ft. _____ lbs.	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Cardboard	_____ cu. ft. _____ lbs.	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Metals	_____ cu. yds. _____ tons	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Unpainted Gypsum / Drywall	_____ cu. yds. _____ tons	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Shingles	_____ cu. yds. _____ tons	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Fluorescent Lamps	_____ cu. ft. _____ lbs.	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Foam Insulation	_____ cu. ft. _____ lbs.	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Carpet Padding	_____ cu. ft. _____ lbs.	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	
Barrels & Drums	_____ units	_____ Recycled	_____ Reused	Name: _____
		_____ Landfilled	_____ Other	

WASTE MANAGEMENT PLAN FORM

Glass	_____ cu. yds. _____ tons	_____ Recycled _____ Landfilled	_____ Reused _____ Other	Name: _____
Other	_____	_____ Recycled _____ Landfilled	_____ Reused _____ Other	Name: _____
Other	_____	_____ Recycled _____ Landfilled	_____ Reused _____ Other	Name: _____
Other	_____	_____ Recycled _____ Landfilled	_____ Reused _____ Other	Name: _____
Other	_____	_____ Recycled _____ Landfilled	_____ Reused _____ Other	Name: _____
Other	_____	_____ Recycled _____ Landfilled	_____ Reused _____ Other	Name: _____

SECTION 02 01 00

SITE PREPARATION

PART 1 - GENERAL

1.1 Section Includes

- A. Clearing, stripping, grubbing, removing, and disposing of trees, shrubs, brush, logs, stumps, roots, windfalls, and other plant life, including dead and decayed matter, that exists within construction and designated borrow areas.
- B. Installation of erosion control and temporary stormwater control measures.

PART 2 - PRODUCTS

2.1 Erosion Control Materials

- A. Silt Fence: Woven or non-woven complying with WDNR Technical Standards.
- B. Erosion Bales: Hay or straw, in good condition, with rectangular surfaces, tightly bound with twine.
- C. Rip Rap:

PART 3 - EXECUTION

3.1 Erosion Control Material Installation

- A. Erosion control materials shall be installed in accordance with the appropriate WDNR Technical Standard at the locations shown on the Construction Drawings.

3.2 Clearing and Grubbing

- A. Install erosion controls prior to site clearing.
- B. Remove trees, shrubs, brush, logs, stumps, roots, windfalls, and other natural growth within construction and borrow areas.
- C. Remove stumps, roots, and logs to a minimum depth of 2 feet below ground surface.
- D. Install silt fence w/in 10' radius of groundwater monitoring wells and gas monitoring probes.

3.3 Disposal

- A. Remove debris/spoil and dispose of in a manner consistent with applicable State and Local regulations. On-site disposal is subject to discretion of landfill manager. Burning of debris is not permitted unless proper permits are obtained and permission is granted by Owner. Strip areas of topsoil prior to placing fill. Stockpile topsoil in area designated on-site.

3.4 Protection of Existing Trees and Vegetation

- A. Preserve and protect from damage trees and vegetation outside the Construction / Borrow Limits.

B. Paint any cut or scarred trees and shrubs with asphaltum-base tree paint.

* * * END OF SECTION * * *

SECTION 03 10 00

CONCRETE FORMWORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General and Supplementary Conditions of the Construction Contract and Division 1 - General Requirements apply to the work specified in this section.
- B. This section includes the design, construction and treatment of formwork and related accessories to confine and shape concrete to the required dimensions.
- C. Structural notes indicated on the drawings regarding concrete formwork shall be considered a part of this specification.

1.2 QUALITY ASSURANCE

- A. Codes and Standards: Comply with the provisions of the following codes, specifications, and standards except where more stringent requirements are shown or specified.
 - 1. ACI 117 – Standard Specification for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 – Standard Specification for Structural Concrete.
 - 3. ACI 318 – Building Code Requirements for Structural Concrete.
 - 4. ASTM C31 – Standard Specification for Making and Curing Concrete Test Specimens in the Field.
 - 5. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Test Specimens.
- B. Where provisions of the pertinent Codes and Standards conflict with this specification, the more stringent provision shall govern.

1.3 SUBMITTALS

- A. Formwork Release Agent: Submit data on the formwork release agent proposed for use with each form surface to be used for acceptance unless otherwise specified in the Contract Documents. Include certification that agent is compatible with finish.
- B. Testing for Formwork Removal: When methods other than cylinder tests are proposed for determining time for formwork removal, submit data on methods for approval.

1.4 DESIGN REQUIREMENTS

- A. Design and Engineering of formwork is the responsibility of the Contractor. Design and construct formwork, shoring and bracing to conform to Contract Documents and building code requirements. Design for construction loads, lateral pressure, and requirements of the applicable building code.

- B. Drawings show the design requirements and dimensions for structural strength, but structural drawings do not show all detail dimensions to fit intricate Architectural and mechanical detail. Contractor shall so construct the concrete work that it will conform to the clearance required by the Mechanical and Electrical design.
- C. Maximum deflection of facing materials forming concrete surfaces exposed to view shall be 1/240 of the center-to-center span between structural members of the formwork.

PART 2 - PRODUCTS

2.1 MATERIALS AND ACCESSORIES

- A. Formwork Accessories: Use commercially manufactured accessories for formwork accessories that are partially or completely embedded in concrete, including ties and hangers.
- B. Formwork Release Agent: Use commercially manufactured form release agents that will prevent formwork absorption of moisture, prevent bond with concrete, and will not stain the concrete surface. Formwork release agent shall be compatible with paint or any other finish applied to the concrete; submit data indicating compatibility.
- C. Form Material:
 - 1. No aluminum shall be allowed in the concrete work unless coated to prevent aluminum-concrete reaction.
 - 2. Concrete form materials must be used in a manner so as to provide the surface finish specified.
 - 3. Design formwork in accordance with the provisions of the building code or the following standards if not covered in the building code:
 - a. Wood - AF & PA "National Design Specification".
 - b. Plywood - American Plywood Association "Plywood Design Specification".
 - c. Steel - AISC "Manual of Steel Construction - Allowable Stress Design".
 - d. Cold-formed Steel - AISI "Cold-Formed Steel Design Manual".
 - e. Aluminum - Aluminum Association "Aluminum Construction Manual".
 - f. Concrete - ACI 318.
 - g. Other materials - as directed by manufacturer.
- D. Chamfer Strips:
 - 1. Chamfer strips shall be 3/4 inch by 3/4-inch strips.

2.2 FORM FINISHES

- A. Rough Form Finish:
 - 1. Concrete surfaces not exposed to view in the finished work shall have a rough-form finish. No form-facing material is specified for rough-form finish.

2. Set and maintain forms so finished concrete dimensions shall conform to the tolerances. Rough form finish is Designated Surface Finish-1.0 from ACI 301, except that surface tolerance Class C is required as specified in ACI 117.
- B. Smooth Form Finish:
1. Concrete surfaces exposed to view in the finished work or surfaces to receive finishes of any type (paint, textured paint, etc.) shall have a smooth form finish. Form-facing material shall be plywood, tempered concrete-form-grade hardboard, metal, plastic, paper, or other acceptable material capable of producing the desired finish. Form-facing material shall produce a smooth, uniform texture on the concrete. Do not use form facing material with raised grain, torn surfaces, worn edges, patches, dents, or other defects that might impair the texture of the concrete surfaces.
 2. Set and maintain forms so finished concrete dimensions shall conform to the tolerances. Smooth form finish is Designated Surface Finish-3.0 from ACI 301, including surface tolerance Class A as specified in ACI 117.
- C. Patching and repairing concrete finishes are specified under Section 03 30 00.

2.3 FABRICATION AND MANUFACTURE

- A. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of the exposed concrete surface.
 2. Furnish ties that, when removed, will leave holes not larger than 1 inch in diameter in concrete surface.

PART 3 - EXECUTION

3.1 CONSTRUCTION OF TEMPORARY FORMWORK

- A. Design, erect, shore, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.
- B. At construction joints, lap contact surface of the form sheathing for flush surfaces exposed to view over the hardened concrete in the previous placement by not more than 1 inch. Ensure formwork is held firmly against hardened concrete to prevent offsets or loss of mortar at construction joints and to maintain a true surface.
- C. Unless specified in the Contract Documents, construct formwork so concrete surfaces conform to tolerance limits. The class of surface for offset between adjacent pieces of formwork facing material shall be Class C, unless specified otherwise.
- D. Provide positive means of adjustment (wedges or jacks) of shores and struts. Do not make adjustments in the formwork after concrete has taken its initial set. Brace formwork securely against lateral deflection and lateral instability.

- E. Fasten form wedges in place after final adjustment of forms and prior to concrete placement.
- F. Anchor formwork to shores, supporting surfaces, or members to prevent upward or lateral movement of the formwork system during concrete placement.
- G. Securely brace and shore forms to prevent displacement and to safely support construction loads.
- H. Construct formwork for wall openings to facilitate removal and to counteract swelling of wood formwork. Keep wood forms wet as necessary to prevent shrinkage.
- I. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces.
- J. Do not use rust-stained steel form-facing material.
- K. Unless noted otherwise, all footings shall be centered under walls, piers or columns.
- L. Provide runways for moving equipment and support runways directly on formwork or structural member without resting on the reinforcing steel.
- M. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for support of adjoining work prior to concrete placement.
- N. Position and support expansion joint material and other embedded items to prevent displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
- O. Projecting corners of walls and piers shall be formed with a 3/4-inch chamfer.
- P. Clean surfaces of formwork and embedded materials of mortar, grout, and foreign material before concrete is placed.
- Q. Cover surfaces of formwork with acceptable formwork release agent. Apply form release agent before placing reinforcing steel and concrete according to manufacturer's written instructions. Do not allow formwork release agent to puddle in forms. Do not allow formwork release agent to contact reinforcing steel or hardened concrete against which fresh concrete is to be placed
- R. Clean and inspect formwork immediately before concrete is placed.
- S. Provide forms for concrete work adjacent to earth banks including sides of footings.
- T. Construct forms plumb and straight to conform to slopes, lines and dimensions shown.
- U. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

3.2 COORDINATION

- A. Install all required pipe sleeves, cavities or slots. Notify appropriate trades in due time so that they may furnish information and make necessary installations. Check sizes, location and alignment of all openings, frames and other work, which are to be built-in including electrical boxes and conduit.
- B. Layout the run of partitions and establish location of openings so that other trades may properly locate their work.
- C. Core drilling concrete is not permitted unless noted otherwise or approved in writing by the Engineer. Notify the Engineer in advance of conditions not shown on the drawings.

3.3 INSTALLATION OF EMBEDDED ITEMS

- A. Built-In Items:
 - 1. Confirm with Engineer that all materials to be embedded are suitable for embedment in concrete.
 - 2. Build in anchors, inserts, and other devices indicated or required for various portions of work.
 - 3. Build in sleeves, thimbles, and other items furnished or set in place by other trades.
 - 4. Accurately position and support all embedded items prior to concrete placement. Secure embedded items against displacement during concrete placement operations.
 - 5. Fill voids with readily removable material to prevent entry of concrete into voids.
 - 6. Mechanical and electrical shall provide and set required sleeves.
 - 7. Coordinate setting of all embedded items.

3.4 REMOVAL OF FORMS

- A. When removal of formwork is based on concrete reaching a specified compressive strength, concrete will be presumed to have reached this strength when either of the following requirements has been met:
 - 1. Test cylinders, molded and cured under the same conditions for moisture and temperature as used for the concrete they represent, have reached the specified compressive strength.
 - 2. Concrete has been cured in accordance with the specifications for the same length of time as laboratory-cured cylinders, which have reached the specified strength. Determine the length of time concrete has been cured in the structure by the cumulative number of days or fractions thereof, not necessarily consecutive, during which the temperature of the air in contact with the concrete is above 50 degrees and the concrete has been damp or thoroughly sealed from evaporation and loss of moisture.

- B. Forms shall remain in place for the following periods of time. These periods represent cumulative number days or hours, not necessarily consecutive, during which the temperature of the air surrounding the concrete is above 50 F:
 - 1. Walls, piers, and footings: 50% specified compressive strength or minimum 24 hours.
- C. When finishing is required, remove forms as soon as removal operations will not damage concrete.
- D. Loosen wood formwork for wall openings when this can be accomplished without causing damage to concrete.
- E. Do not allow removal of formwork to damage the fresh concrete for piers, walls, and other parts supporting the weight of the concrete. Perform needed repair and treatment required on vertical surfaces at once and follow immediately with specified curing.

3.5 FASTENER REMOVAL

- A. Remove all protruding fasteners left as a result of securing inserts to forms by Contractor responsible for insert.
- B. Cutting flush with surface is not acceptable.
- C. Patch exposed concrete surfaces if damaged during fastener removal process.

3.6 REMOVING AND REUSING FORMS

- A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- B. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General and Supplementary Conditions of the Construction Contract and Division 1 - General Requirements apply to the work specified in this section.
- B. This section includes the fabrication and placement of reinforcing steel for concrete, and all related accessories.
- C. Structural notes indicated on the drawings regarding concrete reinforcement shall be considered a part of this specification.

1.2 QUALITY ASSURANCE

- A. Codes and Standards: Comply with the provisions of the following codes, specifications and standards, except where more stringent requirements are shown or specified.
 - 1. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 - Standard Specification for Structural Concrete.
 - 3. ACI 318 - Building Code Requirements for Structural Concrete.
 - 4. ACI 315 - Details and Detailing of Concrete Reinforcement.
 - 5. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - 6. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - 7. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 8. AWS D1.4 - Structural Welding Code - Reinforcing Steel.
 - 9. CRSI - Manual of Standard Practice.
- B. Where provisions of other pertinent codes and standards conflict with this specification, the more stringent provision shall govern.

1.3 SUBMITTALS

- A. Placing Drawings: Submit placing drawings showing fabrication dimensions and locations for placement of reinforcement and reinforcement accessories. Indicate bar sizes, spacing, locations, and quantities of reinforcing steel, bending and cutting diagrams, and supporting and spacing devices. Dowels shall be shown in placing drawings for the element that is to be placed first. Reinforcing steel descriptions or shop drawings shall be inch-pound sizes.

- B. Field Bending: Submit requests and procedure for field bending or straightening of reinforcement partially embedded in concrete not described in the Contract Documents.
- C. Reinforcement Relocation: Submit requests to adjust reinforcement spacing necessitated by conflicts with other reinforcement, conduits, etc. for approval.

1.4 COORDINATION

- A. Coordinate reinforcement installation with the placement of formwork and other embedded items such as inserts, conduit, pipe sleeves, drains, metal supports, anchor rods, etc.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver reinforcement to the jobsite in bundles sorted and labeled with durable tags indicating bar size, length, and shop drawing mark.
- B. Store elevated clear of ground and protect at all times from contamination and deterioration.
- C. Prevent bending, coating with earth, oil, or other material, or otherwise damaging the reinforcement.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Bar Deformations: Bars used for reinforcement shall be deformed except column spirals and welded wire reinforcement, which may be plain.
- B. Reinforcing Steel: Reinforcing steel shall conform to the ASTM standard and grade indicated in the General Notes on the Drawings.
- C. Welded Wire Reinforcement: Welded wire reinforcement shall conform to the ASTM standard indicated in the General Notes on the Drawings.
- D. Joint Dowel Bars: Plain-steel bars. Cut bars true to length with square ends and free of burrs.
- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.
 - 2. Concrete cast against earth: Bars may be supported by precast concrete bricks or approved prefabricated wire bar supports with footpads large enough to support the weight of the bars and construction traffic without being pushed into underlying grade. Precast concrete blocks shall have a minimum compressive strength of 6,000 psi.

- F. Epoxy Anchoring System: Epoxy anchoring shall consist of a reinforcing dowel and the epoxy adhesive cartridge.
 - 1. Reinforcing shall be as specified earlier in this Section.
 - 2. Epoxy injection gel shall consist of a two-component structural epoxy adhesive applied in a dual cartridge dispensing system, which properly mixes the components at the point of application. Refer to General Notes for acceptable epoxy anchoring systems.

2.2 FABRICATION

- A. Fabrication Tolerances: Reinforcing steel shall be shop fabricated within tolerances to conform in size, shape, quantity, dimensions, etc. to the Construction Drawings and approved Shop Drawings.
- B. Bar Condition: Bars shall be free from mill scale, excessive rust and other coatings, which would reduce or destroy the bond with the concrete.
- C. Bars Bending: Bars shall be bent cold, and no method of fabrication shall be used which would be injurious to the material. Heating of bars for bending is not permitted.
- D. Identification: After fabrication, bars shall be sorted, bundled and tagged with metal tags bearing the bar mark before delivery to the jobsite.
- E. Corner Bars: Provide corner bars to make reinforcing continuous at all times, including intersections at footings or walls. Such bars shall be the same size and spacing as the horizontal reinforcing and each leg shall have a length of at least 30 inches.
- F. Reinforcing for continuous footings shall extend into spread footings a minimum of 2'-0".
- G. Dowels between footings and walls or piers shall be the same grade, size and spacing or number as the vertical reinforcing respectively, unless noted otherwise.

PART 3 - EXECUTION

3.1 PLACING

- A. Reinforcement Relocation: When necessary to move reinforcement beyond the specified spacing to avoid interference with other reinforcement, or embedded items, submit resulting arrangement of reinforcement to Engineer for approval.
- B. Reinforcement Cutting: Cutting of reinforcement which conflicts with embedded objects is not acceptable.
- C. Welded Wire Reinforcement: Extend welded wire reinforcement to within 1 inch of the concrete edge. Lap edges and ends of fabric sheets a minimum of one full mesh square plus 2". Support welded wire reinforcement during placing of concrete to assure required positioning in the slab. Do not place wire reinforcement on grade and raise into position in freshly-placed concrete.
- D. Wire Tie Orientation: Set wire ties so that ends are directed away from concrete surface.

- E. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- F. Support for Reinforcement: Unless noted otherwise, supports for reinforcement shall have Class 2 protection as defined in the CRSI Manual of Standard Practice. Submit data on supports indicating class of protection at all different locations for approval.
- G. Support for Bars in Concrete Cast on Ground: Bar supports for slabs on grade, footings, and all other concrete cast directly onto grade shall be supported at an average spacing of 4 feet or less in each direction.
- H. Securing Reinforcing Bars: All bars must be placed, spaced, secured and supported prior to casting concrete. Bars embedded in hardened or partially hardened concrete shall not be bent unless approved in writing prior to placement by the Engineer of Record.
- I. Foot Traffic: Restrict foot traffic over the slab on grade reinforcing after it has been properly positioned.
- J. Reinforcement at Expansion Joints: Do not continue reinforcement or other embedded metal items bonded to concrete through expansion joints except for hairpins in slab on grade. Dowels bonded on only one side of a joint.
- K. Pumping Concrete: When using a pump to place concrete, pump hose shall be supported directly on forms. Do not allow hose to rest on reinforcing bars if doing so could cause displacement of bars.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General and Supplementary Conditions of the Construction Contract and Division 1 - General Requirements apply to the work specified in this section.
- B. The work includes all items required for executing and completing the cast-in-place concrete work and related work shown on the drawings or specified herein. Work shall include installation of items furnished in other sections of these specifications.
- C. Concrete paving, walks, and curbs are specified in Division 3 or 32.
- D. Structural notes indicated on the drawings regarding Cast-In-Place concrete shall be considered a part of this specification.

1.2 QUALITY ASSURANCE

- A. Codes and Standards: Comply with the provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified herein:
 - 1. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 - Standard Specifications for Structural Concrete
 - 3. ACI 305.1 - Specification for Hot Weather Concreting
 - 4. ACI 306.1 - Standard Specification for Cold-Weather Concrete
 - 5. ACI 318 - Building Code Requirements for Reinforced Concrete.
 - 6. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 7. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 8. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 9. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 10. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
 - 11. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
 - 12. ASTM C150 - Standard Specification for Portland Cement.

13. ASTM C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
 14. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
 15. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
 16. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 17. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 18. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 19. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 20. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
 21. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
 22. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 23. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
 24. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
 25. ASTM D1751 - Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
 26. ASTM E154 - Standard Test Method for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
 27. ASTM E329 –Standard Specification for Agencies Engaged in Testing and/or Inspection of Material Used in Construction
 28. ASTM E1155 - Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.
 29. Concrete Reinforcing Steel Institute (CRSI) - Manual of Standard Practice.
- B. Comply with all local building code requirements which are more stringent than those listed above. All referenced codes or standards shall be the most currently adopted as of the date for Receipt of Proposal.
- C. Where any provision of other pertinent codes and standards conflict with this specification, the more stringent provision shall govern.

- D. Maintain records verifying materials used are of the specified and accepted types and sizes and are in conformance with the requirements of the Contract Documents.
- E. Use of testing services will not relieve the Contractor of the responsibility to furnish materials and construction in full compliance with the Contract Documents.

1.3 TESTING AND INSPECTION

- A. Inspection and Testing:
 - 1. The Owner shall employ an Inspection Agency to perform the duties and responsibilities specified below.
 - 2. Refer to civil, mechanical, and electrical specifications for testing and inspection requirements of non-structural components.
 - 3. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected per the table below. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specification to the building official and the Owner and Engineer of Record.
 - 4. Duties of the Inspection Agency:
 - a. Perform all testing and inspection required per the Testing and Inspection Schedule indicated below.
 - b. Furnish inspection reports to the building official, the Owner, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work.
 - c. Submit a final signed report stating whether the work requiring Inspection was, to the best of the Inspection Agency’s knowledge in conformance with the approved plans and specifications.
 - 5. Structural Component Testing and Inspection Schedule for Section 03 30 00 is as follows:

Concrete and Concrete Placement	Continuous	Periodic	Referenced Standard
Review of proposed mix design and supporting test results		X	
Inspect bolts to be installed in concrete prior to and during placement of concrete.	X		ACI 318: 8.1.3, 21.2.8
Inspection of anchors installed in hardened concrete.		X	ACI 318: 3.8.6, 8.1.3, 21.1.8
Verifying use of required design mix		X	ACI 318: Ch. 4, 5.2-5.4

Concrete and Concrete Placement	Continuous	Periodic	Referenced Standard
At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	X		ASTM C172, ASTM C31, ACI 318: 5.6, 5.8
Inspection of concrete placement for proper application techniques	X		ACI 318: 5.9, 5.10
Inspection for maintenance of specified curing temperature and techniques.		X	ACI 318: 5.11 - 5.13
F _F and F _L slab on grade flatness testing			ASTM E1155

B. Sampling and testing requirements:

1. Take samples of fresh concrete at the job site for each mix design placed each day. Sampling and testing shall be done after the final addition and proper mixing of any water or admixtures that are added on site.
 - a. Personnel and testing equipment shall meet the requirements of ASTM E329.
 - b. Testing Frequency: Obtain at least one composite sample for each 150 cu. yd. or 5,000 sq. ft. of surface area, whichever is less or fraction thereof of each concrete mixture placed each day.
 - 1) On a given project, if the total volume of concrete is such that the frequency of testing required above would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.
 - c. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days.
2. For each sample of fresh concrete, perform the following duties:
 - a. Measure and record slump in accordance with ASTM C143.
 - b. Measure and record temperature in accordance with ASTM C1064.
 - 1) Provide one test hourly when air temperature is 40°F (4.4°C) and below and when 80°F (27°C) and above, and one test for each composite sample.
 - c. Measure and record air content by volume in accordance with either ASTM C231 or ASTM C173.

- d. Mold three cylinders (laboratory cylinders) in accordance with ASTM C31 to be laboratory-cured. Protect from moisture loss and maintain at 60°F to 80°F for 24 to 48 hours before moving. Deliver cylinders to testing laboratory for curing and testing.
 - e. Mold one cylinder (field cylinder) in accordance with ASTM C31 to be field-cured. Field cylinder shall be placed as near as possible to the in-place concrete from which it was taken, protected, and cured in the same manner. Deliver field-cured cylinder to testing laboratory, and measure and record compressive strength in accordance with ASTM C39. Field cylinder shall be used to determine if concrete footings, walls, or piers have reached the required compressive strength for steel erection to begin.
3. Measure and record compressive strength in accordance with ASTM C39 for laboratory cylinders. Test one laboratory cylinder at 7 days and all other cylinders at 28 days. Acceptance is based on the average of the two laboratory cured 28-day tests. Notify Engineer in the event strength levels do not meet the acceptance requirements of ACI 318.
 - a. Any additional cylinders molded for Contractor to have a compressive strength test done before seven days shall be at the Contractor's expense.
 4. Prepare and submit test reports to the Engineer, Contractor, and Supplier. Reports shall be completed and furnished within 48 hours of testing. Refer to description in Submittals.
 5. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

1.4 SUBMITTALS

- A. Concrete submittals shall be separated into concrete submittals for structural concrete as specified by the specification and civil concrete as specified by the Civil Engineer.
- B. Concrete Materials: Submit information on concrete materials as listed below.
 1. Cementitious materials: Submit type, class, producer name, and certification not more than 90 days old of compliance with applicable ASTM standard.
 2. Aggregates: Submit type, pit or quarry location, producer name, gradations, specific gravity, water content, and certification not more than 90 days old.
 3. Admixtures: Submit product data sheet. Product data shall include: dosages and performance data, brand names, producers, chloride ion concentrations, and certifications of compliance with applicable ASTM standard. Certifications shall not be more than 90 days old.
 4. Water: Submit name of source.
- C. Product Data: Prepare and submit product and performance data for materials and accessories, including patching compounds, joint systems, curing compounds, finish materials and other concrete related items.

- D. Testing Agency Qualifications: When requested, the proposed testing agencies shall submit data on qualifications for acceptance.
- E. Concrete Mix Design:
 - 1. Concrete mix design submittals shall be submitted at least 14 days prior to placing concrete.
 - 2. Submit concrete mixture proportions and characteristics for each concrete mix. Include standard deviation analysis or trial batch data with mix design. Submit historical field test data to demonstrate the average compressive strength for approval. Concrete mix proportions, materials, and handling methods for field test data or trial batches shall be the same as used for the work. Include the following information for each mix design:
 - a. Water/cementitious materials ratio.
 - b. Slump per ASTM C143
 - c. Air content per ASTM C231 or ASTM C173
 - d. Unit weight of concrete per ASTM C138
 - e. Compressive strength at 28 days per ASTM C39
 - 3. If trial batches are used, submit representative samples of each proposed ingredient to independent testing laboratory for use in preparation of mix design.
 - 4. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments. Indicate amounts of mix water to be withheld for later addition at Project site.
 - 5. Provide a record copy of the final mix designs and test results to the testing agency prior to commencement of the concrete work.
- F. Test Reports: Submit laboratory test reports for concrete materials, mix design, compressive strength, slump, air content, and temperature. Each report shall indicate date of sampling, date of test, mix design, and location of concrete in structure.
- G. Repair Methods: When stains, rust, efflorescence, and surface deposits must be removed, submit the proposed method of removal.
- H. Certificates: Submit written certification regarding the design mix from the ready-mix supplier and the admixture manufacturer stating all concrete and admixtures do not contain chloride ions in excess of concentrations specified herein.
- I. Adjustments: Submit any adjustments to mixture proportions or changes in materials, suppliers, or sources along with supporting documentation during the course of the work.
- J. Cold Weather Procedure Submittal: Refer to Cold Weather Concreting article in Part 3 for more information.

1.5 MATERIAL DELIVERY, STORAGE, AND HANDLING

- A. Cementitious materials: Store cementitious materials in dry weather tight buildings, bins, or silos that exclude contaminants.

- B. Aggregates: Store and handle aggregate in a manner that will avoid segregation and prevent contamination with other materials or other sizes of aggregates. Store aggregates so as to drain freely.
- C. Admixtures: Protect stored admixtures against contamination, evaporation, or damage. Protect liquid admixtures from freezing and temperature changes, which would adversely affect their performance. Handle chemical admixtures in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Portland Cement: Portland cement shall conform to ASTM C150, Type I Normal, and be a standard brand of Portland cement. Use one brand of cement throughout project, unless approved in writing by the Engineer. Cement, which conforms to ASTM C150 Type II, may be used if it also meets the requirements of ASTM C150 Type I. Cement used in concrete shall be of the same brand and type as the cement used in the concrete represented by the submitted field test data or used in the trial mixtures. Maintain consistent cement color throughout project.
 - 1. Total replacement of Portland cement by supplementary cementitious materials in design mixture shall not exceed 50% (by weight).
- B. Supplementary Cementitious Materials
 - 1. Fly Ash: Fly ash shall conform to ASTM C618, Class C or Class F. Replacement of Portland cement by fly ash shall not exceed the following (percentages are by weight):
 - a. Concrete Flatwork: 20 percent.
 - b. All other concrete: 25 percent.
 - c. Concrete to be placed in cold weather as defined herein: No fly ash allowed unless the cold weather procedure submitted has compensated for the increased setting time and decreased rate of strength gain due to cold weather and fly ash.
 - 2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 - a. Ground Granulated Blast-Furnace Slab Limit: 50% by weight of total cementitious materials.
 - b. In mass concrete more than 2 feet thick, the usage rate may be 80% by weight of total cementitious materials.
- C. Coarse Aggregate for Normal Weight Concrete: Comply with ASTM C33. Provide coarse aggregate from a single source for exposed concrete. Gradations shall be similar to that described in the following table:

COARSE AGGREGATE GRADATIONS							
SIEVE SIZE - PERCENT PASSING							
Grade No.	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 16

COARSE AGGREGATE GRADATIONS							
SIEVE SIZE - PERCENT PASSING							
Grade No.	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 16
4	90-100 Note 1	20-55	0-15	---	0-5		---
57	100	95-100	---	25-60	0-10	0-10	---
67		100	90-100	---	20-55	0-10	---

1. Shall be 100 percent passing the 2" sieve.

- D. Fine Aggregate for Normal Weight Concrete: Comply with ASTM C33. Provide fine aggregate from a single source for exposed concrete. Fine aggregate shall consist of washed sand. Gradations shall be similar to that described in the following table:

FINE AGGREGATE GRADATIONS							
SIEVE SIZE - PERCENT PASSING							
Grade No.	3/8	No. 4	No. 8	No. 16	No. 50	No. 80	No. 100
FA	100	95-100	80-100	50-85	5-30	---	0-10

- E. Do not use aggregates containing deleterious substances that could cause spalling on any exterior exposed surface. These include, but are not limited to the following:
1. Organic impurities.
 2. Ferrous metals.
 3. Soluble salts.
 4. Coal, lignite, or other lightweight materials.
 5. Soft particles.
 6. Clay lumps and friable particles.
 7. Cherts of less than 2.40 specific gravity.
- F. Water: Mixing water for concrete shall meet the requirements of ASTM C94. Water shall be clean and free from injurious amounts of acids, alkalies, organic materials, chloride ions and oils deleterious to concrete or reinforcing steel.
- G. Testing agency shall be given access to plants and stockpiles to obtain samples for testing for compliance with the Contract Documents.

2.2 ADMIXTURES

- A. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures. Calcium chloride thiocyanates or admixtures containing more than 0.05 percent chloride ions by weight are not permitted.
- B. Water Reducing Admixture: Material shall comply with ASTM C494, Type A. Acceptable manufacturers and products include:
1. Euclid Chemical Company - Eucon WR Series.
 2. Sika Chemical Corp. - Plastocrete 161.

3. GRT – Polychem 400 NC.
 4. Grace Construction Products - WRDA 82.
- C. High Range Water Reducing Admixture (superplasticizer): Material shall comply with ASTM C494, Type F or Type G. Acceptable manufacturers and products include:
1. Euclid Chemical Company - Eucon 37 or Plastol Series.
 2. Sika – ViscoCrete 2100.
 3. GRT – Melchem.
 4. Grace Construction Products - Mira 110.
- D. High Range Water Reducing, Slump Retaining Admixture: Material shall comply with ASTM C494, Type F or Type G. Acceptable manufacturers and products include:
1. Euclid Chemical Company - Eucon 537, Eucon 1037, or Plastol Series.
 2. Sika – Sikament 686.
 3. GRT – Melchem – M.
 4. Grace Construction Products – ADVA FLEX.
- E. Non-Chloride Accelerator: Material shall comply with ASTM C494, Type C or Type E, and not contain a higher chloride ion concentration than municipal drinking water. Acceptable manufacturers and products include:
1. Euclid Chemical Company - Accelguard Series.
 2. Sika Chemical Corp. - Sika Rapid-1.
 3. GRT – Polychem HE.
 4. Grace Construction Products – Lubricon NCA.
- F. Air Entraining Admixture: Air entraining admixture shall comply with ASTM C260, and be certified by the manufacturer to be compatible with other admixtures to be used. Acceptable manufacturers and products include:
1. Euclid Chemical Company - Air-Mix or AEA Series.
 2. Sika Chemical Corporation - Sika-Aer.
 3. GRT – Polychem VR.
 4. Grace Construction Products - Darex II or Daravair 1000.
- G. Admixtures used in concrete shall be the same brand, type, and dosage used in concrete represented by field test data or used in trial mixes.

2.3 CURING PRODUCTS

- A. Moisture Retaining Cover
1. Plastic Film: Use 6 mil polyethylene film sheet materials that meet the requirements of ASTM C171.
 2. White burlap-polyethylene sheet meeting ASTM C171.
 3. Reinforced Curing Paper complying with ASTM C171.

4. Moisture Retaining Fabric: A naturally colored, non-woven, polypropylene fabric with a 4-mil, non-perforated reflective (white) polyethylene coating containing stabilizers to resist degradation from ultraviolet light. Fabric shall exhibit low permeability and high moisture retention. Acceptable manufacturers and products include:
 - a. PNA Construction Technologies, Inc.: Hydracure M15.
 - b. Reef Industries Incorporated: Transguard 4000.
- B. Dissipating Resin Curing Compound: Clear, waterborne, membrane-forming curing compound complying with ASTM C309, Type 1, Class B shall be composed of hydrocarbon resins and dissipating agents that begin to break down upon exposure to ultraviolet light and traffic approximately 4 to 6 weeks after application, providing a film that is removable with standard degreasing agents, and mechanized scrubbing actions so as to not impair the later addition of applied finishes.
 1. Curing compounds used on interior enclosed environments shall be a water-borne product and VOC compliant as required by the U.S. EPA Architectural Coating Rule.
- C. Non-dissipating Curing Compound: Clear, membrane-forming curing compound complying with ASTM C309, Type 1, Class B.
 1. Curing compounds used on interior enclosed environments shall be a water-borne product and VOC compliant as required by the U.S. EPA Architectural Coating Rule.
- D. Curing and Sealing Compound: Clear, membrane-forming curing and sealing compound complying with ASTM C309, Type 1, and ASTM C1315, Type 1, Class A. Compound shall dry to a clear finish, resist yellowing due to ultraviolet degradation and provide a long-lasting finish that has high resistance to chemicals, oil, grease, deicing salts, and abrasion.
 1. Curing and sealing compounds used on interior enclosed environments shall be a water-borne product and VOC compliant as required by the U.S. EPA Architectural Coating Rule.

2.4 MISCELLANEOUS MATERIALS

- A. Patching Mortar: Non-shrink, non-slump, non-metallic, quick setting. Acceptable manufacturers and products:
 1. Euclid Chemical Company - Eucospeed.
 2. BASF - Thorite.
 3. Adhesive Technologies. - Hard Rok Vertipatch.
 4. W.R. Meadows - Speed Crete (Red Line).
 5. Dayton Superior – Re-Crete 20 minute.
 6. SpecChem - Precast Patch.
- B. Expansion Joint Material: Preformed, resilient, non-extruding asphalt impregnated resilient fiber conforming to ASTM D1751. Thickness of expansion joint material shall be 1/2” unless noted otherwise on the drawings.

- C. Insulation: Polystyrene Insulation, ASTM C578; extruded cellular type, conforming to the following:
1. Thermal Resistance R of 5.0.
 2. Thickness as indicated on plan.
 3. Compressive Strength Minimum: 30 psi.
 4. Water absorption in accordance with ANSI/ASTM.
 5. Edges: Butt.
- D. Vapor Barrier: ASTM E 1745, Class A, not less than 15 mils (0.375 mm) thick. Acceptable manufacturers and products:
1. Stego Industries, LLC - Stego Wrap.
 2. W.R. Meadows, Inc. - Perminator.
 3. Raven Industries - Vapor Block.
 4. Insulation Solutions - Viper VaporCheck II.

2.5 STRENGTH AND PROPERTIES

- A. Concrete Mix Designs: Refer to Drawings for specified compressive strength. Proportion concrete mixes according to the properties in the following tables. The concrete supplier may produce a mix at a lower water-cement ratio to allow for adjustment of slump at the site by adding water. The addition of site water shall be in accordance with ASTM C94, and the total water-cement ratio shall not exceed the value specified below.

Class	Coarse Aggregate Gradation	Fine Aggregate Gradation	Range of Slump	Max. w/c	Air Content	Other Requirements
B	57 or 67	FA	1" to 4"	0.45	5% to 8%	
D	57 or 67	FA	4" to 6"	0.50	—	Use water reducing admixture to achieve slump specified
E	4 or 57	FA	1" to 4"	0.50	—	

Note: w/c = water-cementitious materials ratio.

- B. Schedule of Concrete Classes: Provide concrete of the specified class according to the following schedule.
1. Footings: Class E
 2. Exterior foundation walls and piers: Class B
 3. Interior slabs on grade: Class D
 4. Unless noted otherwise: Class B
- C. Slump of Superplasticized Concrete: Concrete containing high-range water reducing admixtures (superplasticizer) shall have 8" maximum slump, unless otherwise approved by Structural Engineer. Concrete shall arrive at job site with 2" to 3" slump, be verified, then high range water reducing admixture added to increase slump to approved level.

- D. Accelerators: Add non-chloride accelerator to all concrete slabs placed at air temperatures below 50°F.
- E. Water Reducer: Add water reducing admixture or high range water reducing admixtures (superplasticizers) as follows:
 - 1. All pumped concrete.
 - 2. As required for placement or workability.
 - 3. As required by high temperatures, low humidity, or other adverse placement conditions.
 - 4. Concrete with water-cementitious materials ratio below 0.50.
- F. No other admixtures shall be used unless approved by Structural Engineer of record.
- G. Chlorides: Admixtures or other ingredients including aggregates containing calcium chloride or more than 0.05% chloride ions by weight shall not be used.
- H. Workability: Concrete shall have a workability such that it will fill the forms without voids, honeycombs, or rock pockets with proper vibration without permitting materials to separate or excess water to collect on the surface.
- I. Concrete Temperatures: Minimum concrete temperature of fresh concrete varies in relation to average air temperature over a 24-hour period as follows:

1. Air temperature below 0°F	Concrete temperature 70°F min.
2. Air temperature 0°F to 30°F	Concrete temperature 65°F min.
3. Air temperature 30°F to 50°F	Concrete temperature 50°F min.
4. Air temperature above 50°F	No minimum temperature

The maximum temperature of concrete at the time of delivery shall be 90°F. When concrete temperature exceeds 90°F, concrete supplier shall attempt to reduce temperature by shading aggregates and cement and cooling mix water. When these methods fail to reduce concrete temperature below 90°F, supplier shall use ice in the water to reduce the concrete temperature.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Do not place concrete until data on materials and mix designs have been approved and all other affected trades have coordinated their work.
- B. Remove snow, ice, frost, water, mud, and other foreign material from surfaces, reinforcing bars and embedded items against which concrete will be placed.
- C. Do not allow form release agent to contact reinforcing bars.

3.2 SLABS

A. Slab on Grade:

1. Where indicated on the drawings, interior slabs on grades shall have a polyethylene vapor retarder conforming to ASTM E1745. Lap all joints minimum 6" and seal edges with adhesive tape. Fit vapor retarder around utilities and seal with adhesive tape as required. Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.
2. Refer to Drawings and Section 31 23 00 for required sub-grade preparation beneath slabs on grade.
3. Where vapor retarder is not used below slab on grade, wet sub-grade below slab prior to placing concrete. Subgrade shall be moist with no free water and no muddy or soft spots.
4. Saw cut control joints: Cut with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks. Control joints shall be located along column lines, with intermediate joints spaced at a maximum distance of 36 times the slab thickness, unless noted otherwise. Control Joints shall be continuous, not staggered or offset. Slab panels shall have a maximum length to width ratio of 1.5 to 1. Provide additional control joints at all reentrant or isolated corners formed in the slab on grade. Refer to Drawings for typical control joint detail.
5. Provide isolation joints around each pier and along foundation walls. Form isolation joints with 1/2" expansion joint material. Extend isolation joint material full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
6. Verify completion of all under slab work with mechanical and electrical trades before placing slabs.
7. Slope slabs as indicated on Drawings and to provide positive drainage. Slope slab keeping bottom level and varying top. Maintain minimum thickness of concrete as indicated on Drawings. Refer to floor finishes for tolerances.

3.3 CONSTRUCTION JOINTS

- A. Construction Sequence Submittal: Contractor shall submit a construction sequence indicating construction joints and the pour sequence.
- B. Vertical: Locate vertical construction joints in walls not farther than a maximum of 100 feet on center.
- C. Horizontal: Locate horizontal joints in walls and piers at the top of footings unless otherwise indicated. At least 24 hours shall elapse between placing concrete in a footing and placing concrete in an area supported by the walls, unless approved in writing by Structural Engineer.

- D. Reinforcing: Stop all welded wire reinforcement and/or reinforcing at construction joint in slabs on grade and provide dowel bars as detailed. Provide reinforcement at other construction joints as detailed. Roughen and thoroughly clean the surface of the concrete, remove all laitance, and wet the surface before placing new concrete against the joint. Slush vertical joints with a neat cement grout before placing new concrete.

3.4 INSTALLATION – FOUNDATION PERIMETER INSULATION

- A. Adhere insulation boards to foundation wall perimeter with bead adhesive.
- B. Butt edges and ends tight to adjacent board and to protrusions.
- C. Tape seal joints.

3.5 CONCRETE PLACEMENT

- A. Place concrete as continuously as possible until placement is complete. Do not place against concrete that has attained initial set, except at authorized joints. If, for any reason, concrete pour is delayed for more than 45 minutes, bulkhead off pour at last acceptable construction joint. Immediately remove excess concrete and clean forms.
- B. Do not begin to place concrete during periods of rain, sleet or snow unless adequate protection is provided.
- C. No concrete shall be cast onto or against sub-grades containing free water, frost, ice or snow.
- D. Do not place concrete until all reinforcement is in place, forms have been thoroughly cleaned and approval has been given.
- E. Do not accept concrete delivered to the job site more than 90 minutes after initial mixing.
- F. Concrete from its point of release to mixers, hoppers, or conveyances, shall not be permitted to drop more than 5 feet (10 feet for concrete containing high range water reducers). Deposit concrete directly into conveyances and directly from conveyances to final points of deposit. Sufficient transportation equipment in good working order shall be on hand before work begins. All conveying equipment must be clean and kept clean during concreting operations. Take every possible precaution to prevent segregation or loss of ingredients.
- G. Deposit concrete in wall forms in layers not greater than 12 inches in depth, each layer being compacted by internal vibration before succeeding layer is placed.
- H. Place concrete as near as possible to its final position to prevent segregation. Do not use vibrators to transport concrete within forms. Consolidate concrete in walls, columns, beams and slabs or joist construction thicker than 8" with internal vibrators (8,000 to 12,000 V.P.M.). Slabs less than 8" thick may be consolidated with internal vibrators (9,000 to 13,500 V.P.M.) or vibrating screeds supported on forms, boards or rails, approved by Structural Engineer, supplement vibration by forking or spading by hand along surfaces adjacent to forms and construction joints.
- I. Re-tempering of concrete will not be permitted. Concrete that has obtained its initial set shall be discarded.

- J. Exercise care in placing concrete over waterproof membranes, rigid insulation and/or protection boards to avoid damaging those materials. Report damage immediately, and do not proceed until damage is repaired.
- K. Remove loose debris from surfaces, thoroughly wet and slush with a neat cement grout immediately before placing new concrete, or apply bonding compound to surface and let dry before placing new concrete.
- L. Protect existing concrete work to be exposed to view and other finished materials from damage and staining resulting from concreting operations. Handle concrete carefully to avoid dripping and spillage. Remove spilled concrete from existing surfaces immediately. Covering sills, ledges, and other surfaces with protective coverings may be necessary to protect the work.
- M. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.
- N. Concrete piers for metal building columns: Metal building columns are installed without grout pad. Concrete Contractor shall modify top of piers as required to get concrete piers to the correct elevation. Contractor to submit modification procedures to Engineer of Record for review.

3.6 CONCRETE FINISHES AND TOLERANCES

- A. Exposed Smooth Formed Surfaces: Remove forms and perform necessary repairs and patch to produce surface finish-3.0 as specified in ACI 301. Apply the following to smooth-formed finished concrete exposed to view in the finished work.
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.7 CONCRETE SLAB FINISHES AND TOLERANCES

- A. Trowel Finish:
 - 1. Screed concrete to an even plane, float, then power trowel the surface.
 - 2. Hand trowel the surface smooth and free of trowel marks. Continue hand troweling until a ringing sound is produced as the floor is troweled.
 - 3. Provide trowel finish as indicated on the Drawings and at the following locations:
 - a. Concrete floors exposed in finished work unless otherwise indicated.

- B. Fine Broom Finish:
1. Screed concrete to an even plane, float, then power trowel the surface. Provide fine hair broom finish perpendicular to slope, free of loose particles, ridges, projections, voids and concrete droppings.
 2. Provide fine broom finish as indicated on the Drawings and at the following locations:
 - a. Stoop slabs.
- C. Floor Finish Tolerances: Floor finish tolerances as measured in accordance with ASTM E1155, Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System (Inch Pound Units), shall be as follows:

Floor Profile Quality Classification	Minimum Flatness Number Required			
	Test Area		Minimum Local F-Number	
	Flatness F _F	Level F _L	Flatness F _F	Level F _L
Slab on Grade	25	20	15	12

- D. Slab Drainage: Finish all concrete slabs to proper elevations to ensure that all surface moisture will drain freely to floor drains, and that no puddle areas exist. Contractor shall bear the cost of corrections to provide positive drainage.
- E. Special Tolerances for Concrete Slabs: No abrupt change in vertical elevation of 1/4" or more is acceptable at the interface between slabs and within areas where pedestrian traffic is expected.

3.8 CONCRETE CURING

- A. Freshly placed concrete shall be protected from premature drying and excessively hot temperatures.
- B. Concrete other than high-early strength shall be maintained above 50°F and in a moist condition for at least the first 7 days after placement, except when special curing is used. Special curing procedures shall not be used without written permission from the Structural Engineer of Record.
- C. Formed surfaces shall be cured by leaving the formwork in place during the curing period.
- D. Protect concrete from excessive changes in temperature during the curing period and at the termination of the curing process. Changes in the temperature of the concrete shall be as uniform as possible and shall not exceed 5°F in any one hour or 50°F in any 24-hour period.
- E. Protect concrete from injury from the elements until full strength is developed. Protect from mechanical injury.
- F. During cold weather construction, all footings shall be protected from frost penetration until the building is enclosed and temporary heat is provided.

3.9 SLAB CURING

- A. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface. Use one of the methods described below.

- B. **Moisture-Retaining-Cover Curing for Concrete Floors Not Exposed in Final Condition:** Cover concrete surface with waterproof sheet material as soon as finishing operations are complete and the concrete is sufficiently hard to be undamaged by covering. The cover shall be placed flat on the concrete surface, avoiding wrinkles. Sprinkle concrete with water as necessary during application of covering. Place in widest practicable width, with sides and ends lapped at least 12 inches, and seal with waterproof tape or adhesive. Verify that the concrete is continuously wet under the sheets; otherwise, add water through soaker hoses under the sheets. Weight down covering to prevent displacement. Immediately repair any holes or tears during the curing period using polyethylene sheet and waterproof tape. Curing process shall be maintained for a minimum of 7 days.
- C. **Moisture-Retaining-Fabric Curing for Concrete Floors to Remain Exposed:** Cover concrete surface with moisture retaining fabric as soon as finishing operations are complete and the concrete is sufficiently hard to be undamaged by covering. The cover shall be installed in accordance with manufacturer's written recommendations, in largest practical widths. Wet the slab to rejection, then thoroughly wet fabric side of cover and install with poly side up. Lap over adjacent covers a minimum of 18". Wet all laps and outside edges to prevent displacement and to ensure intimate contact with concrete and adjacent covers. Rewet as necessary and protect covers from damage during curing process.
1. After minimum 7-day cure, remove moisture retaining fabric in sections.
 2. A maximum of 3,500 square feet of concrete curing cover may be removed at any one time. At no time shall the exposed area be permitted to dry prior to completion of the floor scrubbing process.
 3. Using a high-powered floor scrubber capable of a minimum 80 pounds head pressure, and a mild citrus-based detergent that does not damage or mar the surface in any way, scrub the floor to remove any minerals or soluble salts that may have accumulated at the floor surface. Rinse area thoroughly with clean fresh water. Remove water and allow floor to dry. If whitening occurs during drying, repeat scrubbing process before floor dries until no whitening occurs during drying.
 4. All areas of the floor shall remain wet during floor scrubbing process. Expose only the amount of floor surface that can be cleaned before any drying occurs without exceeding the maximum allowable exposed area.
- D. **Curing Compound:** Apply uniformly in continuous operation by low pressure spray equipment or roller as soon as finishing operations are complete, free water on the surface has disappeared and no water sheen can be seen. Follow the manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period. Verify compatibility of the curing compound with paint, finishes, or toppings that require positive bond to the concrete. If curing compound is not compatible with paint finishes or toppings, utilize a dissipating curing compound and remove in accordance with the manufacturer's recommendations.

3.10 APPLICATION OF FLOOR SEALER - FINISH COAT

- A. Give concrete floors second coat of curing and sealing compound immediately prior to Substantial Completion.

- B. Clean floors and apply sealer strictly according to manufacturer's instructions. Dilution and coverage shall be as recommended by the manufacturer. Apply sealer evenly.

3.11 COLD WEATHER CONCRETING

- A. Definition: Cold weather shall be defined as a period when for more than three successive days the average daily outdoor temperature drops below 40°F. The average daily temperature is the average of the highest and lowest temperature during the period from midnight to midnight. When temperatures above 50°F occur during more than half of any 24-hour duration, the period shall not be regarded as cold weather.
- B. All cast-in-place concrete work occurring during cold weather shall conform to all requirements of ACI 306.1, “Standard Specification for Cold Weather Concreting”, published by the American Concrete Institute, Detroit, Michigan, except as modified by the contract documents or this specification.
- C. Planning: The General Contractor, concrete contractor, concrete supplier and the Engineer shall have a pre-construction conference to outline the cold weather concreting operations concerning the placing, finishing, curing and protection of the concrete during cold weather. Pre-construction conference shall occur before cold weather is expected to occur.
- D. Detailed procedure submittal: Concrete contractor shall prepare and submit for review detailed procedures for the production, transportation placement, protection, curing and temperature monitoring of concrete during cold weather. Include procedures to be implemented upon abrupt changes in weather conditions. Do not begin cold weather concreting until these procedures have been reviewed and approved.
- E. Mixing: Concrete flatwork poured in cold weather shall be proportioned to obtain a lower slump to minimize the amount of bleed water during finishing. All bleed water should be skimmed off flatwork prior to troweling. Concrete that will be exposed to cycles of freezing and thawing while saturated should be properly air entrained as outlined in this specification.
- F. Protection of Concrete: Cure and protect concrete against damage from freezing for a minimum period of 72 hours, unless approved by the structural engineer. The protection period may be reduced according to ACI 306.1 requirements. Concrete contractor shall submit a letter of request to reduce the protection period, by outlining the method used to achieve the reduction per ACI 306.1.
 - 1. When practical for the construction schedule, formwork shall be insulated and remain in place for at least the required protection period.
- G. Concrete Temperatures: The minimum temperature of concrete immediately after placement shall be as specified in the following table.

Section Size	Minimum temperature of concrete as placed and maintained during the protection period	Maximum gradual decrease in surface temperature during any 24 hours after the end of the protection.	Mixing Temperatures		
			Above 30°F	0 to 30°F	Below 0°F
< 12 in	55°F	50°F	60°F	65°F	70°F

Section Size	Minimum temperature of concrete as placed and maintained during the protection period	Maximum gradual decrease in surface temperature during any 24 hours after the end of the protection.	Mixing Temperatures		
			Above 30°F	0 to 30°F	Below 0°F
12-36 in	50°F	40°F	55°F	60°F	65°F
36-72 in	50°F	30°F	50°F	55°F	60°F
> 72 in	50°F	20°F	45°F	50°F	55°F

- H. Mixing Temperatures: As the ambient air temperature decreases the concrete mixing temperature shall be increased to compensate for the heat lost in the period between mixing and placement. The concrete supplier shall use one or both of the following methods for increasing the concrete temperature.
1. Heating the mixing water to a temperature necessary to offset the temperature losses during transport. Supplier shall not heat water to temperatures in excess of 140°F, without taking special precautions as outlined in ACI 306.
 2. Heating the aggregate with a circulated steam piping system.
- I. Temperature measurements: The Contractor shall be responsible for monitoring and recording the concrete temperatures during placement and throughout the protection period.
1. Inspection personnel shall keep a record of the date, time, outside air temperature, temperature of concrete as placed, and weather conditions.
 2. Temperature of the concrete and the outside air shall be recorded at regular intervals but not less than twice in a 24-hour period. The record shall include temperatures at several points within the enclosure and on the concrete surface of sufficient frequency to determine a range of temperatures.
 3. Inspection agency shall submit the temperature logs to the Engineer for permanent job records.

3.12 HOT WEATHER PROTECTION

- A. Definition: Hot weather shall be defined as any combination of high ambient temperature, low relative humidity, high winds and intense solar radiation that leads to higher than usual evaporation. The table below defines low relative humidity based on air temperature. For a given air temperature, if the relative humidity is equal to or less than the specified minimum, provisions for hot weather concreting shall be as follows:

Air Temperature	Minimum Relative Humidity
105°F	90%
100°F	80%
95°F	70%
90°F	60%
85°F	50%

Air Temperature	Minimum Relative Humidity
80°F	40%
75°F	30%

- B. Scheduling: When hot weather is expected, adjust concrete placement schedules to avoid placing or finishing during the period from noon until 3:00 pm. When possible, slab pours should be delayed until the building is enclosed to protect the concrete from wind and direct sunlight, Construction schedule shall account for 7-day moist curing period.
- C. Mixing: Concrete supplier shall adjust mix designs and admixtures to minimize slump loss. Concrete shall be mixed at a water-cement, which is lower than the specified maximum to allow for the adjustment of slump by addition of water in the field. Water reduction shall be accomplished without reducing initial slump by increasing dosage of water reducing admixture.
- D. Preparation: Do not order concrete earlier than is required to avoid delays. Cool forms, subgrades and reinforcing bars with water spray from fog nozzle prior to concrete placement.
- E. Delivery: Site traffic shall be coordinated and delivery times scheduled to minimize waiting times for concrete trucks.
- F. Placement: Preparations shall be made to place and consolidate the concrete at the fastest possible rate. Maintain a continuous flow of concrete to the job site to avoid development of cold joints, during placement of slabs, apply fog spray to prevent moisture loss without causing surplus water to stand on concrete surface.
- G. Finishing: Finish concrete as fast as practical. Continue fogging concrete during finishing. Where fogging is not possible, apply sprayable moisture-retaining film between finishing passes.
- H. Curing: Formed concrete shall be covered with a waterproof material to retain moisture. Flat work shall be moisture cured as described in this specification. Moist curing shall continue for at least 7 days.

3.13 FIELD QUALITY ASSURANCE

- A. Independent Testing Agency and Inspector shall each perform their prescribed inspection, sampling, and testing services as described in Part 1 of this specification section.
- B. In cases where samples have not been taken or tests conducted as specified or strength of laboratory test cylinders for a particular portion of the structure fails to meet requirements of ACI 301, for evaluation of concrete strength, Structural Engineer shall have the right to order compressive or flexural test specimens or both be taken from the hardened concrete according to ASTM C42, load tests according to ACI 318, or such other tests as may be necessary to clearly establish the strength of the in situ concrete, and such tests shall be paid for by the Contractor.

3.14 REPAIR OF DEFECTIVE AREAS

- A. All repair of defective areas shall be made, with prior approval of Engineer, as to method and procedure, in accordance with Section 5 of ACI 301, except specified bonding compound must be used.
- B. Patch form tie holes at the following locations:
 - 1. Unfinished exposed concrete (not scheduled for painting, plus at board formed concrete finish).
 - 2. All other areas: Prime voids with bonding compound and fill with patching mortar. Strike flush without overlap, float to uniform texture to match adjacent surfaces.
 - 3. Exposed areas:
 - a. Remove projections, ridges and other protrusions not conforming to requirements specified under Section 03 10 00.
 - b. Fill voids and pin holes not conforming to requirements specified under Section 03 10 00.
- C. All structural repairs shall be made, with prior approval of the Engineer, as to method and procedure, using the specified epoxy adhesive and/or epoxy mortar.
- D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
- E. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

3.15 CLEANING

- A. Clean exposed concrete to remove laitance, efflorescence and stains.

END OF SECTION

SECTION 13 34 19

METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General and Supplementary Conditions of the Construction Contract and Division 1 - General Requirements apply to the work specified in this section.
- B. This section includes metal building systems that consist of integrated sets of mutually dependent components as shown on the drawings and specified herein. Work shall include, but not be limited to, the following items:
 - 1. Structural steel framing and sub-framing
 - 2. Complete metal roof system.
 - 3. Complete metal wall system.
 - 4. Soffit panel system.
 - 5. Sheet metal flashing and trim.
 - 6. Wall and roof insulation.
 - 7. Gutters, downspouts, trim and accessories,
 - 8. Miscellaneous fasteners and accessories as required for erection of the metal building.
 - 9. Doors.
 - 10. Windows.
- C. The intent of this specification is to establish a quality and performance level for buildings as shown on the contract documents.
- D. The General Contractor shall coordinate the requirements of other specific building systems and other project features, including mechanical and electrical requirements, site and foundation requirements, and construction of the interior of the metal building.
- E. Mechanical, Equipment, and Electrical Contractors shall provide the following information to the General Contractor for use in the design of the metal building system:
 - 1. Dead load of all hanging items, including pipes and equipment.
 - 2. Requirements for support.
 - 3. Location of all roof and wall openings.
 - 4. Support requirements of roof and wall openings.

- F. The building shall be designed and detailed by the Metal Building Contractor. This contractor is responsible for submittal of the design and engineering documents for the metal building system, sealed by a Structural Engineer licensed in the state in which the project is located to the building department for review and approval.
- G. References in the drawings to the pre-engineered building (PEB), PEB. manufacturer, and similar terminology refer to the work of this section.
- H. Structural notes indicated on the drawings regarding metal building manufacturer shall be considered a part of this specification.
- I. No substitutions will be allowed without the Engineer's approval.
- J. Refer to the following specification divisions for additional information:
 - 1. Division 3 for "Cast-in-Place Concrete" for concrete foundations.

1.2 QUALITY ASSURANCE

- A. Codes and Standards: Comply with the provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified.
 - 1. AISC – Specification for Structural Steel Buildings – Allowable Strength Design (ASD) 13th Edition.
 - 2. AISC - Specification for Structural Joints Using High-Strength Bolts.
 - 3. AISC - Code of Standard Practice for Buildings and Bridges.
 - 4. ASTM A36 - Standard Specification for Carbon Structural Steel.
 - 5. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - 6. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - 7. ASTM A500 - Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 8. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
 - 9. ASTM A572 - Standard Specification for High Strength, Low-Alloy Columbium-Vanadium Structural Steel.
 - 10. ASTM A992 - Standard Specification for Steel for Structural Shapes for use in Building Framing.
 - 11. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - 12. ASTM E1592 D - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.

13. ASTM F436 - Standard Specification for Hardened Steel Washers.
 14. ASTM F1554 - Standard Specification for Anchor Bolts, Steel 36, 55 and 105 ksi Yield Strength
 15. ASTM F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength, Inch Dimensions.
 16. AWS D1.1 - Structural Welding Code.
 17. ASTM C991 – Standard Specification for Flexible Glass Fiber Insulation for Metal Buildings.
 18. SSPC - Steel Structures Painting Council.
 19. UL 580 - Underwriters Laboratories - Test for Wind Uplift Resistance of Roof Assemblies.
 20. “Low Rise Building System Manual”, Metal Building Manufacturer’s Association. (MBMA).
 21. “Cold Formed Steel Design Manual”, American Iron and Steel Institute (AISI)
- B. Where any provisions of other pertinent codes and standards conflict with this specification, the more stringent provision shall govern.
- C. Manufacturer’s Qualifications: Provide a metal building system manufactured by a company with five (5) years’ experience in manufacturing the type of metal building system similar to the one indicated for this project and have a record of successful in-service performance.
1. Engineering Responsibility: Preparation of shop drawings and engineering analysis by a qualified Structural Engineer registered in the state in which the project is located.
- D. Installer’s Qualifications: Installer shall be certified in writing by metal building manufacturer as qualified for erection of the manufacturer’s product. The installer shall have a minimum of five (5) years’ experience in the erection of the type of metal building system similar to the one indicated for this project.
- E. Single Source Responsibility: Obtain the metal building system components, including the structural framing, wall and roof covering, and accessory components, from one single manufacturer.
- F. Tolerances: Tolerances shall be as indicated by the AISC Code of Standard Practice for Buildings and Bridges, except that tolerances for fabricating, rolling, cambering and erection shall not be cumulative.

1.3 SYSTEM DESCRIPTION

A. Building Description:

1. Drawings indicate basic building layout for member sizes, profiles, dimensional requirements, lateral system locations and lateral system types. Do not modify the intended aesthetic effects or system layout without Architect's and Engineer's approval. If modifications are proposed, submit comprehensive explanatory data for review.
2. Primary Framing:
 - a. The primary structure shall be a rigid clear span frame with I-shaped tapered columns and tapered depth rafters of shop welded steel plates without interior columns.
3. End Wall Framing:
 - a. The end wall framing shall be manufacturer's standard framing, with load bearing I-shaped columns along the wall and at the corners.
4. Secondary Framing: Z or C purlins, girts, eave struts, ridge members, flange bracing, clips and other accessories required.
 - a. Girts to be as shown on the drawings.
 - b. Girts to be bypass.
5. Overhead Door Framing: Steel channels framing the door openings. Include wall support for door torsion spring and roof support for track.
6. Bay spacing: As shown on the drawings.
7. Roof Slope: As shown on the drawings.
8. Minimum Eave Height: As shown on the drawings.
9. Roof System: Manufacturer's standard with insulation.
10. Gutters and Downspouts: Manufacturer's standard gutter and downspout profile. Size by manufacturer. Downspout spacing by manufacturer at locations shown on drawings.
11. Base Plates and Anchor Rods:
 - a. Column base plates have pinned bases that do not transfer moments to the foundations.
 - b. Base plates shall not have a grout pad underneath the base plate.
 - c. Base plate tension forces are resisted by anchor rods. Metal building designer to design anchor rods for tension.
 - d. Rigid frame base plate shear forces are resisted by anchor rods. Metal building designer to design anchor rods for shear.

- e. Anchor rod embedment to be designed by IMEG. Design to be completed once shop drawings are submitted with building reactions. For bid purposes, use anchor rod embedment of 12 times anchor rod diameter, unless noted otherwise.
- B. All metal building components shall be designed under the direct supervision of a registered Structural Engineer, licensed in the state in which the project is located.
- C. Design Loads:
- 1. Building Code: IBC 2009.
 - 2. Building Occupancy Category: II
 - 3. Roof Design Dead Load:
 - a. Building Self-Weight: by metal building designer.
 - b. Superimposed Dead Load (Collateral Dead Load): 5 psf minimum. Total dead load (self-weight plus collateral) is 20 psf minimum (owner requirement).
 - c. Concentrated Equipment Loads: Mechanical, Electrical, and Equipment Contractors shall provide the dead load weight of all hanging equipment weighing more than 100 lbs. to the General Contractor for use in the design of the metal building system.
 - 4. Live Loads:
 - a. Roof: 20 psf roof live load.
 - 5. Snow Load:
 - a. Uniform load as shown on the drawings.
 - b. Drift load as shown on the drawings.
 - 6. Wind Load:
 - a. Main wind force resisting system: as shown on the drawings.
 - b. Components and cladding: per ASCE 7-05.
 - 7. Seismic Load: Metal building engineer to design metal building systems capable of withstanding the effects of earthquake motions determined according to ASCE 7-05. Refer to drawings for additional site information.
 - 8. Rain Load:
 - a. Minimum per code.
 - 9. Load Combinations: As required by the building code specified.

10. Deflection Criteria: Design the assemblies to withstand design loads with deflections no greater than the following:
 - a. Roof and Wall Panels: 1/180 of the span for total load.
 - b. Purlins: 1/120 of the span for vertical total load and 1/240 of the span for vertical live load.
 - c. Girts: 1/120 of the span.
 - d. Primary Framing Members:
 - 1) Wind: 1/90 of the building height under specified wind pressure (50-year recurrence interval).
 - 2) Seismic: Per ASCE 7-05 allowable story drift.
 - e. End Wall Wind Columns: 1/180 of the column length.
 11. Design the secondary framing to accommodate deflection of primary building's structure and construction tolerances, and to maintain clearances at openings.
 12. Thermal Movements: Provide metal panel systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on the surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - a. Temperature Change (range): 150°F, ambient, 180°F material surfaces.
 13. Thermal Performance: Provide metal panel assemblies with the following minimum R-values:
 - a. Thermal Resistance of Wall Insulation: R-13
 - b. Thermal Resistance of Roof Insulation: R-19
- D. Provide drainage to exterior for water entering or condensation occurring within wall or roof system.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide overhead coiling doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:
 1. Wind Load: Uniform pressure (velocity pressure) of 25 lbf/sq. ft. acting inward and outward.
 2. Impact Test for Flying Debris: Comply with ASTM E1996, tested according to ASTM E1886.
 - a. Level of Protection: Basic Protection

- b. Wind Zone: 90 mph, pressure test to 1/2 and 1-1/2 x design pressure (positive and negative).
- B. Operation-Cycle Requirements: Provide overhead coiling door components and operators capable of operating for not less than 20,000 cycles and for 40 cycles per day.

1.5 SUBMITTALS

- A. Design Calculations: Submit four (4) copies of the design calculations prepared under the direct supervision of a registered Structural Engineer licensed to practice in the state in which the project is located. All copies of the calculation shall bear the Engineer's State seal and signature. The calculation package shall include, but not be limited to, the following information:
 - 1. Load reactions for all metal building columns: Submit diagram indicating building column reactions along all three principal axes to the General Contractor for foundation design. Loads shall be provided as unfactored service loads and broken out into dead loads, live load, snow load, wind load, and earthquake load components.
 - 2. Frame analysis for all the building frames for this project: Analysis shall indicate the loads applied, the load combination used for the analysis, the member forces for all load combinations, the calculated deflections for all load combination and the actual stress/allowable stress ratios for all load combinations.
 - 3. Structural analysis of the roof purlins and wall girts for the all-applied load combinations: Include calculated member deflections and forces.
 - 4. Allowable span tables and allowable load table for the roof and wall panels. Indicate all loads used to select the roof and wall panels.
 - 5. Lateral force resisting system analysis indicating the member stresses, the calculated deflections, and the connection design.
 - 6. Anchor rod and base plate calculations for all metal building columns.
- B. Shop Drawings:
 - 1. Prepare and submit complete erection and detailed shop drawings prepared by or under the direct supervision of a Structural Engineer legally authorized to practice in the jurisdiction where the Project is located for Engineer's approval.
 - 2. Structural Framing: Shop drawings shall indicate dimensions, locations of structural members, methods of connecting, anchoring, fastening, bracing, openings, cambers, loads and support reactions.
 - 3. Roof and Wall Panels: Provide layouts plans of all wall and roof panels, include details of roof edge conditions, joints, corners, custom profiles, supports, anchorage, trim, flashings, closures and methods of installation.
 - 4. Building Accessory Components: Provide details of metal building accessory components to indicate the method of installation.
 - a. Provide details of gutters, downspouts and other sheet metal accessories.

- b. Provide details of all special framing, flashing, and trim required for the roof and wall openings for mechanical and electrical system components.
- 5. Connection and framing details for all building frames, sidewalls, end-walls, and roof-framing members.
- 6. Welder's Certification: Submit certification for all welders employed on the project demonstrating they have been AWS qualified to perform the welding procedures required for this project.
- 7. Provide anchor rod setting plans for use by IMEG and the concrete contractor.
- 8. General Contractor to provide copies of field concrete cylinder breaks indicating the concrete meets 75% of the design compressive strength to the steel erector.
- C. The General Contractor shall conduct a field survey of as-built anchors and bearing plate locations and elevations prior to steel erection. Survey shall be furnished to the steel fabricator. Contractor shall identify deviations from approved shop drawings and submit proposed repairs and modifications to the metal building manufacturer and Engineer for approval.
- D. Product Data: For each type and size of overhead coiling door and accessory.
- E. Permit Drawings: Submit to the building department having jurisdiction for this project, documents adequate for their review and approval, prepared by and bearing seal of a Structural Engineer licensed in the state in which the project is located.
- F. Color Samples: Submit to the Owner and Engineer the manufacturer's standard color charts or chips showing the full range of colors, textures, and patterns available for the metal roofing and wall panels with factory-applied finishes.
- G. Product Samples: Provide sample panels, 12" long by actual panel width, demonstrating the panels' style, profile, color, and texture indicated for the Owner and Engineer to review.
- H. Provide a letter of certification from the metal building manufacturer indicating that the installer is qualified for the erection of the manufacturer's products.
- I. Maintenance Data: For metal panel finishes and door hardware to include in maintenance manuals.
- J. Door Schedule: For doors and frames. Use same designations indicated on the drawings. Include details of reinforcement and attachment to secondary framing.
- K. Door Hardware Schedule: Include details of fabrication and assembly of door hardware. Organize into door hardware sets indicating complete designations of every item required for each door or opening.
- L. Keying Schedule: Detail Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations. Match existing doors where required by Owner.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Building members shall be transported, stored and erected in a manner that will avoid any damage or deformation. Materials should be stored to allow easy access for inspection and identification. Bent or deformed members will be rejected and shall be replaced or repaired at the expense of the responsible party. Store clear of the ground and in such a manner as to eliminate excessive handling. Bent or deformed items will be rejected and shall be replaced or repaired at the expense of the responsible party.
- B. Store fasteners in a protected location. Clean and re-lubricate bolts and nuts before use.
- C. Protect insulation from the elements. Do not expose to rain and complete installation and concealment of insulation as rapidly as possible in each area of construction.

1.7 WARRANTIES

- A. All Components: Manufacturer's standard one (1) year workmanship warranty.
- B. Roofing and Siding Panels Finish Warranty: Furnish the roofing and siding panel manufacturer's written warranty, covering failure of the factory-applied exterior finish on metal wall and roof panels within the warranty period.
- C. Roof Panels: Manufacturer's standard 20-year paint finish warranty.
- D. Wall Panels: Manufacturer's standard 20-year paint finish warranty.
- E. All warranties shall commence after the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 STANDARD OF QUALITY

- A. The framing system shown in the bid set for this metal building has been laid out based on the framing system manufactured by Nucor Building Systems, and details and specifications are based on their products.
- B. Bidders may use equivalent metal building system packages by the listed manufacturers, subject to the following:
 - 1. The metal building package shall consist of components and accessories as shown on the drawings and called out in these specifications, equivalent to those shown or specified. Wall and roof systems must be equivalent in appearance and performance characteristics.
 - 2. The proposed package complies with all applicable standard specifications, design standards, design loads, and design load combinations.
 - 3. The bid shall be accompanied by a written outline of any revisions that must be made to the proposed framing layout or any other components of the total building in order to accommodate the metal building package of another manufacturer.
 - 4. Product data of roof and wall panels proposed for use in place of the Nucor products shall accompany the bid.

2.2 ACCEPTABLE MANUFACTURERS

- A. The following manufacturers are acceptable provided they can furnish all components that meet the specification requirements:
1. Nucor Building Systems
 2. Star Building Systems
 3. Butler Manufacturing Company
 4. Ceco Building Systems
 5. Behlen Buildings
 6. Chief Buildings
 7. Gold Seal Steel Buildings
 8. As approved substitution

2.3 MATERIALS

- A. Structural Metal:
1. All structural metal shall be free from defects impairing strength, durability or appearance. All structural metal shall meet the latest minimum requirements as follows:
 - a. Structural Steel Plate, Bar, Channel, Angle, Sheet, and Strip: ASTM A36; or ASTM A572, ASTM A529, or ASTM A992, Grade 50 or 55.
 - b. Structural Steel W-shapes: ASTM A529, ASTM A572, or ASTM A992, Grade 50 or 55.
 - c. Galvanized Steel Sheet: ASTM A653, structural quality, Grade 50, with G60 coating.
 - d. Aluminum Zinc-Coated Steel Sheet: ASTM A792, Grade 40.
 - e. Aluminum Coated Steel Sheet: ASTM A463.
 - f. Structural Bolts: ASTM F3125, Grade A325 or Grade A490.
 - g. Bolts for Secondary Framing: ASTM A307.
 - h. Tubing or Pipes for Structural Components: ASTM A500, Grade B.
 - i. Anchor Rods: ASTM F1554, Grade 36.
 - j. Steel Rods: ASTM A36
- B. Welding Materials:
1. Type required for material being welded in conformance with AWS D1.1.

2.4 STRUCTURAL FRAMING COMPONENTS

- A. Primary Framing: Shop fabricate framing components to indicate size and section with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.
 2. Join flanges to webs of built-up members by a continuous submerged arc-welding process.
 3. Brace compression flange of primary framing with steel angles, or cold-formed structural tubing between frame web and purlin or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
 4. Weld or bolt clips to frames for attaching secondary framing members.
 5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary structural members with specified primer after fabrication.
- B. Secondary Framing: Shop fabricate framing components to indicate size and section by roll-forming or break-forming, with baseplates, bearing plates, stiffeners and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.
1. Make shop connections by welding or by using high-strength bolts.
 2. Provide manufacturer's standard secondary framing members, including purlins, girts, eave struts, flange bracing, sag bracing, base or sill members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Fabricate framing from cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet prepainted with coil coating, unless otherwise indicated.
- C. Lateral Bracing Members: Provide adjustable lateral bracing as follows:
1. Rods: ASTM A36; ASTM A572, Grade 50; or ASTM A529, Grade 50; minimum 1/2-inch diameter steel; threaded a minimum of 6 inches on each end.
 2. Rigid Portal Frames: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

2.5 METAL PANEL MATERIAL FINISH

- A. Approved finish is Star Building Systems Signature 300 Colors.
- B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

- D. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755.
1. Sheet Steel Stock: Pre-finished, zinc-coated (galvanized) ASTM A653, structural quality, with a G90 coating.
 2. Surface: Smooth, flat finish.
 3. Exposed Finishes: Apply the following coil coating:
 - a. Interior Finish: Acrylic-Enamel Coating - Epoxy primer and acrylic-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
 - b. Exterior Finish: Siliconized-Polyester Coating - Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
 4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored backer finish, consisting of prime coat and wash coated with a total minimum dry film thickness of 0.5 mil.

2.6 ROOF PANEL SYSTEM:

- A. Tapered-Rib-Profile, Lap-Seam Metal Roof Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be field assembled by lapping side edges of adjacent panels and mechanically attached panels to supports using exposed fasteners in side laps.
1. Color: Brownstone. Star Building Systems Commercial / Industrial Signature 300 Kynar 500 numbers SR. 47 SRI 54; verify with Owner.
 2. Thickness: 26 GA.
 3. Panel Coverage: 36 inches and maximum length to minimize end laps. End laps shall occur over secondary structural members and be sealed with tape mastic and non-skinning butyl caulk.
 4. Panel Height: 1.25 inch or 1.5 inch.
 5. Major-Rib Spacing: 12 inches on center.

2.7 WALL PANEL SYSTEM:

- A. Tapered-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be field assembled by lapping side edges of adjacent panels and mechanically attached panels to supports using exposed fasteners in side laps.
1. Profile: Behlen ADP2 or approved equal.
 2. Color: Brownstone. Star Building Systems Commercial / Industrial Signature 300 Kynar 500 numbers SR. 47 SRI 54; verify with Owner.

3. Thickness: 26 GA.
4. Panel Coverage: 36 inches and maximum length to minimize end laps. Minimum one panel for heights less than 30 feet.
5. Panel Height: 1.25 inch or 1.5 inch.
6. Major-Rib Spacing: 12 inches on center.

2.8 THERMAL INSULATION

- A. Metal Building Insulation: ASTM C991, Type I, or NAIMA 202 glass-fiber-blanket insulation; 0.5-lbs/cu.ft. density; 2-inch-wide continuous, vapor-tight edges tabs; and with a flame-spread index of 25 or less.
- B. Vapor-Retarder Facing: ASTM C1136, with permeance not greater than 0.02 perm when tested according to ASTM E96, Desiccant Method.
 1. Composition: White vinyl film facing, fiberglass scrim reinforcement, and metallized-polyester film backing.
- C. Retainer Strips: 0.019-inch thick, formed, galvanized steel or PVC retainer clips colored to match insulation facing.
- D. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.9 ACCESSORIES

- A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to the greatest extent possible by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.
 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folder back to form hems.
- B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels, unless otherwise indicated.
 1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or cross-linked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch thick, flexible closure strips; cut or premolded to match metal roof profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

4. Thermal Spacer Blocks: Where metal panels attach direction to purlins, provide thermal spacer blocks of thickness required to provide 1-inch standoff; fabricated from extruded polystyrene.
- C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels, unless otherwise indicated.
1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded cellular, rubber or cross-linked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- D. Flashing and Trim: Formed from minimum 0.0159-inch thick, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating.
1. Color: Almond. Star Building Systems Commercial / Industrial Signature 300 Kynar 500 numbers SR. 63 SRI 76; verify with Owner.
 2. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
 3. Opening Trim: Minimum 0.0159 inch thick, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.
- E. Gutters: Formed from minimum 0.0159-inch thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."
1. Gutter Supports: Fabricated from same material and finish as gutter; spaced 36 inches on center.
 2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.
- F. Downspouts: Formed from 0.0159-inch thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot long sections, complete with formed elbows and offsets.
1. Mounting Straps: Fabricated from same material and finish as gutters; spaced 10 feet on center.

2.10 MISCELLANEOUS MATERIALS

- A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
 - 1. Fasteners for Metal Roof Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless-steel cap or zinc-aluminum-alloy head and EPDM or neoprene sealing washer.
 - 2. Fasteners for Metal Wall Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with nylon or polypropylene washer.
 - 3. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
- B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- C. Metal Panel Sealants:
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
 - 2. Joint Sealant: ASTM C920; one-part elastomeric polyurethane, polysulfide, or silicone-rubber sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.11 PAINTS AND PRIMERS

- A. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP3, "Power Tool Cleaning."
- B. Galvanizing:
 - 1. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.
 - a. Fill vent holds and grind smooth after galvanizing.
 - 2. All framing members, nuts, bolts, and washers to be galvanized.

2.12 DOORS AND FRAMES

A. Materials:

1. Cold-Rolled Sheet Steel: ASTM A1008, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Hot-Rolled Steel Sheet: ASTM A1011, Commercial Steel (CS), Type B, free of scale, pitting, or surface defects; pickled and oiled.
3. Metallic-Coated Steel Sheet: ASTM A653, Commercial Steel (CS), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.

B. Swinging Personnel Doors and Frames: Metal building system manufacturer's standard doors and frames; prepared and reinforced at strike and hinges to receive factor- and field-applied hardware according to ANSI/DHI A115 series.

1. Steel Doors: 1-3/4 inches thick; fabricated from 0.0329 inch uncoated thickness, metallic-coated steel face sheets; of styles indicated; seamless at both vertical edges; with 0.0528 inch uncoated thickness, inverted metallic-coated steel channels welded to face sheets at top and bottom of door.
 - a. Core: Polyurethane foam with U-factor rating of at least 0.07 Btu/square feet x h x deg F.
 - b. Glazing Frames: Steel frames to receive field-installed glass.
2. Glazing: Tempered Float Glass: ASTM C1048, Kind HS or FT, Condition A, Type 1, Quality-Q3, Class 1 (clear), 3 mm thick.
3. Steel Frames: Fabricate 2 inch wide face frames from 0.0528 inch uncoated thickness, metallic-coated steel sheet.
 - a. Type: Factory welded.
4. Fabricate concealed stiffeners, reinforcement, edge channels, and moldings from either cold- or hot-rolled sheet.
5. Hardware:
 - a. Provide hardware for each door leaf, as follows:
 - 1) Hinges: Three antifriction-bearing, standard weight, full-mortise, stainless-steel or bronze, template-type hinges; 4-1/2 by 4-1/2 inches, with nonremovable pin.
 - 2) Lockset: Mortise, with lever handle type.
 - 3) Panic Device: Touch-bar or push-bar type.
 - 4) Threshold: Extruded aluminum.

- 5) Silencers: Pneumatic rubber; three silences on strike jambs of single door frames and two silences on heads of double door frames.
 - 6) Closer: Surface-applied, standard-duty, hydraulic type.
 - 7) Weather Stripping: Vinyl applied to head and jambs, with vinyl sweep at sill.
6. Anchors and Accessories: Manufacturer's standard units, galvanized according to ASTM A123.
7. Fabrication: Fabricate doors and frames to be rigid; neat in appearance; and free from defects, warp, or buckle. Provide continuous welds on exposed joints; grind, dress, and make welds smooth, flush and invisible.
8. Finishes for Personnel Doors and Frames:
- a. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections and abraded areas, and apply galvanized repair paint specified below to comply with ASTM A780.
 - 1) Galvanized Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
 - b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply the primer specified below immediately after cleaning and pretreating.
 - 1) Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI 250.10 acceptance criteria.
 - c. Color: Medium Bronze. Star Building Systems Commercial / Industrial Signature 300 Kynar 500 numbers SR. 33 SRI 36; verify with Owner.
- C. Overhead Coiling Doors: Interlocking slats in a continuous length for width of door of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door.
1. Door size to fit door opening shown on drawings.
 2. Doors shall have manual opening device.
 3. Slats constructed of an exterior face of anodized aluminum and an interior face of rigid polyvinyl chloride and capped with nylon end caps. Slats to be filled and unitized with pour-type polyurethane foam having a "K" Factor of .12 at 75°F.
 4. Doors to be fully weathersealed, with top seal to include headermounted brushes and bottom seal to include safety reversing edge.

5. Side guides to be lined with high density PVC to prevent metal-to-metal contact with slats. Curtain travel guide system with roller wheels will not be allowed.
6. Exterior and interior color to be Medium Bronze. Star Building Systems Commercial / Industrial Signature 300 Kynar 500 numbers SR. 33 SRI 36; verify with Owner.

2.13 WINDOWS

- A. Aluminum Windows: Metal building system manufacturer's standard, with self-flashing mounting fins, and as follows:
 1. Type, Performance Class, and Performance Grade: Comply with AAMA/NWWDA 101/I.S.2 and as follows:
 - a. Fixed Units: F-LC25.
 2. Aluminum Extrusions: ASTM B221, alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 0.062 inch thickness at any location for main frame and sash members.
 - a. Thermally Improved Construction: Fabricate window units with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.
 3. Mullions: Between adjacent windows, fabricated of extruded aluminum matching finish of window units.
 4. Fasteners, Anchors, and Clips: Aluminum, nonmagnetic stainless steel, or other noncorrosive material, compatible with aluminum window members, trim, hardware, anchors, and other components of window units. Fasteners shall not be exposed, except for attaching hardware.
 - a. Reinforcement: Where fasteners screw-anchor into aluminum less than 0.125 inch thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, splined grommet nuts.
 5. Finish: Mill.
 6. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - a. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 0.7 mil, medium gloss.
 - 1) Color: As indicated by manufacturer's designations.

- B. Glazing:
1. Tempered Float Glass: ASTM C1048, Kind HS or FT, Condition A, Type 1, Quality-Q3, Class 1 (clear), 3 mm thick.
 2. Glazing Stops: Screw-applied or snap-on glazing stops coordinated glazing system indicated. Match material and finish of window frames.
 3. Factory-Glazed Fabrication: Glaze window units in the factory to greatest extent possible and practical for applications indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify site conditions.
- B. Verify that foundations are positioned correctly and the anchor rods installed as indicated on the shop drawings.
- C. For baseplates without grout, Concrete Contractor shall modify top of piers as required to get the concrete piers to the correct elevation. Contractor to submit modification procedures to Engineer of Record and metal building manufacturer for review.

3.2 INSTALLATION – EMBEDDED ITEMS

- A. Anchor Rods:
1. All anchor rods are to be set by the Concrete Contractor and shall be furnished promptly so that they may be built in as the work progresses.

3.3 ERECTION

- A. Bracing and Protection:
1. The erector and not the Structural Engineer of Record shall be responsible for the means, methods and safety of erection of the structural steel framing.
 2. Erect metal building system according to manufacturer's written erection instructions and erection drawings.
 3. Erection of all structural steel items shall meet the requirements of AISC "Specification and Code of Standard Practice."
 4. Steel shall be well plumbed, leveled and braced to prevent any movement.
 - a. Contractor shall provide and maintain all necessary temporary guying of steel frame to resist safely all wind and construction loads during erection and to assure proper alignment of all parts of the steel frame.
 5. Provide all temporary bracing, shoring and guards necessary to prevent damage or injury. All partially erected metal shall be secured in an approved manner during interruptions of work.

- B. Framing:
1. All work shall be erected square, plumb, straight and true, accurately fitted and with tight joints and intersections, by mechanics experienced in the erection of metal buildings. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
 2. Do not field cut or alter structural members without approval of Metal Building Engineer.
 3. Steel erection shall not proceed without concrete in footings, piers, and walls attaining 75% of the intended minimum compressive design strength. Documentation must be provided indicating compliance with this requirement.

3.4 METAL PANEL INSTALLATION, GENERAL

- A. Verify the structural panel support members and anchorages have been installed within alignment tolerances required by manufacturer.
1. Examine rough-in for components and systems penetrating metal panels to verify actual location of penetrations relative to seam locations of metal panels before metal panel installation.
- B. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.
 2. Field cutting of metal panels by torch is not permitted.
 3. Install metal panels perpendicular to structural supports, unless otherwise indicated.
 4. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
 5. Locate and space fastenings in uniform vertical and horizontal alignment.
 6. Locate metal panel splices over, but not attached to, structural supports with end laps in alignment. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 7. Lap metal flashing over metal panels to allow moisture to run over and off the material.
- C. Lap-Seam Metal Panels: Install screw fasteners with power tools controlled torque adjusted to compress neoprene washer tightly without damage to washer, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugations. Apply metal panels and associated items for neat and weathertight enclosure. Avoid “panel creep” or application not true to line.
- D. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
- E. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers and sealants indicated or, if not indicated, types recommended by metal panel manufacturer.
1. Seal metal panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal panel manufacturer.
 2. Prepare joints and apply sealants to comply with requirements in Division 7 Section “Joint Sealants.”

3.5 METAL ROOF PANEL INSTALLATION

- A. Provide metal roof panels of full length from eave to ridge, unless otherwise indicated or restricted by shipping limitations.
1. Install ridge caps as metal roof panel work proceeds.
 2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.
- B. Field-Assembled, Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint at location and spacing recommended by manufacturer.
1. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal roof panels.
 2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
 3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels; on side laps of ribbed or fluted metal panels; and elsewhere as needed to make metal panels weatherproof to driving rains.
 4. At metal panel splices, nest panels with minimum 6 inch end lap, sealed with butyl-rubber sealant and fasten together by interlocking clamping plates.
- C. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

- D. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated and within 1/8 inch offset adjoining faces and of alignment of matching profiles.

3.6 METAL WALL PANEL INSTALLATION

- A. Install metal wall panels in orientation, sizes, and locations indicated on drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
1. Unless otherwise indicated, begin metal panel installation at corners, with center of rib lined up with line of framing.
 2. Shim or otherwise plumb substrates receiving metal wall panels.
 3. When two rows of metal panels are required, lap panels 4 inches minimum.
 4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
 5. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Pre-drill panels.
 6. Flash and seal metal wall panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
 7. Install screw fasteners in pre-drilled holes.
 8. Install flashings and trim as metal wall panel work proceeds.
 9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated, or if not indicated, as necessary for waterproofing.
 10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws.
 11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
- B. Field-Assembled, Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.
1. Field-Insulated Assemblies: Install thermal insulation as specified. Install metal liner panels over insulation on interior side of girts at locations indicated. Fasten with exposed fasteners as recommended by manufacturer.
- C. Factory-Assembled, Insulated Metal Wall Panels: Install insulated metal wall panels on exterior side of girts. Attach panels to supports at each panel joint with concealed clip and fasteners at 42 inches on center, but spaced not more than as recommended by manufacturer. Fully engage tongue and groove of adjacent insulated metal wall panels.
1. Install clips to supports with self-tapping fasteners.

2. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
- D. Installation Tolerances: Shim and align metal walls panels within installed tolerance of 1/4 inch in 20 feet, noncumulative, on level, plumb, and location lines indicated and within 1/8 inch offset adjoining faces and of alignment of matching profiles.

3.7 THERMAL INSULATION INSTALLATION FOR FIELD-ASSEMBLED METAL PANELS

- A. Install insulation concurrently with metal wall panel installation, in thickness indicated to cover entire wall, according to manufacturer's written instructions.
1. Set vapor-retarder-faced units with vapor retarder to warm side of construction, unless otherwise indicated. Do not obstruct ventilation spaces, except for firestopping.
 2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight insulation.
 3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths, with both sets of facing tabs sealed to provide a complete vapor retarder.
 4. Protect insulation from getting wet. Remove and replace water-logged insulation at Contractor's expense.
 5. Install blankets straight and true in one-piece lengths. Install vapor retarder over insulation with both sets of facing tabs sealed to provide a complete vapor retarder.
- B. Blanket Roof Insulation: Comply with the following installation method:
1. Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing members. Install layer of filler insulation over first layer to fill space formed by metal roof panel standoffs. Hold in place by panels fastened to standoffs.
 2. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
 3. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.
- C. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing members. Hold in place by metal wall panels fastened to secondary framing:
1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
 2. Sound-Absorption Insulation: Where sound-absorption requirement is indicated for metal liner panels, cover insulation with polyethylene film and provide inserts of wire mesh to form acoustical spacer grid.

3.8 DOOR AND FRAME INSTALLATION

- A. Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.
- B. Personnel Doors and Frames: Install doors and frames according to ANSI A250.8. Shim as necessary to comply with DHI A115.IG. Fit non-fire-rated doors accurately in their respective frames, with the following clearances:
 - 1. Between Doors and Frames at Jamb and Head: 1/8 inch.
 - 2. Between Edges of Pair of Doors: 1/8 inch.
 - 3. At Door Sills with Threshold: 3/8 inch.
 - 4. At Door Sills without Threshold: 3/4 inch.
- C. Coiling Doors:
 - 1. Install coiling doors and operating equipment complete with necessary hardware, jamb and head molding strips, anchors, inserts, hangers, and equipment supports.
 - 2. Lubricate bearings and sliding parts; adjust doors to operate easily, free of warp, twist, or distortion, and with weathertight fit around entire perimeter.
- D. Door Hardware: Mount units at heights indicated in DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 1. Install surface-mounted items after finishes have been completed on substrates involved.
 - 2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
 - 4. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant.

3.9 WINDOW INSTALLATION

- A. Install windows plumb, rigid, properly aligned, without warp or rack or frames or sash, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each window frame with elastomeric sealant used for metal wall panels.
 - 1. Separate dissimilar materials from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in "Dissimilar Materials" Paragraph in Appendix B in AAMA/NWWDA 101/I.S.2.
- B. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.

- C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- D. Mount screens direct to frames with tapped screw clips.

3.10 ACCESSORY INSTALLATION

- A. Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 - 2. Install components for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure, strips, and similar items.
 - 3. Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installations, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 - 1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet, with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet on center using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- D. Downspouts: Join sections with 1-1/2 inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom at approximately 60 inches on center in between.
 - 1. Provide elbows at base of downspouts to direct water away from building.

3.11 ADJUSTING

- A. Doors: After completing installation, test and adjust doors to operate easily, free of warp, twist, or distortion.
- B. Door Hardware: Adjust and check each operating item of door hardware and each door to ensure proper operation and function of every unit. Replace units that cannot be adjusted to operate as intended.
 - 1. Door Closures: Adjust door closers to compensate for final operation of heating and ventilating equipment. Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

3.12 CLEANING, REPAIRS, PROTECTION, AND TOUCHUP

- A. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field welds, final connections, rust spots, and abraded surfaces of prime-painted structural framing and accessories.
 - 1. Clean and prepare surfaces by SSPC-SP2 hand-tool cleaning or SSPC-SP3 power-tool cleaning.
 - 2. Apply a compatible primer of the same type as shop primer used on adjacent surfaces.
- B. Metal Panels: Replace temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in clean condition during construction.
 - 1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
- C. Doors and Frames: Immediately after installation, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.
 - 1. Immediately before final inspection, remove protective wrappings from doors and frames.
- D. Windows: Clean metal surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances. Clean factory-glazed glass immediately after installing windows.
- E. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

3.13 COLOR SCHEDULE

- A. Exterior Wall and Roof Panels: Brownstone. Star Building Systems Commercial / Industrial Signature 300 Kynar 500 numbers SR. 47 SRI 54; verify with Owner.
- B. Corner Trim, Rake Trim, Eave Trim, and Gutters: Almond. Star Building Systems Commercial / Industrial Signature 300 Kynar 500 numbers SR. 63 SRI 76; verify with Owner.
- C. Doors: Medium Bronze. Star Building Systems Commercial / Industrial Signature 300 Kynar 500 numbers SR. 33 SRI 36; verify with Owner.
- D. Color Formulations: Available upon request.

END OF SECTION

SECTION 23 05 00

BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 23 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 REFERENCES

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make his portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- D. Scope of Work:
 - 1. Plumbing Work shall include, but is not necessarily limited to:
 - a. Furnish and install all items listed in the Plumbing Material List.
 - b. Furnish and install gas piping system including all meter requirements.
 - c. Furnish and install a new fire protection service to the building including backflow preventer as required by Code.
 - d. Furnish and install all fire hydrants and associated piping, valves, and supports including connection to the water main.
 - e. Furnish and install makeup water connection to hydronic heating and/or cooling systems including reduced pressure principle type backflow preventer.
 - 2. Air Conditioning and Ventilating Work shall include, but is not necessarily limited to:
 - a. Furnish and install air-cooled condensing units and curbs.
 - b. Furnish and install complete supply air ductwork systems including all fittings, insulation, and outlets.
 - c. Furnish and install complete return air ductwork systems including all fittings, insulation, and inlets.

- d. Furnish and install mechanical room ventilation systems including louvers, ductwork, insulation, and fans.
 - e. Furnish and install all temperature control systems.
 - f. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
3. Temperature Control Work shall include, but is not necessarily limited to:
- a. Furnish and install a complete temperature control system as specified in Section 23 09 00.
 - b. Temperature control system shall consist of a full Direct Digital Control (DDC) system including all accessories, sensors, and programming.
 - c. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
4. Testing, Adjusting, and Balancing Work shall include, but is not necessarily limited to:
- a. Furnish complete testing, adjusting, and balancing as specified in Section 23 05 93, including, but not limited to, air systems, hydronic systems.

1.3 OWNER FURNISHED PRODUCTS

- A. The Owner will supply the following items for installation and/or connection by This Contractor:
- B. The following items shall be relocated, installed and/or connected by This Contractor:
- C. The Owner will supply manufacturer's installation data for Owner-purchased equipment for this project.
- D. This Contractor shall make all mechanical system connections shown on the drawings **or** as required for fully functional units.
- E. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.

1.4 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours will be required.
- B. Schedule overtime for the following work:
- C. Itemize all work and list associated hours and pay scale for each item.

1.5 ALTERNATES

- A. Refer to drawings for identification of bid alternates.

1.6 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
 - a. Plumbing Contractor.
 - b. Heating Contractor.
 - c. Air Conditioning and Ventilating Contractor.
 - d. Temperature Control Contractor.
 - e. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
 - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed.

Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.

2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements, California Code of Regulation Title 24, Article E725.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
 - a. Light fixtures.
 - b. Gravity flow piping, including steam and condensate.
 - c. Electrical busduct.
 - d. Sheet metal.
 - e. Electrical cable trays, including access space.
 - f. Sprinkler piping and other piping.
 - g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
 - a. Computer Room Air Conditioning Units.
 - b. Condensing Units.
 - c. Makeup Air Units.
 - d. Gas Trains.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Temperature Control Subcontractor's Responsibility:
 - a. Wiring of all devices needed to make the Temperature Control System functional.
 - b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.

- c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
 4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.
- D. Electrical Contractor's Responsibility:
 1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
 2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
 3. Provides motor control and temperature control wiring, where so noted on the drawings.
 4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
 5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
 6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.7 QUALITY ASSURANCE

- A. Contractor's Responsibility Prior to Submitting Pricing Data:
 1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
 2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Wisconsin Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.

7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.
- E. Utility Company Requirements:
1. Secure from the appropriate private or public utility company all applicable requirements.
 2. Comply with all utility company requirements.
 3. Make application for and pay for service connections, such as gas.
 4. Make application for and pay for all meters and metering systems required by the utility company.
- F. Examination of Drawings:
1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
 2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
 3. Scaling of the drawings is not sufficient or accurate for determining these locations.
 4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
 5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
 6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
 7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
 8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 - a. Any item listed as furnished shall also be installed, unless otherwise noted.
 - b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.8 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

<u>Referenced Specification Section</u>	<u>Submittal Item</u>
23 05 00	Owner Training Agenda
23 05 13	Motors
23 05 15	Variable Frequency Drives
23 05 48	Vibration Isolation Equipment
23 05 93	Testing, Adjusting, and Balancing
23 34 13	Axial Fans
23 34 16	Centrifugal Fans
23 34 23	Power Ventilators
23 82 00	Terminal Heat Transfer Equipment

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:
1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
 2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
 3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
 4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
 5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
-

- b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. **The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 23 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 23 XX XX.description.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

D. Paper Copy Submittal Procedures:

1. Paper copies are acceptable where electronic copies are not provided.
2. The Contractor shall submit ten (10) paper copies of each shop drawing.
3. Each set shall be bound in a three-ring binder or presentation binder. Copies that are loose or in pocket folders are not acceptable.

1.9 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.

- B. Change order work shall not proceed until authorized.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
 - 1. Air Cooled Condensers
 - 2. Boilers, Burners and Boiler Trim
 - 3. Computer Room Units
 - 4. Condensing Units
 - 5. Gas Fired Makeup Air Units
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.14 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.15 CONTINGENCY

- A. The Mechanical Contractors shall include in the Base Bid a contingency of one percent (1%) to be used only by change orders issued by the Architect/Engineer. The unused portion of the contingency shall be deducted from the Contract price before final payment is made.

1.16 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employee and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:
1. Placing fill over underground and underslab utilities.
 2. Covering exterior walls, interior partitions and chases.
 3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
 3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
 4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

- C. Before final payment is authorized, this Contractor must submit the following:
1. Operation and maintenance manuals with copies of approved shop drawings.
 2. Record documents including marked-up or reproducible drawings and specifications.
 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
 4. Inspection by State Boiler Inspector.
 5. Start-up reports on all equipment requiring a factory installation inspection or start-up.
 6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.4 OPERATION AND MAINTENANCE MANUALS

- A. General:
1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
 2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.
- B. Electronic Submittal Procedures:
1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
 3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
 4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div23.contractor.YYYYMMDD

b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD

5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as “1 of 2”, “2 of 2”, etc.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title “Operation and Maintenance Instructions”, title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, _____ paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.
2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. “Peel and stick” labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with “Operation and Maintenance Instructions”, title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect’s/Engineer’s shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Refer to Section 23 09 00 for additional requirements for Temperature Control submittals.
5. Copy of final approved test and balance reports.
6. Copies of all factory inspections and/or equipment startup reports.
7. Copies of warranties.
8. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
9. Dimensional drawings of equipment.
10. Capacities and utility consumption of equipment.
11. Detailed parts lists with lists of suppliers.
12. Operating procedures for each system.
13. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
14. Repair procedures for major components.
15. List of lubricants in all equipment and recommended frequency of lubrication.
16. Instruction books, cards, and manuals furnished with the equipment.

3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by **FACTORY PERSONNEL** in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The instructions shall include:
 1. Explanation of all system flow diagrams.
 2. Explanation of all air handling systems.
 3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
 4. Maintenance of equipment.
 5. Smoke control systems.
 6. Stairwell pressurization systems.
 7. Start-up procedures for all major equipment.
 8. Explanation of seasonal system changes.
 9. Description of emergency system operation.

- E. The Architect/Engineer shall be notified of the time and place instructions will be given to the Owner's representatives so he or his representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
 - 1. Heat Pump System - 4 hours.
 - 2. Exhaust Systems - 2 hours.
 - 3. Temperature Controls - As defined in Section 23 09 00.
- G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
- H. Operating Instructions:
 - 1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
 - 2. If the Contractor does not have staff that can adequately provide the required instructions he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.6 SYSTEM STARTING AND ADJUSTING

- A. The mechanical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels. Areas with mechanical cooling shall be maintained below 60% RH.
- D. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- E. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- F. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution

issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.7 RECORD DOCUMENTS

- A. The following paragraph supplements Division 1 requirements:

Contractor shall maintain at the job site a separate and complete set of mechanical drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the mechanical systems.
- B. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- C. Refer to Section 23 09 00 for additional requirements for Temperature Control documents.
- D. Before completion of the project, a set of reproducible mechanical drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.8 PAINTING

- A. This Contractor shall paint the following items:
- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor.

- D. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer his color preference and furnish this color.
- F. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- G. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.
- H. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
 - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
 - 2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.

3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

END OF SECTION

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All air handling units operating and balanced.
3. All fans shall be operating and balanced.
4. All pumps, boilers and chillers operating and balanced.
5. All miscellaneous mechanical systems (unit heaters, fan coil units, cabinet heaters, etc.) operating.
6. All temperature control systems operating, programmed and calibrated.
7. Pipe insulation complete, pipes labeled and valves tagged.
8. Fire damper and fire/smoke damper access doors labeled in accordance with specifications.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

* * * * *

SECTION 23 05 13

MOTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Single Phase and Three Phase Electric Motors.

1.2 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- E. ANSI/NEMA MG 1 - Motors and Generators.
- F. ANSI/NFPA 70 - National Electrical Code.
- G. Energy Independence and Security Act of 2007.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 05 00. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.
- B. Submit shop drawings for all three phase motors.
- C. Submit motor data with equipment when motor is installed by the manufacturer at the factory.
- D. Submit shaft grounding device for all motors as required.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories, with a minimum of three years documented manufacturing experience.

PART 2 - PRODUCTS

2.1 MOTORS - GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Refer to the drawings for required electrical characteristics.
- B. Design motors for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- C. Explosion-Proof Motors: UL listed and labeled for the hazard classification shown on the drawing, with over-temperature protection.
- D. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.
- E. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- F. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.
- G. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.
- H. Each contractor shall set all motors furnished by him.
- I. All motors shall have a minimum service factor of 1.15.
- J. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.
- K. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.
- L. Aluminum end housings are not permitted on motors 15 HP or larger.
- M. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Motors over 40 HP shall have dual screw adjusters. Slide bases shall conform to NEMA standards.
- N. Motors for fans and pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of varying motor speed.

2.2 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

- A. All motors, unless exempted by EPA legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

HP	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10.0	91.7	91.7	89.5	91.0	91.7	90.2
15.0	91.7	93.0	90.2	91.7	92.4	91.0
20.0	92.4	93.0	91.0	91.7	93.0	91.0
25.0	93.0	93.6	91.7	93.0	93.6	91.7
30.0	93.6	94.1	91.7	93.0	93.6	91.7
40.0	94.1	94.1	92.4	94.1	94.1	92.4
50.0	94.1	94.5	93.0	94.1	94.5	93.0
60.0	94.5	95.0	93.6	94.5	95.0	93.6
75.0	94.5	95.0	93.6	94.5	95.4	93.6
100.0	95.0	95.4	93.6	95.0	95.4	94.1
125.0	95.0	95.4	94.1	95.0	95.4	95.0
150.0	95.4	95.8	94.1	95.8	95.8	95.0
200.0	95.4	95.8	95.0	95.8	96.2	95.4
250.0	95.4	95.8	95.0	95.8	96.2	95.8
300.0	95.4	95.8	95.4	95.8	96.2	95.8
350.0	95.4	95.8	95.4	95.8	96.2	95.8
400.0	95.8	95.8	95.8	95.8	96.2	95.8
450.0	96.2	96.2	95.8	95.8	96.2	95.8
500.0	96.2	96.2	95.8	95.8	96.2	95.8

- B. Motor nameplate shall be noted with the above ratings.

2.3 MOTORS ON VARIABLE FREQUENCY DRIVES

- A. All motors driven by VFDs shall be premium efficiency type.
- B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.
- C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors."

- D. All 460-volt motors controlled by VFDs shall be equipped with an alternate discharge path, such as a shaft grounding ring or grounding brush, to divert adverse shaft currents from the motor bearings on the drive end of the motor shaft. Motor shafts 2” and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.
 - 1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.

2.4 MOTORS FOR WET OR CORROSIVE DUTY

- A. Where noted for wet and/or corrosive duty, motors shall be designed for severe duty with cast-iron frame, epoxy finish, stainless steel nameplate, polymer shaft seal, corrosion resistant fasteners and fan, moisture resistant windings, and non-wicking leads.

2.5 MOTORS FOR HAZARDOUS DUTY

- A. Where noted for hazardous duty, motors shall be designed for the class, group, and T code listed for the application. Frame sizes 143T and larger shall have normally closed winding thermostats to keep surface temperatures below the nameplate T code under all conditions.

2.6 MOTOR DRIVEN EQUIPMENT

- A. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.
- B. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.

2.7 SHEAVES

- A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.
- B. When replacing sheaves, use sheaves of at least the originally supplied sizes.
- C. Contractor responsible for motor shall also be responsible for replacement sheaves. Coordinate with testing and balancing of the equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

- B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.
- C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

END OF SECTION

SECTION 23 05 15

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Variable frequency drives

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Variable Frequency Drive Schedule for rating and configuration.

1.3 REFERENCES

- A. ANSI/UL Standard 508
- B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- C. IEEE Standard 519-1992 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters
- D. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 26 05 00.
- B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- C. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 EXTRA MATERIAL

- A. Furnish under provisions of Section 26 05 00.
- B. Provide two of each air filter.
- C. Provide three of each fuse size and type.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 26 05 00.
- B. Accept controllers on site in original packing. Inspect for damage.

- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 26 05 00.
- B. Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.
- C. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- D. Shop Drawings: For each VFD.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. UL listing for series rating of overcurrent protective devices in combination controllers.
 - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS: Refer to Variable Frequency Drive Schedule.

2.2 DESCRIPTION

- A. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC squirrel cage motors. The controller shall be suitable for use with standard NEMA B squirrel cage 1.15 service factor induction motors without requiring any modifications to the motor or the drive.
- B. Controller shall have sufficient capacity to provide speed control of the motors shown or noted throughout the specified environmental operating conditions.

C. Controller shall have the functional components listed below:

1. Door interlocked input circuit breaker/fused switch.
2. Input rectifier section to supply fixed DC bus voltage.
3. Smoothing reactor for DC bus.
4. DC bus capacitors.
5. Control transformer.
6. Separate terminal blocks for power and control wiring.
7. Terminal block for operator controls.
8. Sine weighted PWM generating inverter section.

2.3 RATINGS

- A. Rated Input Voltage: Refer to Variable Frequency Drive Schedule 480V.
- B. Motor Nameplate (Drive Output) Voltage: Refer to Mechanical Schedules.
- C. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
- D. Operating Ambient: 0°C to 40°C.
- E. Minimum Relative Humidity Range: 5% to 90% (non-condensing).
- F. Minimum Elevation without Derating: 3300 feet.
- G. Minimum Efficiency at Full Load: 96 percent.
- H. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds or 180% for 0.5 seconds.
- I. Starting Torque: 100 percent of rated torque or as indicated.
- J. Speed Regulation: Plus or minus 1 percent with no motor derating.

2.4 DESIGN

- A. Pulse Width Modulated (PWM) Variable Frequency Drives:
 1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section.
 2. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz. If derating of the inverter is necessary to run at 8kHz, then the unit's derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.
 3. All controllers supplied with semi-conductors capable of switching at less than 8,000 Hertz shall be supplied with a motor acoustic noise reduction filter.
 4. Pulse width modulated (PWM) drives shall be supplied with drive input line reactors with a minimum impedance of 3%. Reactors shall be installed to filter entire drive input circuit.

5. Pulse width modulated (PWM) drives shall be supplied with drive input harmonic filter to reduce the total harmonic distortion to less than the IEEE519-1992 limits at the utility service entrance.
 6. Drives that are located beyond the manufacturer's recommended maximum distance from the motor shall be provided with dV/dt (long lead) filters.
- B. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.
- C. Drive shall restart after power loss and under-voltage fault. The minimum number of restart attempts required shall be three, field adjustable.
- D. The drive shall allow unlimited switching of the output without damage to the drive or motor.

2.5 PRODUCT FEATURES

- A. Display: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current.
- B. Protection:
1. Input transient protection by means of surge suppressors.
 2. Snubber networks to protect against malfunctions due to system transients,
 3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 4. Motor thermal overload relay(s) adjustable and capable of NEMA Class 10 motor protection and sized per motor nameplate data. When multiple motors are connected to the VFD output, each motor shall have a manual starter with properly sized overload protection.
 5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 6. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.
 7. Loss-of-phase protection.
 8. Reverse-phase protection.
 9. Short-circuit protection (fuses or circuit breaker).
 10. Motor overtemperature fault.
- C. Acceleration Rate Adjustment: 0.5 - 30 seconds.
- D. Deceleration Rate Adjustment: 1 - 30 seconds.

- E. Minimum Adjustment Range for the Lower Output Frequency shall be: 0 to 40 Hertz.
- F. Minimum Adjustment Range for the Upper Output Frequency Range shall be: 40 to 90 Hertz.
- G. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hertz.
- H. Provide MANUAL-OFF-AUTOMATIC selector switch and manual analog speed control mounted on the front of the enclosure.
- I. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.
- J. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.
- K. Provide adjustable skip frequencies on the drive output (minimum of three ranges).
- L. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- M. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Overvoltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- Q. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
 - 1. Output frequency (Hz).
 - 2. Motor speed (rpm).
 - 3. Motor status (running, stop, fault).
 - 4. Motor current (amperes).
 - 5. Motor torque (percent).

6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

S. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0 to 10-V dc.
 - b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Keypad display for local hand operation.
3. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).
4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.

T. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 23 09 00. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.

U. Two- Contactor Manual Bypass:

1. Provide contactors, motor running overload protection, under-voltage and loss of phase protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include to allow maintenance of inverter during bypass operation.

2. All bypass circuitry shall be located within the same enclosure as the variable frequency drive.
3. All fire alarm and/or smoke control interconnections (e.g., air handling unit shutdown) shall apply regardless of whether control is through VFD or bypass.
4. Provide a Drive-Bypass Selector Switch.
5. Provide nameplate with instructions for switching from drive to bypass and from bypass to drive. Provide instructions for isolating VFD for maintenance.

V. Control:

1. With the "Manual-Off-Auto" switch in the "Manual" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the manual speed potentiometer on the drive door.
2. With the "Manual-Off-Auto" switch in the "Auto" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the input signal from an external source.
3. If applicable, with the "Drive-Bypass" in the "Bypass" position, regardless the position of the "Manual-Off-Auto" switch, the motor shall be connected across the lines and shall be run at full speed.
4. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.
5. If applicable, signal from the fire alarm control panel shall shut down VFD and bypass.
6. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.

2.6 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. All VFD supplied for fans shall have dynamic or DC injection braking capability to provide a means of rapid deceleration of the AC motor in not more than one (1) minute. Adjust controls to stop the motor within 30 seconds.
- C. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- D. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- E. Control Relays: Auxiliary and adjustable time-delay relays.

- F. Standard Displays:
 - 1. Output frequency (Hz).
 - 2. Set-point frequency (Hz).
 - 3. Motor current (amperes).
 - 4. DC-link voltage (VDC).
 - 5. Motor torque (percent).
 - 6. Motor speed (rpm).
 - 7. Motor output voltage (V).

- G. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.

- H. Fabrication:
 - 1. Enclosure: NEMA 250, Type 4X.
 - 2. Finish: Manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. The VFD manufacturer shall provide certification that heat test has been completed.

- B. The Electrical Contractor shall have a factory service engineer present for the start-up, field calibration, and check-out of each VFD installed. Factory service engineer shall be required to return to the site for recalibration or set-up should unit not function as specified during system commissioning. All costs shall be a part of This Contract. Provide tag with date and signature of factory service Engineer on inside cover of each drive.

3.2 INSTALLATION

- A. Install variable frequency drive equipment in accordance with the manufacturer's instructions.

- B. Floor mount VFD on prefabricated or field fabricated supports with controls no higher than 6'-6" and no lower than 3'-0" AFF. Mount supports on 1/2" thick vibration isolation pads set on concrete housekeeping pads.

- C. Provide engraved phenolic nameplates under the provisions of Section 26 05 53.

- D. Connections: All conduit connections to the VFD shall be by flexible conduit.

- E. Input, output, and control wiring shall each be run in separate conduits.

- F. All interlocking required by the drive manufacturer shall be the responsibility of the Electrical Contractor.

3.3 STARTUP AND COMMISSIONING

- A. Verify all settings, parameters, and adjustments with other contractors prior to startup. Make all adjustments and setting to coordinate with controls and equipment.
- B. Accelerate the motor to full speed and verify operation. Decelerate the motor to a stop and verify operation. Slowly operate the motor over the speed range and check for resonance.
- C. Make all adjustments and settings to coordinate with controls and equipment prior to Substantial Completion. Verify that drive is set for auto restart after power loss and undervoltage fault.
- D. Document settings in the Operations and Maintenance manual.

END OF SECTION

SECTION 23 05 53

HVAC IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Identification of products installed under Division 23.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. 3M, Bunting, Calpico, Craftmark, Emedco, Kolbi Industries, Seton, W.H. Brady, Marking Services.

2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

<u>OD of Pipe or insulation</u>	<u>Marker Length</u>	<u>Size of Letters</u>
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

Plastic tags may be used for outside diameters under 3/4".

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- D. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
 - 1. All valves (except shutoff valves at equipment) shall have numbered tags.

2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
6. Number all tags and show the service of the pipe.
7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.

D. Pipe Markers:

1. Stencil Painted Pipe Markers:
 - a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
 - b. Apply primer on non-insulated pipes before painting.
 - c. Use background and letter colors as scheduled later in this section.
2. Apply markers and arrows in the following locations where clearly visible:
 - a. At each valve.
 - b. On both sides of walls that pipes penetrate.
 - c. At least every 20 feet along all pipes.
 - d. On each riser and each leg of each "T" joint.
 - e. At least once in every room and each story traversed.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.

F. Miscellaneous:

1. Attach self-adhesive vinyl labels at all duct access doors used to reset fusible links or actuators on fire, fire/smoke, or smoke dampers. Lettering shall be a minimum of 1/2" high. Labels shall indicate damper type.
2. Provide engraved plastic tags at all hydronic or steam system make-up water meters.

3.2 SCHEDULE

- A. Pipes to be marked shall be labeled with the text as shown in the following table regardless of which method or material is used:

<u>Pipe Service</u>	<u>Lettering Color</u>	<u>Background Color</u>
HEATING WATER SUPPLY	Black	Yellow
HEATING WATER RETURN	Black	Yellow
LOW PRESSURE CONDENSATE	Black	Yellow
PUMPED CONDENSATE	Black	Yellow
CONDENSATE DRAIN	Black	Yellow
NATURAL GAS	Black	Yellow
REFRIGERANT LIQUID	Black	Yellow
REFRIGERANT SUCTION	Black	Yellow

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjusting, and balancing of air systems.
- B. Measurement of final operating condition of HVAC systems.

1.2 QUALITY ASSURANCE

- A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years' experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.
- B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

1.3 REFERENCES

- A. AABC - National Standards for Total System Balance, 2002.
- B. ADC – Test Code for Grilles, Registers, and Diffusers.
- C. AMCA – Publication 203-90; Field Performance Measurement of Fan Systems.
- D. ASHRAE - 2003 HVAC Applications Handbook; Chapter 37, Testing, Adjusting and Balancing.
- E. ASHRAE/ANSI - Standard 111-1988; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.
- F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Sixth Edition, 1998.
- G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing, Third Edition, 2002.
- H. TABB – International Standards for Environmental Systems Balance.

1.4 SUBMITTALS

- A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.
- B. Electronic Copies:
 - 1. Submit a certified copy of test reports to the Architect/Engineer for approval. Electronic copies shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Copies that are not legible will be returned to the Contractor for resubmittal. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
 - 2. Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as “1 of 2”, “2 of 2”, etc.
 - 3. All text shall be searchable.

4. Bookmarks shall be used. All bookmark titles shall be an active link to the index page and index tabs.
- C. Paper Copies:
1. Submit four (4) certified copies of test reports to the Architect/Engineer for approval in soft cover, 3-hole binder manuals, with cover identification. Include index page and indexing tabs.

1.5 REPORT FORMS

- A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.
- B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.
- C. Refer to PART 4 for required reports.

1.6 WARRANTY/GUARANTEE

- A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 manhours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.7 SCHEDULING

- A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the Architect/Engineer prior to performing each test.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.

- B. The Balancing Contractor shall incorporate all pertinent documented construction changes (e.g. submittals/shop drawings, change orders, RFIs, ASIs, etc.) and include in the balancing report.
- C. Recorded data shall represent actual measured or observed conditions.
- D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.
- E. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.
- G. The Balancing Contractor shall measure terminal air box air flow, and the TCC shall adjust DDC readout to match. Refer to Section 23 09 00 for additional information.
- H. Installations with systems consisting of multiple components shall be balanced with all system components operating.

3.2 EXAMINATION

- A. Before beginning work, verify that systems are complete and operable. Ensure the following:
 - 1. General Equipment Requirements:
 - a. Equipment is safe to operate and in normal condition.
 - b. Equipment with moving parts is properly lubricated.
 - c. Temperature control systems are complete and operable.
 - d. Proper thermal overload protection is in place for electrical equipment.
 - e. Direction of rotation of all fans and pumps is correct.
 - f. Access doors are closed and end caps are in place.
 - 2. Duct System Requirements:
 - a. All filters are clean and in place. If required, install temporary media.
 - b. Duct systems are clean and free of debris.
 - c. Fire/smoke and manual volume dampers are in place, functional and open.
 - d. Air outlets are installed and connected.
 - e. Duct system leakage has been minimized.
 - 3. Pipe System Requirements:
 - a. Coil fins have been cleaned and combed.
 - b. Hydronic systems have been cleaned, filled, and vented.
 - c. Strainer screens are clean and in place.
 - d. Shutoff, throttling and balancing valves are open.
- B. Report any defects or deficiencies to Engineer.

- C. Promptly report items that are abnormal or prevent proper balancing.
- D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- E. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Engineer for spot checks during testing.
- B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

3.4 INSTALLATION TOLERANCES

- A. $\pm 10\%$ of scheduled values:
 - 1. Adjust air inlets and outlets to $\pm 10\%$ of scheduled values.
 - 2. Adjust piping systems to $\pm 10\%$ of design values.

3.5 ADJUSTING

- A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.
- B. Once balancing of systems is complete, at least one damper or valve must be 100% open.
- C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.
- D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.
- E. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on all pumps not driven by a VFD. Coordinate with contractor.

3.6 SUBMISSION OF REPORTS

- A. Fill in test results on appropriate forms.

PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

4.1 GENERAL REQUIREMENTS

- A. Title Page:
 - 1. Project name.
 - 2. Project location.
 - 3. Project Architect.
 - 4. Project Engineer (IMEG Corp.).
 - 5. Project General Contractor.

6. TAB Company name, address, phone number.
 7. TAB Supervisor's name and certification number.
 8. TAB Supervisor's signature and date.
 9. Report date.
- B. Report Index
- C. General Information:
1. Test conditions.
 2. Nomenclature used throughout report.
 3. Notable system characteristics/discrepancies from design.
 4. Test standards followed.
 5. Any deficiencies noted.
 6. Quality assurance statement.
- D. Instrument List:
1. Instrument.
 2. Manufacturer, model, and serial number.
 3. Range.
 4. Calibration date.

4.2 AIR SYSTEMS

- A. Air Moving Equipment:
1. General Requirements:
 - a. Drawing symbol.
 - b. Location.
 - c. Manufacturer, model, arrangement, class, discharge.
 - d. Fan RPM.
 - e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
 - f. Final frequency of motor at maximum flow rate (on fans driven by VFD).
 2. Flow Rate:
 - a. Supply flow rate (cfm): specified and actual.
 - b. Return flow rate (cfm): specified and actual.
 - c. Outside flow rate (cfm): specified and actual.
 - d. Exhaust flow rate (cfm): specified and actual.
 3. Pressure Drop and Pressure:
 - a. Filter pressure drop: specified and actual.
 - b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
 - c. Inlet pressure.
 - d. Discharge pressure.
- B. Fan Data:
1. Drawing symbol.
 2. Location.
 3. Manufacturer and model.
 4. Flow rate (cfm): specified and actual.

5. Total static pressure: specified and actual. (Indicate measurement locations).
6. Inlet pressure.
7. Discharge pressure.
8. Fan RPM.

C. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps in each phase.

D. Air Terminal (Inlet or Outlet):

1. Drawing symbol.
2. Room number/location.
3. Terminal type and size.
4. Velocity: specified and actual.
5. Flow rate (cfm): specified and actual.
6. Percent of design flow rate.

END OF SECTION

SECTION 23 21 00
HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Heating Water Piping System.
- D. Glycol Water Piping System.
- E. Chilled Water Piping System.
- F. Condenser Water Piping System.
- G. Heating/Cooling Water Piping System.
- H. Acoustical Lagging.

1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 23 05 00. Include data on pipe materials, fittings, valves, and accessories. Include manufacturers' support spacing requirements for plastic piping.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 GLYCOL HEATING WATER

- A. Design Pressure: 125 psig.
Maximum Design Temperature: 225°F.
- B. Piping - 2" and Under:
 - 1. Pipe: Standard weight black steel, threaded and coupled, ASTM A53; Type E, F, or S; Grade B.
 - 2. Joints: Screwed.

3. Fittings: Class 125 cast iron, ASTM A126, ASME B16.4; or Class 150 malleable iron, ASTM A197, ASME B16.3.
 4. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.
- C. Piping - 2-1/2" and Over:
1. Pipe: Standard weight black steel, beveled ends, ASTM A53, Type E or S, Grade B.
 2. Joints: Butt-welded or flanged.
 3. Fittings: Standard weight wrought steel, butt-welding type, ASTM A234, ASME B16.9.
 4. Flanges: Class 150 forged steel, welding neck or slip-on, ASTM A181 or A105, Class 60, ASME B16.5 up to 24" and B16.47 above 24". ASME B16.1 for flanges mating with flat face equipment flanges.
- D. Shutoff Valves:
1. Gate Valves:
 - a. GA-1: 2" and under, 125 psi S @ 353°F, 300 psi WOG @ 150°F, screwed, bronze, rising stem, screwed bonnet. Crane #431, Hammond #IB641, Stockham #B122, Walworth #56, Milwaukee #1150, Watts #B-3210, NIBCO #T-131.
 - b. GA-2: 2-1/2" thru 12", 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, iron body, bronze mounted, OS&Y. Crane #465-1/2, Hammond, Stockham #G623, Walworth, Milwaukee #F2885, Watts #F-503, NIBCO F-617-O.
 2. Ball Valves:
 - a. BA-1: 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and stem, Teflon seats and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

NOTES:

- 1) Provide extended shaft for all valves in insulated piping.
- 2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

- b. BA-1A: 2-1/2" and 3", 125 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals. Apollo #88A-100, Nibco #F510-CS/66, Milwaukee #F90.

NOTES:

- 1) Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.
- 2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

3. Butterfly Valves:

a. BF-1:

- 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 225°F continuous and 250°F intermittent at 125 psig, fully lugged end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), 10 position locking operator up to 6" size. Cv of at least 1580 in 6" size. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, Nibco N200 Series or LD2000 Series, Milwaukee CL series, Hammond 5200 series.

E. Throttling Valves:

1. Globe Valves:

- a. GL-1: 3" and under, 125 psi saturated steam, 300 psi WOG, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #95, Milwaukee #590, Hammond #IB413T, Watts #B-4010-T, or NIBCO #T-235.
- b. GL-2: 4" thru 10", 125 psi @ 353°F, 200 psi WOG @ 150°F, flanged, iron body, bronze mounted. Crane #351, Hammond #IR116, Stockham #G-512, Walworth #906F, Milwaukee #F2981, Watts #F-501, or NIBCO #F-718.

2. Ball Valves:

- a. BA-9: 2" and under, 125 psi saturated steam, 600 psi WOG, standard port, screwed (solder ends are acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body and ball of copper

alloy containing less than 15% zinc, chrome plated or stainless steel ball, Teflon seats and seals with memory stop. Apollo #70-120, Stockham #S-216BR-R, Milwaukee #BA-100, Watts #B-6000, Hammond #8501, Nibco #580-70.

NOTE: Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.

3. Butterfly Valves:

a. BF-4:

- 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 225°F continuous and 250°F intermittent at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size. Victaulic #300, Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, NIBCO LD2000 Series, Milwaukee CL series, Hammond 5200 series.

F. Check Valves:

1. CK-1: 2" and under, 125 psi @ 353°F, 200 psi WOG @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319, Walworth #406, Milwaukee #509, Watts #B-5000, or NIBCO #T-413.
2. CK-13: 2-1/2" thru 12", 200# WOG, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size. Mueller Steam Specialty Co. #71-AHB-6-H, Stockham #WG-961, NIBCO W-920-W, Crane, Victaulic #716/716H.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53, Schedule 40 galvanized.

1. Fittings: Galvanized cast iron screwed drainage type, ASME B16.12.
2. Joints: Screwed.
3. Service: Not allowed on boiler drains and overflow.

B. Steel Pipe: ASTM A53. [for boiler drains only]

1. Pipe: Standard weight black steel, threaded and coupled, ASTM A53.
2. Joints: Screwed.

3. Fittings: Class 125 cast iron, ASTM A126, ASME B16.4.
- C. Shutoff Valves:
1. Ball Valves:
 - a. BA-1: 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

NOTES:

- 1) Provide extended shaft for all valves in insulated piping.
- 2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

2.3 AIR VENTS

- A. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.
- B. On branch lines and small heating units - Use coin-operated air vent equal to B&G #4V, attached to 1/8" coupling in top of pipe. Install air vents on all coils and terminal heating units.

2.4 AUTOMATIC AIR VENTS

- A. Low capacity automatic air vent (for bladder tank anti-thermosyphon loops). Maximum operating pressure and temperature of at least 240°F and 125 psi, 1/2" or 3/4" inlet. B&G #87, Armstrong, Spirotherm, Taco, or Watts.
- B. High/low capacity automatic air vent (for air separator connection). Maximum operating pressure and temperature of at least 240°F and 125 psi, 3/4" inlet, 3/8" minimum outlet. B&G #107, Armstrong, Spirotherm, Taco, or Watts.

2.5 MAKE-UP WATER ACCESSORIES

- A. Relief Valve:
 1. For water fill lines to hydronic systems.
 2. Cast iron or bronze body, 1/2" or 3/4" screwed connections, 125 psig working pressure, 225°F maximum temperature. Minimum 500,000 Btuh capacity at 30 psig. Manual test lever.

3. Acceptable Manufacturers: Armstrong, Bell & Gossett, Conbraco, Taco, Watts.

2.6 SAFETY RELIEF VALVES

- A. SRV-1 (Hydronic Heating Systems): Spring-loaded disc type with cast iron or bronze body, bronze or stainless steel disc, side outlet and lifting lever for maximum service of 125 psig at 250°F. For relieving water during pressure fluctuations and in case of control failure. Capacities shall be ASME Section IV certified and labeled. Acceptable Manufacturers: Kunkle # 537, B&G, Conbraco, McDonnell & Miller, or Watts.

2.7 CONNECTIONS BETWEEN DISSIMILAR METALS

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:
 1. Iron, steel, and stainless steel connected to each other.
 2. Brass, copper, and bronze connected to each other.
 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
 1. Dielectric waterway rated for 300 psi CWP and 225°F.
 2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic Series 647, Grinnell Series 407, Matco-Norca.
- F. Flanged Joints (any size):
 1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
 2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
 3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.

4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

2.8 LOCK OUT TRIM

- A. Provide lock out trim for all quarter turn valves opening to atmosphere installed in heating water piping over 120°F and as indicated on the drawings.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Connect to all equipment with flanges or unions.
- D. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for treatment.

3.2 TESTING PIPING

Glycol Heating Water:

1. Complete testing before insulation is applied. If insulation is applied before pipe is tested and a leak ruins the insulation, replace all damaged insulation.
2. Test the pipe with 100 psig water pressure. Hold pressure for at least two hours.
3. Test to be witnessed by the Engineer or their representative, if requested by the Engineer.

3.3 CLEANING PIPING

- A. Assembly:
 1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
 2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.

3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

3.4 INSTALLATION

A. General Installation Requirements:

1. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.
2. Install piping to conserve building space, and not interfere with other work.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
5. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.
6. Install bell and spigot pipe with bells upstream.
7. Seal pipes passing through exterior walls with a wall seal per Section 23 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
8. Branch takeoffs shall be from the top side (if branch is two sizes smaller than main), or any angle from the horizontal plane to the top of piping.

B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment plus its required clearance space.

C. Valves/Fittings and Accessories:

1. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.
2. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.
3. Provide clearance for installation of insulation, and access to valves and fittings.

4. Provide access doors where valves are not exposed.
5. Where a manual balance valve is shown to be installed in series with a service (isolation) valve, separate balance and service (isolation) valves shall be installed.
6. Install balancing valves with the manufacturer's recommended straight upstream and downstream diameters of pipe.
7. Prepare pipe, fittings, supports, and accessories for finish painting.
8. Install valves with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.
9. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
10. Provide flanges or unions at all final connections to equipment, traps and valves.
11. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

3.5 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.
- B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.
- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. **2-1/2" and larger fittings shall be long radius type**, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.
- F. Use full and double lengths of pipe wherever possible.
- G. Unless otherwise indicated, install all inlet and outlet piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or pump.

- H. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- I. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

3.6 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate, and venting.
- B. Provide drain valves at all low points of water piping systems or where indicated on drawings for complete or sectionalized draining. Drain valves are defined above.
- C. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install all liquid lines with top of pipe and eccentric reducers in a continuous line.
- D. Provide air vents at all high points and wherever else required for elimination of air in all water piping systems. Do not use automatic air vents in glycol systems unless they are piped to the fill tank.
- E. Air vents shall be in accessible locations. If needed to trap and vent air in a remote location, a 1/8" pipe shall connect the tapping location to a venting device in an accessible location.
- F. All vent and drain piping shall be of same materials and construction as the service involved.

3.7 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.
- B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- C. Use of forged weld-on fittings is also limited as follows:
 - 1. Must have at least same pressure rating as the main.
 - 2. Header or main must be 2-1/2" or over.
 - 3. Branch line is at least two pipe sizes under header or main size.

3.8 JOINING OF PIPE

- A. Threaded Joints:
 - 1. Ream pipe ends and remove all burrs and chips.
 - 2. Protect plated pipe and valve bodies from wrench marks when making up joints.
 - 3. Apply Teflon tape to male threads.
- B. Flanged Joints:
 - 1. Bronze flanges shall conform to B16.24 and ductile iron flanges to B16.42. Steel flanges shall be raised face except when bolted to flat face cast iron flange.

2. Bolting shall be ASTM A307 Grade B with bolts and heavy hexagonal nuts conforming to ASME B18.2.1 and B18.2.2.
3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.
4. Gaskets for flat face flanges shall be full-face type. Gaskets for raised faced flanges shall conform to requirements for "Group I gaskets" in ASME B16.5. All gaskets shall conform to ASME B16.21. Unless otherwise specified, gaskets shall meet the following requirements:
 - a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
 - b. Maximum pressure rating of at least 250 psig.
 - c. Minimum temperature rating: -10°F.
 - d. Maximum temperature rating of at least 170°F for water and glycol solution systems operating 140°F and less.
 - e. Maximum temperature rating of at least 250°F for water and glycol solution systems operating above 140°F and up to 180°F.

C. Welded Joints:

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.
5. Single-welded butt joints may be employed with or without the use of backing rings in all sizes. Where backing rings are not used on pumped pressurized systems, the root side of the weld shall either be chipped or ground flush with the piping wall. For services such as vents, overflows, and gravity drains, the backing ring may be eliminated, and the root of the weld need not be chipped or ground. Backing rings shall be of the material being welded.

END OF SECTION

SECTION 23 31 00

DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Galvanized Ductwork
- B. Ductwork Reinforcement
- C. Ductwork Sealants
- D. Rectangular Ductwork
- E. Round and Flat Oval Ductwork
- F. Exposed Ductwork (Rectangular, Round, or Oval)
- G. Flexible Duct
- H. Leakage Testing
- I. Ductwork Penetrations
- J. Duct Cleaning
- K. Painting

1.2 DEFINITIONS

- A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
- B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.

PART 2 - PRODUCTS

2.1 GALVANIZED DUCTWORK

- A. General Requirements:
 - 1. Duct and reinforcement materials shall conform to ASTM A653 and A924.
 - 2. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
 - 3. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.
 - 4. Ductwork reinforcement shall be of galvanized steel.
 - 5. Ductwork supports shall be of galvanized or painted steel. Slip cable hangers are acceptable. Acceptable manufacturers are Gripple, Ductmate, Duro Dyne, or Architect/Engineer approved.
 - 6. Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel attached to the bottom of ducts at 8'-0" OC and as required by CMC/UMC and SMACNA guidelines.

7. All fasteners shall be galvanized or cadmium plated.

2.2 DUCTWORK REINFORCEMENT

A. General Requirements:

1. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.
 - a. Ducts must be over 18" wide.
 - b. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
 - c. Tie rods must not exceed 1/2" diameter.
 - d. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

2.3 DUCTWORK SEALANTS

- A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M.
- B. Two-part joint sealers shall consist of a minimum 3" wide mineral-gypsum compound impregnated fiber tape and a liquid sealant. Sealant system shall meet the following requirements: maximum 48-hour cure time, service temperature of 0°F to 200°F, resistant to mold, mildew, and water, flame spread rating below 25 and smoke developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes.
- C. Pressure sensitive tape used for sealing ductwork shall be minimum 2.5-inch wide, listed and marked UL 181A-P, having minimum 60 oz/inch peel adhesion to steel, and service temperature range from -20°F to +250°F.
- D. Where pressure sensitive tape is called for on drawings and specifications for sealing flexible ductwork, tape shall be minimum 2.5-inch wide, UL 181 B-FX listed, and marked tape having minimum 60 oz/inch peel adhesion to steel and service temperature range from -20°F to +250°F. Acceptable manufacturers include: Venture Tape 1581A, Compac #340, Scotch Foil Tape 3326, Polyken 339.

2.4 RECTANGULAR DUCT - SINGLE WALL

A. General Requirements:

1. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
2. Transitions shall not exceed the angles in Figure 4-7.

B. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:

1. All ducts shall be cross-broken or beaded.
2. Snap lock seams are not permitted.
3. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:
 - a. Type 1:
 - 1) **Description:** Single wall type with 22-gauge (0.029") or heavier vanes, 3-1/4" blade spacing, and 4" to 4-1/2" radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra-long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.
 - 2) **Usage:** Limited to 3,000 fpm and vane lengths 36" and under.
 - b. Type 2:
 - 1) **Description:** Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.
 - 2) **Usage:** No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.
 - c. Type 3 (acoustical - where acoustical lagging is located or as noted on drawings):
 - 1) **Description:** Same as Type 2, except filled with fiberglass and with slotted or perforated inner curve. Minimum insertion loss of 9 dB at 250 Hz and 6 dB at 1 KHz.
 - 2) **Usage:** No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.
 - d. Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.
 - e. Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.
 - f. Omitting every other vane is prohibited.
4. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. **Mitered elbows (with or without turning vanes) may not be substituted for radius elbows.** Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.

5. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45° entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.
6. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.
7. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45° rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.
8. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30° maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30° angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.
9. All lined duct shall utilize dovetail joints where round or conical taps occur. The dovetail joints shall extend past the liner before being folded over.
10. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2" pressure class, and must be less than 6" in length.
11. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
 - a. Apply sealant to all inside corners. Holes at corners are not acceptable.
 - b. Acceptable Manufacturers: Ductmate Industries - 25/35/45, Nexus, Mez, or WDCI. Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.
12. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
 - a. Apply sealant to all inside corners. Holes at corners are not acceptable.
 - b. Flanges shall be 24-gauge minimum (not 26 gauge).
 - c. Acceptable Manufacturers: Lockformer TDC, TDF, United McGill, or Sheet Metal Connectors. Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide openings in ducts for thermometers and controllers.
- B. Locate ducts with space around equipment for normal operation and maintenance.
- C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms.
- D. During construction provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork. Supply ductwork shall be free of construction debris, and shall comply with level "B" of the SMACNA Duct Cleanliness for New Construction Guidelines.
- E. Repair all duct insulation and liner tears.
- F. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.
- G. Insulate terminal air box reheat coils. Seal insulation tight to form a tight vapor barrier.
- H. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.
- I. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.
- J. Install all exterior ductwork per SMACNA Fig. 6-3. Where drawings do not indicate otherwise, ductwork seams and joints shall be sealed watertight and pitched to shed water.
- K. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible.
- L. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by California Building Codes.
- M. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.
- N. Kitchen Grease and Dishwasher Ductwork:
 - 1. All kitchen grease and dishwasher ductwork shall be installed with a continuous slope and grease tight welds on all seams and joints.

3.2 DUCTWORK APPLICATION SCHEDULE

USAGE	MATERIAL	PRESSURE CLASS	SEAL CLASS †	INSULATION
Supply Duct from Terminal Air Boxes to Outlets	Galvanized Sheet Metal - Rectangular	+2"	A	1-1/2" thick Type A (R=5.4) 2" thick Type A (R=7.1)
Return Duct	Galvanized Sheet Metal	-2"	A	None
General Exhaust Duct	Galvanized Sheet Metal	-1"	A	None or 1" thick Type C (R=3.6)
† Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual				

3.3 DUCTWORK SEALING

A. General Requirements:

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.
4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.

- #### B.
- For Seal Class A ducts, all transverse joints, longitudinal seams, and duct wall penetrations shall be sealed. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.

3.4 TESTING

A. Duct - 2" WG or Less (positive or negative):

1. Systems shall not leak more than shown in Table 4-1 of SMACNA HVAC Air Duct Leakage Test Manual for Seal Class A.
2. Leak testing of these systems is not normally required for interior ductwork. However, leak tests will be required if, in the opinion of the Architect/Engineer, the leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.
3. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.

4. Seal ducts to bring the air leakage into compliance.
5. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

3.5 DUCTWORK PENETRATIONS

- A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.
- B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Architect/Engineer.
- C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms.

END OF SECTION

SECTION 23 34 23

POWER VENTILATORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Roof Exhaust Fans.
- B. Rooftop Fan Curbs.
- C. Propeller Fans.

1.2 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300.
- C. Fabrication: Conform to AMCA 99.

1.3 REFERENCES

- A. AMCA 99 - Standards Handbook.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- C. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- D. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
- E. NFPA-13 – The Standard for Sprinkler Installation.
- F. SMACNA - HVAC Duct Construction Standards, 1995 Edition.

1.4 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00. Include product data on wall and roof exhausters, and ceiling and cabinet fans.
- B. Provide multi-rpm fan curves with specified operating point clearly plotted.
- C. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 ROOFTOP EXHAUST FAN - DIRECT DRIVEN

- A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Construction: Fan construction shall meet the intent of AMCA 99-0401 construction requirements for Spark B.
- D. Direct drive, motor mounted outside of air stream and ventilated with outside air.
- E. Aluminum or brass bird screen. Plastic mesh will not be allowed.

- F. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- G. Furnish solid-state dial speed controller. Mount and wire inside fan unless shown otherwise on the drawings. Provide permanent marking at balanced point.
- H. Furnish normally closed, electric motorized damper. Provide step-down transformer if required. Install and wire damper to open when fan runs.
- I. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods.
- J. Mill aluminum finish.
- K. Furnish permanently lubricated sealed ball type motor and drive shaft bearings. Motor and wheel supported by vibration isolators.
- L. Acceptable Manufacturers: Aerovent "FACX", Cook "ACE-D", Greenheck, ILG – CRD, ACME PX, Penn DX, Carnes, Twin City DCRU.

2.2 ROOFTOP FAN CURBS

- A. Furnish and install prefabricated roof curbs for all rooftop fans.
- B. Size curb to match the curb cap of fan.
- C. Top of all curbs shall be at least 12" above the top of the roof. Increase curb height to allow for roof insulation.
- D. Unitized construction, continuous arc welded corner seams. Insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board. Damper support angle. Pressure treated wood nailer.
- E. If called for in the drawings, curbs shall be of the sound attenuation type. Sound attenuation curbs shall reduce the fan sone rating by at least 40% and not decrease fan cfm more than 8% (which is accounted for in the scheduled fan cfm). Baffles shall be removable for access to the dampers.
- F. 14-gauge aluminum construction.
- G. Acceptable Manufacturers: Same manufacturer as the fan, Pate, RPS or Thy.

2.3 PROPELLER FANS

- A. Direct-driven as scheduled propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.
- B. Cast-aluminum blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- C. Construction: Fan construction shall meet the intent of AMCA 99-0401 construction requirements for Spark B.
- D. Provide motor-side back guard complying with OSHA specifications, removable for maintenance.

- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
- F. Shaft Bearings: Permanently lubricated, L₁₀ of 100,000 hours, permanently sealed, self-aligning ball bearings.
- G. Provide with the following accessories:
 - 1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
 - 2. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
- H. Acceptable Manufacturers: Aerovent, Cook, Greenheck, ACME, Penn, Carnes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with cadmium plated lag screws to roof curb.
- C. If manufacturer has no recommendations, secure roof exhaust fans to curbs with 1/4" lag bolts on 8" maximum centers.
- D. MC shall install and wire factory provided damper to open when the fan runs if the manufacturer does not provide an option to pre-wire the damper.

END OF SECTION

SECTION 23 82 00

TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Gas Fired Low Intensity Radiant Tube Heaters.

1.2 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00.
- B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.
- C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.
- D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.
- E. Submit manufacturers' installation instructions.
- F. Manufacturer shall provide special seismic certification per OSHPD CAN 2-1708a.5 with submittal. Submittals without certification will be returned and not reviewed.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

1.4 REGULATORY REQUIREMENTS

- A. Conform to ASHRAE 90.1.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

PART 2 - PRODUCTS

2.1 GAS FIRED LOW INTENSITY RADIANT TUBE HEATERS

- A. Units shall be ceiling hung, gas fired, low intensity radiant type.
- B. System shall include all burner, controls, combustion tube, reflector, venting materials, hanging chains, and accessories.

- C. Include the following controls: Electric room thermostat, solenoid gas valve, safety pilot valve, main gas pressure regulator, pilot gas pressure regulator, main manual shutoff, high limit switch.
- D. Enameled steel control housing.
- E. 4" OD 16 gauge aluminized steel finished combustion tube with high emissivity black coating.
- F. Polished aluminum endcaps.
- G. Provide all vents and intakes in accordance with manufacturer's recommendations.
- H. Provide aluminum reflector system for the entire length of the combustion tube.
- I. Acceptable Manufacturers: Schwank, Re-Verber-Ray, Co-Ray-Vac, or Reflecto-Ray.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
 - 1. Install all products per manufacturers' instructions.
 - 2. Coordinate recess sizes for recessed equipment.
 - 3. Protect units with protective covers during construction.
 - 4. Comb all coils to repair bent fins.
- B. Gas Fired Radiant Tube Heaters:
 - 1. Hang tube heaters from building structure. Mount as high as possible unless otherwise indicated.
 - 2. Position reflectors horizontally **OR** at 30° angles on tube heaters for maximum coverage areas.
 - 3. Route positive pressure gas vent and combustion air from tube heater to roof terminations. Provide flex connections as required.

3.2 CLEANING

- A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.

END OF SECTION

SECTION 26 05 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Interior Communications Pathways Section 27 05 28.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced in each specification section.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)

1.3 SCOPE OF WORK

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make his portion of the Electrical Work a finished and working system.
- C. Description of Systems shall be as follows:
 - 1. Electrical power system to and including luminaires, equipment, motors, devices, etc.
 - 2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.
 - 3. Grounding system.
 - 4. Security system.
 - 5. Wiring system for temperature control system as shown on the drawings.
 - 6. Lightning protection system.
 - 7. Wiring of equipment furnished by others.
 - 8. Removal work and/or relocation and reuse of existing systems and equipment.
 - 9. Technology Systems as described in Division 27/28 and on the T-series documents as described in the Suggested Matrix of Scope Responsibility.

- D. Work Not Included:
1. Telecommunications cabling will be by others, in raceways and conduits furnished and installed as part of the Electrical work.
 2. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

1.4 OWNER FURNISHED PRODUCTS

- A. The Owner will supply manufacturer's installation data for new equipment purchased by him for this project.
- B. This Contractor shall make all electrical system connections shown on the drawings **or** required for fully functional units.
- C. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.

1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, AND CONTROL CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
 1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
 2. "Technology Contractors" refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.
 3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
 4. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
 5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.

6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
9. Low Voltage Technology Wiring: The wiring associated with the Technology Systems, used for analog or digital signals between equipment.
10. Telecommunications Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications information outlets.

C. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
 - a. Luminaires.
 - b. Gravity flow piping, including steam and condensate.
 - c. Electrical bus duct.
 - d. Sheet metal.
 - e. Cable trays, including access space.
 - f. Other piping.
 - g. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:

1. Wiring of all devices needed to make the Temperature Control System functional.
2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:

1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

G. General (Electrical/Technology):

1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".
2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.
3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.
4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

H. Technology Contractor's Responsibility:

1. Assumes all responsibility for the Low Voltage Technology Wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility".
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of Technology equipment which is required to be bonded to the telecommunications ground bar.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign-off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.7 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the

individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.
2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Madison, Wisconsin Codes, Laws, Ordinances and other regulations having jurisdiction over this installation.
2. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
3. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
4. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
5. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
6. If there are no local codes having jurisdiction, the current issue of the NEC shall be followed.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.

4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
 5. Pay all charges arising out of required inspections by an authorized body.
 6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
 7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.
 8. Pay all telephone company charges related to the service or change in service.
- E. Utility Company Requirements:
1. Secure from the private or public utility company all applicable requirements.
 2. Comply with all utility company requirements.
 3. The Owner shall make application for and pay for new electrical service equipment and installation. The Contractor shall coordinate schedule and requirements with the Owner and Utility Company.
 4. Furnish the meter socket and metering compartment. Verify approved manufacturers and equipment with the Utility Company.
 5. The Owner shall apply and pay for any changes for removal of existing electrical service by the utility company. The Contractor shall verify approved manufacturers and equipment with the Utility Company.
- F. Examination of Drawings:
1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
 2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.
 3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
 4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
 5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
 6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.

7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.
8. Where used in electrical documents the word “furnish” shall mean supply for use, the word “install” shall mean connect up complete and ready for operation, and the word “provide” shall mean to supply for use and connect up complete and ready for operation.
9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed “Electronic File Transmittal” form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor’s use of these documents.

H. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.

1.8 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

<u>Referenced Specification Section</u>	<u>Submittal Item</u>
26 05 17	Electric Heat Trace and Snow Melt
26 05 73	Power System Study
26 09 33	Lighting Control Systems
26 20 00	Service Entrance
26 22 00	Dry Type Transformers
26 24 13	Switchboards
26 24 16	Panelboards
26 24 19	Motor Control
26 27 26	Wiring Devices
26 28 16	Disconnect Switches
26 28 21	Contactors
26 41 00	Lightning Protection Systems
26 43 00	Surge Protection Devices
26 51 00	Lighting
28 31 00	Fire Alarm and Detection Systems

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

- a. Date
- b. Project title and number
- c. Contractor's name and address
- d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
- e. Description of items submitted and relevant specification number
- f. Notations of deviations from the contract documents
- g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

- a. Date
- b. Project title and number
- c. Architect/Engineer
- d. Contractor and subcontractors' names and addresses
- e. Supplier and manufacturer's names and addresses
- f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
- g. Description of item submitted (using project nomenclature) and relevant specification number
- h. Notations of deviations from the contract documents
- i. Other pertinent data
- j. Provide space for Contractor's review stamps

3. Composition:

- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

- b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. **The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**

6. Submittal Identification and Markings:
 - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 26 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 26 XX XX.description.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

1.9 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
 1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
 2. Submit in Excel format.
 3. Support values given with substantiating data.
- C. Preparation:
 1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
 2. Break down all costs into:
 - a. Material: Delivered cost of product with taxes paid.
 - b. Labor: Labor cost, excluding overhead and profit.
- D. Update Schedule of Values when:
 1. Indicated by Architect/Engineer.
 2. Change of subcontractor or supplier occurs.
 3. Change of product or equipment occurs.

1.10 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
- B. Change order work shall not proceed until authorized.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING AND MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.
- B. Keep all materials clean, dry and free from damaging environments.

- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability (“Network Capability”). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

- A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.14 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.15 MATERIAL SUBSTITUTION

- A. Where several manufacturers’ names are given, the manufacturer for which a catalog number is given is the basis of design and establishes the quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fit in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.

- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on his part or on the part of other Contractors whose work is affected.
- E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

- A. General:
 - 1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
 - 2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with his work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Architect/Engineer or their representative, and do no further work until the Architect/Engineer or their representative gives further instructions.
9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.
10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.
12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.

C. Dewatering:

1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. No rubbish or waste material is permitted for fill or backfill.
2. Furnish all necessary sand for backfilling.
3. Dispose of the excess excavated earth as directed.
4. Backfill materials shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to rise in unbackfilled trenches.
5. Backfill all trenches and excavations immediately after installing of conduit, or removing forms, unless other protection is directed.
6. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Spread fill and backfill materials in 6" uniform horizontal layers with each layer compacted separately to required density.
7. For conduits that are not concrete encased, lay all conduits on a compacted bed of sand at least 3" deep. Backfill around conduits with sand, in 6" layers and compact each layer.
8. Backfill with sand up to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.
9. Place all backfill above the sand in uniform layers not exceeding 6" deep. Place then carefully and uniformly tamp each layer to eliminate lateral or vertical displacement.
10. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
11. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting and landscaping features removed or damaged to its original condition. At least 6" of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition. Broken edges shall be saw cut and repaired as directed by Architect/Engineer.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation:

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
 - a. All junction boxes are closed and identified in accordance with Section 26 05 53 Electrical Identification.
 - b. Luminaires, including ceiling-mounted exit and emergency lights, are installed and operational.
 - c. Luminaire whips are supported above the ceiling.
 - d. Conduit identification is installed in accordance with Section 26 05 53 Electrical Identification.
 - e. Luminaires are suspended independently of the ceiling system when required by these contract documents.
 - f. All wall penetrations have been sealed.
2. To prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until full access has been provided.

3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
 1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
 3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.
 4. Contractor shall notify Architect/Engineer 48 hours prior to installation of ceilings or lay-in ceiling tiles.
- C. The following must be submitted before Architect/Engineer recommends final payment:
 1. Operation and maintenance manuals with copies of approved shop drawings.
 2. Record documents including reproducible drawings and specifications.
 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.
 4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed and submit receipt to Architect/Engineer.
 5. Start-up reports on all equipment requiring a factory installation or start-up.

3.5 OPERATION AND MAINTENANCE MANUALS

- A. General:
 1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.

2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div23.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copies of all factory inspections and/or equipment startup reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
7. Dimensional drawings of equipment.
8. Detailed parts lists with lists of suppliers.
9. Operating procedures for each system.
10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
11. Repair procedures for major components.
12. Replacement parts and service material requirements for each system and the frequency of service required.
13. Instruction books, cards, and manuals furnished with the equipment.
14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.
15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by **FACTORY PERSONNEL** in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
 1. Maintenance of equipment.
 2. Start-up procedures for all major equipment.
 3. Description of emergency system operation.
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to the Owner's representative so his representative can be present if desired.
- F. Minimum hours of instruction time for each item and/or system shall be as indicated in each individual specification section.

- G. Operating Instructions:
1. Contractor is responsible for all instructions to the Owner's representatives for the electrical and specialized systems.
 2. If the Contractor does not have staff that can adequately provide the required instructions, he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 RECORD DOCUMENTS

- A. The following paragraphs supplement the requirements of Division 1.
- B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.8 PAINTING

- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.
- B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor. Painting shall be performed as described in project specifications.
- C. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chipping, etc. If color option is specified or is standard to the unit, verify with the Architect his color preference before ordering.

- E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, and storage rooms. Equipment furnished with a suitable factory finish need not be painted; provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- F. All electrical conduit and equipment, fittings, hangers, structural supports, etc., in unfinished areas, such as equipment and storage room area, shall be painted two (2) coats of oil paint of colors selected by the Architect.
- G. Do NOT paint electric conduits in crawl spaces, tunnels, or spaces above suspended ceilings except that where conduit is in a damp location give exposed threads at joints two coats of sealer after joint is made up.
- H. After surfaces have been thoroughly cleaned and are free of oil, dirt or other foreign matter, paint all raceway and equipment with the following:
 - 1. Bare Metal Surfaces - Apply one coat of metal primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
 - 2. Plastic Surfaces - Paint plastic surfaces with two coats of semi-gloss acrylic latex paint.

3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

- A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.
- B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.11 INDOOR AIR QUALITY (IAQ) MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Within the limits of Construction:
 - 1. The Electrical Contractor shall coordinate all work with the contractor responsible for IAQ.

2. The means, methods and materials used by the Electrical Contractor shall be coordinated with the contractor responsible for IAQ and shall comply with the IAQ requirements set forth in Division 1 and Division 21/22/23 of these specifications.
- B. Outside the limits of Construction:
1. IAQ shall be the responsibility of the electrical contractor for work that is required outside the limits of construction.
 2. The Electrical Contractor is responsible for the IAQ set forth in Division 1 and Division 21/22/23 of these specifications.
 3. The Electrical Contractor shall review and coordinate all IAQ plans and procedures with the owner's IAQ representative.

3.12 SYSTEM STARTING AND ADJUSTING

- A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.
- C. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.
- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.13 FIELD QUALITY CONTROL

- A. General:
 1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester's name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.
 2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
 3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.

4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than NEC Standards. Take readings between conductors, and between conductors and ground.
6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.

B. Ground Resistance:

1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Architect/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)
2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain.
3. If the ground resistance value obtained is more than the value set forth in Section 26 05 26, the following shall be done to obtain the value given:
 - a. Verify that all connections in the service ground system are secure.
 - b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.
 - c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.
 - d. Review results with the Architect/Engineer.
4. Before final payment is made to the Contractor submit a written report to the Architect/Engineer including the following:
 - a. Date of test.
 - b. Number of hours since the last rain.
 - c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.
 - d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.
 - e. Make, model, and calibration date of test equipment.
 - f. Tabulation of measurements taken and calculations made.

- C. Other Equipment:
 - 1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.
- D. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.
- E. Contractor shall thermographic study all electrical gear, switchboard, panelboards, etc. at the end of construction to identify any unusual conditions/heating within the equipment. Coordinate with Owner/Architect/Engineer to have an Owner/Architect/Engineer representative present during testing.
- F. Report shall include color printouts, in binder, of pictures taken to use as a baseline reading after building is occupied.
- G. Upon completion of the project, the Contractor shall provide amperage readings for all panelboards and switchboards and turn the results over to the Owner for “benchmark” amperages.

3.14 CONSTRUCTION WASTE MANAGEMENT

- A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).
 - 1. This Contractor shall coordinate with the General Contractor to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.
 - 2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor’s scope of work. The Contractor shall provide this information to the General Contractor so that it can be incorporated with similar information from all other contractors for the project.
 - a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the General Contractor to establish the preferred calculation method and report the results accordingly.
 - b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.

3.15 UTILITY REBATE

- A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.
- B. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

END OF SECTION

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations of fire-rated construction fire sealed in accordance with specifications.
2. Electrical panels have typed circuit identification.
3. Per Section 26 05 00, cable insulation test results have been submitted.
4. Per Section 26 05 00, ground resistance test results have been submitted.
5. Operation and Maintenance manuals have been submitted as per Section 26 05 00.
6. Bound copies of approved shop drawings have been submitted as per Section 26 05 00.
7. Report of instruction of Owner's representative has been submitted as per Section 26 05 00.
8. Start-up reports from factory representative have been submitted as per Section 26 05 00.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

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SECTION 26 05 03

THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

- A. UL 723 - Surface Burning Characteristics of Building Materials
- B. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- C. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- D. Intertek / Warnock Hersey - Directory of Listed Products
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- F. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- G. Wisconsin Administrative Code

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

1.5 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
 - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.

- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
 - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - 2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings:
 - a. Floor penetrations located outside wall cavities.
 - b. Floor penetrations located outside fire-resistance-rated shaft enclosures.
 - 3. L-Rated Systems: Provide through-penetration firestop systems with L-ratings of not more than 5.0 cfm/sq.ft. (0.0254 cu. m/s x sq. m) at both ambient temperature and 400°F (204°C) for smoke barriers.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.
- F. In accordance with LEED EQc4.1, Low-Emitting Materials - Adhesives and Sealants, all adhesives and sealants used on the interior of the building must comply with the following requirements:
 - 1. Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.
 - 2. Aerosol adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

1.6 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
 - 1. Review foreseeable methods related to firestopping work.
 - 2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.7 WARRANTY

- A. Provide one year warranty on parts and labor.

- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
 - 1. 3M; Fire Protection Produces Division.
 - 2. Hilti, Inc.
 - 3. RectorSeal Corporation, Metacaulk.
 - 4. Tremco; Sealant/Weatherproofing Division.
 - 5. Johns-Manville.
 - 6. Specified Technologies Inc. (S.T.I.)
 - 7. Spec Seal Firestop Products
 - 8. AD Firebarrier Protection Systems
 - 9. Wiremold/Legrand: FlameStopper

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- E. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- F. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated
 F Rating = Floor/Wall Rating
 T Rating = Floor/Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated
 F Rating = Wall Rating
 T Rating = 0

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated
 F Rating = Wall/Floor Rating
 T Rating (Floors) = Floor Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

- G. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.

- H. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION

SECTION 26 05 13

WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Building wire
- B. Remote control and signal cable
- C. Fire rated cable and assemblies
- D. Healthcare facilities cable (HFC)
- E. Armored cable (AC)
- F. Metal-clad cable (MC)
- G. Nonmetallic-sheathed cable (NM)

1.2 RELATED WORK

- A. Section 26 05 53 – Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

- A. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
- B. NFPA 70 - National Electrical Code (NEC)
- C. UL 44 – Thermoset-Insulated Wires and Cables
- D. UL 83 – Thermoplastic-Insulated Wires and Cables
- E. UL 854 – Service-Entrance Cables
- F. UL 1581 – Standard for Electrical Wires, Cables, and Flexible Cords
- G. UL 2196 – Fire Resistive, Fire Resistant and Circuit Integrity Cables

PART 2 - PRODUCTS

2.1 BUILDING WIRE

- A. Feeders and Branch Circuits Larger Than 6 AWG: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.
- B. Feeders and Branch Circuits Larger Than 6 AWG in Underground Conduit: Copper, stranded conductor, 600-volt insulation, XHHW-2.
- C. Feeders and Branch Circuits 6 AWG and Smaller: Copper conductor, 600-volt insulation, THHN/THWN. 6 and 8 AWG, stranded conductor; smaller than 8 AWG, solid or stranded conductor, unless otherwise noted on the drawings.

- D. Three conductor stranded copper, 600-volt XHHW-2 insulation, with copper ground and overall helical copper tape shield. Shield shall be terminated at both ends of cable with an approved termination.
- E. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.
- F. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

2.2 REMOTE CONTROL AND SIGNAL CABLE

- A. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
- C. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.3 FIRE-RATED CABLE AND ASSEMBLIES

- A. Properties and requirements of fire rated cables and assemblies:
 - 1. 2HR fire rated for horizontal and vertical installations.
- B. Acceptable fire-rated cables and listed assemblies:
 - 1. Feeder assembly located outside the structure (example: below finished grade) or encased in concrete; minimum 2 inches [50mm] of concrete).
 - 2. Mineral Insulated Cables: Copper conductor, 600-volt insulation, rated 90°C, Type MI.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE

- A. Above Accessible Ceilings:
 - 1. Building wire shall be installed in raceway.
- B. All Other Locations: Building wire in raceway.
- C. Above Grade: All conductors installed above grade shall be type “THHN”.
- D. Underground or In Slab: All conductors shall be type “THWN”.
- E. Low Voltage Cable (less than 100 volts): Low voltage cable shall be installed in raceway.

- F. Fire-Rated 2-Hour Feeders and Circuit Requiring Continuous Operation (CI): Refer to Part 2 of this section for acceptable products and assemblies. Installation shall meet UL 2196.

3.2 WIRE FOR SPECIALIZED SYSTEMS

- A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed:
 - 1. Fire alarm
 - 2. Low voltage switching
 - 3. Nurse call
 - 4. Electronic control
 - 5. Security
 - 6. TV
 - 7. Telephone
 - 8. Data

3.3 CONTRACTOR CHANGES

- A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.16. Service entrance and fire pump feeder conductors are based on copper conductor installed in underground electrical ducts, NEC Table B.310.15(B)(2)(7).
- B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.
- C. Underground electrical duct ampacity rating shall be in accordance with NEC Table B.310.15(B)(2)(7) or calculated in accordance with Annex B Application Information for Ampacity Calculation. The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.
- D. Record drawing shall include the calculations and sketches.

3.4 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.
- B. Use no wire smaller than 18 AWG for low voltage control wiring (<100 volts).
- C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.
- D. Use no wire smaller than 8 AWG for outdoor lighting circuits.
- E. The ampacity of multiple conductors in one conduit shall be derated per NEC 310. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.

- F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.
- G. Splice only in junction or outlet boxes.
- H. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- I. Make conductor lengths for parallel circuits equal.
- J. All conductors shall be continuous in conduit from last outlet to their termination.
- K. Terminate all spare conductors on terminal blocks, and label the spare conductors.
- L. Cables or wires shall not be laid out on the ground before pulling.
- M. Cables or wires shall not be dragged over earth or paving.
- N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
- O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.
- P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.5 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.
- D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.
- E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.
- F. Only nylon rope shall be permitted to pull cables into conduit and ducts.
- G. Completely and thoroughly swab raceway system before installing conductors.
- H. Conductor Supports in Vertical Raceways:
 - 1. Support conductors in vertical raceways in accordance with NEC 300.19 and Table 300.19(A) Spacing of Conductors Supports.

2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

3.6 CABLE INSTALLATION

- A. Provide protection for exposed cables where subject to damage.
- B. Use suitable cable fittings and connectors.
- C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", recognized industry standards; and coordinated with other contractors.
- D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.
- E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.
- F. J-hook supports shall be installed at a maximum of five-foot (5') intervals. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.
- G. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

3.7 FIRE-RATED CABLE AND ASSEMBLY INSTRUCTIONS

- A. Terminations of the fire-rated cable must be outside of the fire zone.
- B. Fire-rated cable shall be installed according to the manufacturer's instructions, recommendations, and UL listing.
- C. Route fire-rated cable and assemblies separate from other feeders and distribution. Install cable and assemblies in locations protected from physical damage.
- D. Refer to Electrical Identification Section 26 05 53 for specific identification requirements.

3.8 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice and tap only in accessible junction boxes.
- B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.

- C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.
- D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.
- E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor. Cold shrink connector insulator with 1kV rating shall be used in damp and wet locations.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.
- I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:
 - 1. Facing the front and operating side of the equipment, the phase identification shall be:
 - a. Left to Right - A-B-C
 - b. Top to Bottom - A-B-C
- J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

3.9 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a “Megger”. The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.
- C. MI cable shall have the insulation resistance of each cable tested with a 500-volt dc megohmmeter prior to energizing the cables. Tabulate resistance values and submit to Architect/Engineer for acceptance.
- D. Inspect wire and cable for physical damage and proper connection.
- E. Torque test conductor connections and terminations to manufacturer's recommended values.

- F. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.
- G. Protection of wire and cable from foreign materials:
 - 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.
- H. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

END OF SECTION

SECTION 26 05 17

ELECTRIC HEAT TRACE AND SNOW MELT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Heat tracing cables
- B. Snow and ice melting cables
- C. Controls

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. ASTM 2633 - Standard Test Method for Thermoplastic Insulations
- C. ASTM B193 - Standard Test Method for Resistivity of Electrical Conductor Materials
- D. UL 746B - Polymeric Materials - Long Term Property Evaluations

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 26 05 00.
- B. Product Data: For each type of product indicated.
 - 1. Field Test Reports: Submit written test reports to include test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Submit manufacturer's instructions under provisions of Section 26 05 00.

1.4 COORDINATION

- A. Coordinate layout and installation of electrical heating cables and system components with General Contractor.
- B. Coordinate installation of snow-melting cable with installation of concrete framework and concrete placement.

1.5 WARRANTY

- A. Provide a ten (10) year warranty under provisions of Section 26 05 00.

PART 2 - PRODUCTS

2.1 HEAT-TRACING CABLE

A. Self-Regulating Heating Cable:

1. Cable shall be capable of crossing over itself without overheating.
2. Provide power connection, end seal and splices as required.
3. Each circuit shall be protected by a 30-mA ground-fault protection device. Provide number of breakers based on manufacturer's maximum length for startup at 0°F. Identify breaker in panel directory as "HEAT TAPE".
4. Heat tape shall be meggered prior to insulating piping.
5. **[HT-1]:** Suitable for freeze protection of above grade insulated metal or plastic piping, valves, and equipment to maintain fluid temperature above 40°F. 8 watts per foot @ 50°F, 277V.
 - a. Approved Manufacturers: Ray-Chem XL1, Chromalox SRL, Thermon BSX.
6. **[HT-2]:** Suitable for freeze protection of underground insulated metal or plastic piping to maintain fluid temperature above 40°F. 8 watts per foot, 277 V.
 - a. Approved Manufacturers: Ray-Chem XL, Chromalox SRL, Thermon BSX.

2.2 CONTROLS

A. Ambient Thermostat:

1. Remote bulb unit with adjustable temperature range from 15°F to 150°F (-9°C to 60°C) snap action, open-on-rise, single-pole double throw switch with 22A 125/250/480VAC ratings. Provide one pipe thermostat for each circuit of heat trace.
2. Acceptable Manufacturer: Pentair AMC-1A.

B. Pipe Thermostat:

1. Ambient sensing unit with adjustable temperature range from 15°F to 150°F (-9°C to 60°C) snap action; open-on-rise, single-pole double throw switch with 22A 125/250/480VAC ratings; and remote bulb for directly sensing pipe-wall temperature. Provide one pipe thermostat for each circuit of heat trace.
2. Acceptable Manufacturer: Pentair AMC-1A.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surface and substrates to receive heating cables for compliance with requirements for installation, tolerances, and other conditions affecting performance.
 - 1. Ensure surfaces and pipes in contact with electrical heating cables are free of burrs and sharp protrusions.
 - 2. Ensure pipe testing is complete.
 - 3. Ensure surfaces and substrates are level and plumb.
- B. Test cables for electrical continuity before installing.
- C. Test cables for insulation resistance before installing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Verify field measurements are as shown on the Drawings.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. The heating cable shall be protected from where it leaves the pavement to the junction box by installing the cable in rigid metal conduit. Use one conduit for each heating cable.
- C. Avoid crossing expansion, construction, or control joints with heating cables. Provide sufficient slack conductor in expansion loop.
- D. Do not energize cables embedded in concrete, asphalt, or plaster until those assemblies are cured, except for brief testing.
- E. Install cables after applying bituminous binder course to lower base. Ensure that second labeling bituminous binder is applied to cables before pouring finish topping.
- F. Provide labeling in paving where snow melt cables are present. A metal plate or stamp used prior to concrete setting must contain the name of the snow melt company, the word "CAUTION", the phrase "EMBEDDED SNOW MELTING SYSTEM", and the date the system was installed. The labeling of the system must be able to handle the outdoor environment without degrading.
- G. Provide labeling to outside of the pipe thermal insulation weather barrier to indicate the presence of electric heating tracing. Labeling should contain the name of the heat trace company, the word "CAUTION" and the phrase "ELECTRIC HEAT TRACE". Labels should be placed every ten feet of pipe alternating on either side of the pipe.

3.3 CONNECTIONS

- A. Cable splices and repairs shall be made using a splice kit provided by the manufacturer and specifically designed for that purpose.

- B. Power connection and end seal junction box shall be mounted above grade. The junction box shall be installed in such a way so that water cannot enter it.

3.4 FIELD QUALITY CONTROL

- A. Inspect cable for physical damage before installation.
- B. Test cables for electrical continuity before energizing.
- C. Test cables for insulation resistance before energizing. Remove cables if measured resistance is less than 10 megohms to ground.
- D. Repeat test for continuity and insulation resistance after applying paving or thermal insulation.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment grounding system
- B. Bonding system
- C. Grounding electrode system

1.2 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
- B. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with UL 467 Grounding and Bonding Equipment.
- E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
- F. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE/ANSI C2 National Electrical Safety Code (NESC).

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 26 05 00.
- B. Field Test Reports: Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Indicate layout of ground field, location of system grounding electrode connections, and routing of grounding electrode conductor and ground ring.

1.4 SUMMARY

- A. This section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section 26 05 13 "Wire and Cable".
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- F. Sizes and types below are typical. Adjust to suit Project conditions and requirements.
- G. Copper Bonding Conductors: As follows:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- H. **[GB]:** Grounding Bus:
 - 1. Bare, annealed copper bars of rectangular cross section, with insulators. 1/4" x 2" x 24".
- I. **[IBT]:** Intersystem Bonding Termination:
 - 1. Copper bar, 1/4" x 2" x 24". Provide with wall mounting brackets, insulators and pre-tapped holes.
 - 2. Approved Manufacturers: Harger GBI Series, Erico B544 Series.

2.2 CONNECTOR PRODUCTS

- A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Connectors: Hydraulic compression type or exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- C. Bolted Connectors: Bolted-pressure-type connectors.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.

- B. Ground Rods: Sectional type; copper-clad steel.
 - 1. Size: 3/4" in diameter by 120 inches per section.
- C. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.
- D. Concrete-Encased Grounding Electrode (Ufer): Fabricate according to NFPA 70, Paragraph 52-(3), using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG or 20 feet (6.0 m) of 1/2" (13mm) steel reinforcing bar.

2.4 STATIC DISCHARGE REEL

- A. **[DR-1]: Heavy-Duty Enclosed Discharge Reel:**
 - 1. Heavy-duty discharge reel with steel enclosed housing, ratchet lock with on/off switch, 50' nylon covered stainless steel cable with hand clamp.
 - 2. Approved Manufacturers: Gleason Reel Corp SD-20500S

PART 3 - EXECUTION

3.1 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

- D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.
- G. Connections at Test Wells: Use compression-type connectors on conductors and make two bolted- and clamped-type connections between conductors and ground rods.
- H. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- I. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.2 INSTALLATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.
- C. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.
- D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then use a bolted clamp. Bond straps directly to the basic structure, taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- E. In raceways, use insulated equipment grounding conductors.
- F. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.3 EQUIPMENT GROUNDING SYSTEM

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.
- C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.
- E. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- F. Isolated Grounding Circuits: Install an insulated equipment grounding conductor connected to the receptacle or equipment grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at isolated equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- G. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

3.4 BONDING SYSTEM

- A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.
- B. Isolated Equipment Enclosure: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment bonding conductor.
- C. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.
- D. Equipment Circuits: Install a bonding conductor to equipment mounted electrical devices operating at 120 V and more, including air cleaners, dampers, and heaters. Bond conductor to each unit and to air duct. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps or copper conductor sized equal to the equipment grounding conductor.
- E. Bond metal ducts of dust collectors, particulate conveying, fume hoods, and other hazardous materials to the equipment grounding conductors of associated pumps, fans, or blowers. Use braided-type bonding straps. Provide braided bare copper bonding conductor in nonmetallic dust collector ductwork to each equipment inlet location, and bond to equipment.

- F. Water Heater, Heat-Tracing, Metal Well Casing, and Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, well casing, connected equipment, and components.
- G. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
- H. Connect bonding conductors to all metal gas piping on site using a suitable ground clamp.
- I. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated bonding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location. Leave 10 feet of slack conductor at terminal board.
- J. Telecom Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bar.
- K. Terminal Cabinets: Terminate bonding conductor on cabinet grounding terminal.
- L. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.
- M. Metal Poles Supporting Outdoor Lighting Fixtures > 15 feet: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.5 GROUNDING ELECTRODE SYSTEM

- A. Ground Ring (Counterpoise):
 - 1. Ground the steel framework of the building/equipment with a driven ground rod at the base of every corner, column, and at intermediate locations at average distances not more than 20 feet (18 m) apart. Provide a grounding conductor, electrically connected to each ground rod and to each steel column or equipment frame, extending around the perimeter of the building/equipment. Use tinned-copper conductor not less than No. 2 AWG for ground ring and for tap to building/equipment steel. Bury conductor not less than 30 inches (760 mm) below grade, 24 inches (600 mm) from building foundation, and 18 inches (459 mm) outside of roof drip line.
- B. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.
- C. Provide bonding at Utility Company's metering equipment and pad mounted transformer.
- D. Ground Rods: Install at least two rods spaced at least 20 feet from each other and located at least the same distance from other grounding electrodes.
 - 1. Drive ground rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.

2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- E. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- G. Bond each aboveground portion of natural gas metallic piping system at equipment locations. The equipment grounding conductor may serve as the bonding means.
- H. Concrete-Encased Grounding Electrode (Ufer): Install concrete-encased grounding electrode encased in at least 2 inches (50mm) of concrete horizontally within the foundation that is in contact with the earth. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.6 CONCRETE OR WOOD BUILDING GROUNDING SYSTEM

- A. Provide a copper common grounding electrode conductor for the attachment of multiple separately derived systems in accordance with NEC 250.30(A)(4)(a) through 250.30(A)(4)(c). Individual grounding conductor taps from the separately derived systems to the common grounding electrode shall be sized in accordance with NEC 250.66. All tap connections shall be made in an accessible location in such a manner that common grounding electrode conductor remains without a splice or joint.

3.7 EQUIPOTENTIAL (MULTI-POINT) GROUNDING SYSTEM

- A. Provide an equipotential grounding system in the following locations:
 1. Critical patient care and special care areas as indicated on drawings.
- B. The non-current-carrying metal parts of equipment, raceways and other enclosures shall be bonded to the grounding system.

3.8 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
 1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
 2. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:

3. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
4. Testing: Perform the following field quality-control testing:
 - a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - b. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
 - c. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
 - 1) Equipment Rated 500 kVA and Less: 10 ohms.
 - 2) Equipment Rated 500 to 1000 kVA: 5 ohms.
 - 3) Equipment Rated More Than 1000 kVA: 3 ohms.
 - 4) Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - 5) Manhole Grounds: 10 ohms.
 - d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

3.9 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2. Maintain restored surfaces. Restore disturbed paving.

END OF SECTION

SECTION 26 05 27

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit and equipment supports
- B. Fastening hardware
- C. Concrete housekeeping pads

1.2 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.3 COORDINATION

- A. Coordinate size, shape and location of concrete pads with Section on Cast-in-Place Concrete or Concrete Topping.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Allied Support Systems
- B. Cooper B-Line
- C. Erico, Inc.
- D. Hilti
- E. Power Fasteners

2.2 MATERIAL

- A. Support Channel: Stainless steel for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.
- B. Hardware: Corrosion resistant.
- C. Anchorage and Structural Attachment Components:
 - 1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.
 - a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
 - 2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
 - 3. Welding Lugs: Comply with MSS-SP-69, Type 57.

4. Beam clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.
5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.
7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-08. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

D. Conduit Sleeves and Lintels:

1. Each Contractor shall provide, to the General Contractor for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.
2. Refer to Structural General Notes for lintel requirements in masonry construction.
3. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Architect or Structural Engineer.
4. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.
5. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
6. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
7. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
8. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

9. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
 10. Size sleeves large enough to allow expansion and contraction movement.
- E. Concrete Housekeeping Pads:
1. Concrete bases for all floor mounted equipment and wall mounted equipment which is surface mounted and extends to within 6" of the finished floor, unless shown otherwise on the drawings, shall be 3-1/2" thick concrete.
 2. Bases shall extend 3" on all sides of the equipment (6" larger than factory base).
 3. Where the base is less than 12" from a wall, the base shall be carried to the wall to prevent a "dirt-trap".
 4. Concrete materials and workmanship required for the Contractor's work shall be provided by him. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.
- F. Rooftop Support System:
1. Provide pre-fabricated roof supports for all conduit and equipment installed above the roof. Support all conduit and equipment a minimum of 4" above roof.
 2. Support system shall be compatible with single ply, bituminous, metal, and spray foam roof systems. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
 3. All metal components shall be hot dipped galvanized. Mounting hardware shall be stainless steel or hot dipped galvanized. Support shall be UV, corrosion, and freeze/thaw resistant. Support shall include orange paint, reflective safety orange accents, or similar markings for increased visibility.
 4. Acceptable Products: Anvil International HBS-Base Series, Cooper B-Line Dura-Blok, Erico Caddy Pyramid 50, 150, 300, or 600 (to match load).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.
- B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

- C. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.
- D. Do not use powder-actuated anchors without specific permission.
- E. Do not drill structural steel members.
- F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- G. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.
- H. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting.
- I. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- J. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- K. Refer to Section 26 05 33 for special conduit supporting requirements.

3.2 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
- B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION

SECTION 26 05 33

CONDUIT AND BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Rigid metallic conduit and fittings (RMC)
- B. Intermediate metallic conduit and fittings (IMC)
- C. Electrical metallic tubing and fittings (EMT)
- D. Flexible metallic conduit and fittings (FMC)
- E. Liquidtight flexible metallic conduit and fittings (LFMC)
- F. Rigid polyvinyl chloride conduit and fittings (PVC)
- G. High density polyethylene conduit and fittings (HDPE)
- H. Wall and ceiling outlet boxes
- I. Electrical connection
- J. Pull and junction boxes
- K. Rough-ins
- L. Handholes
- M. Accessories

1.2 RELATED WORK

- A. Section 26 05 53 – Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
 - 2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
 - 3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
 - 4. ANSI C80.6 – Intermediate Metal Conduit, Zinc Coated
 - 5. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
 - 6. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
- B. Federal Specifications (FS):
 - 1. A–A–50553A – Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
 - 2. A–A–55810 – Specification for Flexible Metal Conduit
- C. NECA “Standards of Installation”
- D. National Electrical Manufacturers Association (NEMA):
 - 1. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

2. RN 1 – Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
 3. TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit
 4. TC 9 – Fittings for PVC Plastic Utilities Duct for Underground Installation
- E. NFPA 70 – National Electrical Code (NEC)
- F. Underwriters Laboratories (UL): Applicable Listings
1. UL 1 – Flexible Metal Conduit
 2. UL 6 – Rigid Metal Conduit
 3. UL 360 – Liquid Tight Flexible Steel Conduit
 4. UL514-B – Conduit Tubing and Cable Fittings
 5. UL651-A – Type EB and a PVC Conduit and HDPE Conduit
 6. UL651-B – Continuous Length HDPE Conduit
 7. UL746A – Standard for Polymeric Materials – Short Term Property Evaluations
 8. UL797 – Electrical Metal Tubing
 9. UL1242 – Intermediate Metal Conduit
- G. American Standard of Testing and Materials (ASTM):
1. ASTM D 570 - Standard Test Method for Water Absorption of Plastics
 2. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics
 3. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edge Wise Position
 4. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
 5. ASTM D 2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
 6. ASTM D 3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material
- H. Definitions:
1. Fittings: Conduit connection or coupling.
 2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
 3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
 4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.
 5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.

6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

PART 2 - PRODUCTS

2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

- A. Acceptable Manufacturers:
 1. Acceptable Manufacturers: Allied, LTV, Steelduct, Wheatland Tube Co, O-Z Gedney, or approved equal.
 2. Acceptable Manufacturers of RMC Conduit Fittings: Appleton Electric, O-Z/Gedney Co., Electroline, Raco, Bridgeport, Midwest, Regal, Thomas & Betts, Crouse-Hinds, Killark, or approved equal.
- B. Minimum Size Galvanized Steel: 3/4 inch (19mm), unless otherwise noted.
- C. Fittings and Conduit Bodies:
 1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
 2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
 3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
 4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**
 5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.
- D. PVC Externally Coated Conduit: Compliant with UL 6, ANSI C80.1 and NEMA RN 1; rigid galvanized steel conduit with external 40 mil PVC coating and internal 2 mil urethane coating surface. All fittings and conduit bodies shall be complete with coating. Threads shall be hot galvanized and coated with a clear coat of urethane. The PVC coated system shall include necessary PVC coated fittings, boxes and covers to form a complete encapsulated system. Acceptable Manufacturers: Robroy, T&B Ocal or approved equal.

2.2 STAINLESS STEEL CONDUIT (316SS) AND FITTINGS

- A. Acceptable Manufacturers: Gibson Stainless & Specialty, Calbrite, Eaton/Crouse-Hinds, Thomas & Betts, or approved equal.

- B. All material shall be Type 316 stainless steel, meet ASTM A-321 and SA-312 standards, and be UL 6A approved.
- C. All conduit shall be heavy wall Schedule 40 with standard NPT threads.
- D. Minimum Size Stainless Steel: 3/4 inch (19mm), unless otherwise noted.
- E. Fittings, conduit bodies, couplings, nipples, bushings, connectors, supports, clamps, and all accessory hardware shall be made of Type 316 stainless steel.

2.3 INTERMEDIATE METALLIC CONDUIT (IMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.
- B. Acceptable Manufacturers: Allied, LTV, Steelduct, Wheatland Tube Co, O-Z Gedney, or approved equal.
- C. Fittings and Conduit Bodies:
 - 1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
 - 2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
 - 3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
 - 4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**
 - 5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

2.4 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.
- B. Acceptable Manufacturers of EMT Conduit: Allied, LTV, Steelduct, Wheatland Tube Co, or approved equal.
- C. Fittings and Conduit Bodies:
 - 1. 2" Diameter or Smaller: Compression type of steel designed for their specific application.
 - 2. Larger than 2": Compression type of steel designed for their specific application.
 - 3. Acceptable Manufacturers of EMT Conduit Fittings: Appleton Electric, O-Z/Gedney Co., Electroline, Raco, Bridgeport, Midwest, Regal, Thomas & Betts, or approved equal.

2.5 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8" FMC shall be six (6) feet.
- B. Acceptable Manufacturers: American Flex, Alfex, Electri-Flex Co, or approved equal.
- C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.
- D. Fittings and Conduit Bodies:
 - 1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
 - 2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
 - 3. Acceptable Manufacturers: O-Z/Gedney Co., Thomas & Betts, Appleton Electric, Electroline, Bridgeport, Midwest, Regal, or approved equal.

2.6 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

- A. Acceptable Manufacturers: Anaconda Type UA, Electri-Flex Type LA, Alfex, Carlon (Lamson & Sessions), or approved equal.
- B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.
- C. Fittings and Conduit Bodies:
 - 1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
 - 2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
 - 3. Acceptable Manufacturers: Appleton Electric, O-Z/Gedney Co., Electroline, Bridgeport, Thomas & Betts, Midwest, Regal, Carlon (Lamson & Sessions), or approved equal.

2.7 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

- A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.
- B. Acceptable Manufacturers: Carlon (Lamson & Sessions) Type 40, Cantex, J.M. Mfg., or approved equal.

- C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.
- D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
- E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

2.8 HIGH DENSITY POLYETHYLENE (HDPE)

- A. Minimum Size: 2 inch, unless noted otherwise.
- B. Acceptable Manufacturers: Carlon, Chevron Phillips Chemical Company, or approved equal.
- C. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	< .941
D-1238	Melt Index, g/10 min Condition E	> .55 grams/10 min.
D-638	Tensile Strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B, F 20	96 hrs.
D-790	Flexural Modulus, MPa (psi)	< 80,000
D-746	Brittleness Temperature	-75°C Max

- D. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.
- E. Fitting and Conduit Bodies:
 1. Directional Bore and Plow Type Installation: Electrofusion or Universal Aluminum threaded couplings. Tensile strength of coupled pipe must be greater than 2,000 lbs.
 2. For all other type of installation: Coupler must provide a water tight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.
 3. E-loc type couplings are not acceptable in any situations.
 4. Acceptable Manufacturers: ARCON, Carlon, or approved equal.

2.9 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, minimum of 14 gauge, with 1/2-inch male fixture studs where required.
- B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.

- C. Cast Boxes: NEMA FB1, Type FD, Aluminum or cast ferrous alloy, deep type, gasketed cover, threaded hubs.
- D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.
- E. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.
- F. Outlet boxes for telephone substations in walls and columns shall be 4 inches square and 2-1/8 inches deep with single gang raised cover to fit flush with finished wall line equipped with flush telephone plate.
- G. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.10 [ECONN]: ELECTRICAL CONNECTION

- A. Electrical connection to equipment and motors, sized per NEC. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.11 [JB]: PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.
- C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.
- E. Flanged type boxes shall be used where installed flush in wall.

2.12 ROUGH-IN

- A. Provide with one (1) flush mount double gang box with single gang plaster ring and appropriate cover plate,
- B. Conduit stubbed to above the lay-in ceiling.

- C. **[RI-TECH]:** Technology Rough-in:
 - 1. Rough-in shall have one (1) 1” conduit.
- D. **[RI-TECH-W]:** Technology Rough-in - Wall Phone:
 - 1. Mount on wall +54” or as noted in plans. Rough-in shall have one (1) 1” conduit.
- E. **[RI-TV]:** Television Antenna Outlet Box Rough-in:
 - 1. Rough-in shall have one (1) 3/4” conduit.

2.13 HANDHOLES

- A. **[HH-1]:** Handhole, composite polymer concrete body and cover. Stainless steel hardware. Bolted non-skid cover rated for 20,000 pounds. Design load occasional non-deliberate vehicular traffic. Stack units to achieve depth shown on plans. Units in landscaped areas shall be green in color. 11”W, 18”L, 18”D or dimensions as shown on plans.
 - 1. Approved Manufacturers:
 - a. Hubbell/Quazite PG#####BB18, PG#####HA00
 - b. Carson Industries H Series
 - c. Armorcast
 - d. Highline Products
 - e. Synertech
- B. **[HH-2]:** Handhole, cast iron, hot dipped galvanized with checkered cover sidewalk weatherproof box, flat neoprene cover gasket. Stainless steel screw hardware. Mounted flush in concrete. 12”W, 18”L, 12”D or dimensions as shown on plans.
 - 1. Approved Manufacturers:
 - a. Appleton Electric WYT Series, WYT 181212
 - b. OZ Gedney YT Series
 - c. Crouse Hinds WJBF Series
- C. **[HH-3]:** Handhole, concrete traffic box and galvanized steel checkered cover. Stainless steel hardware. Bolted cover and box rated for H/20 vehicular traffic. Reinforced concrete slab for bottom. 11”W, 18”L, 24”D or dimensions as shown on plans.
 - 1. Approved Manufacturer: Oldcastle Precast B1017 Box

2.14 ACCESSORIES

- A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes. Kinetics Noise Control – IsoBacker Pad, SpecSeal – SSP Putty and Pads, 3M #MPP-4S or equal.
- B. Sound Barrier Insulation Pads: Mastic, non-hardening, sheet material, minimum 1/8" thickness applied to all five sides of back boxes. Kinetics Noise Control – SealTight Backer Pad, L.H. DOTTIE Co., #68 or equal.

PART 3 - EXECUTION

3.1 CONDUIT SIZING

- A. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to NEC. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the NEC (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.
- B. Minimum Conduit Size (Unless Noted Otherwise):
 - 1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
 - 2. Below Grade 5' or less from Building Foundation: 1 inch.
 - 3. Below Grade More than 5' from Building Foundation: 1 inch.
 - 4. Telecommunication Conduit: 1 inch.
 - 5. Controls Conduit: 3/4 inch.
- C. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.2 CONDUIT ARRANGEMENT

- A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.
- B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.
- C. Conduit shall not share the same cell as structural reinforcement in masonry walls.
- D. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.

- E. Contractor shall adapt his work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.
- F. Contractor shall cooperate with all Contractors on the project. He shall obtain details of other Contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by him. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.3 CONDUIT SUPPORT

- A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.
- B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.
- C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.
- D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.
- F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.
- G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the NEC requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.

- J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.
- K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the NEC requirements.
- L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.
- M. Finish:
 - 1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
 - 2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

3.4 CONDUIT INSTALLATION

- A. Conduit Connections:
 - 1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
 - 2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
 - 3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
 - 4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.
- B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.
- C. Conduit Bends:
 - 1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
 - 2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).

3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.
4. Telecommunications conduits shall have no more than two (2) 90-degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.
 - a. A third bend is acceptable if:
 - 1) The total run is not longer than (33) feet.
 - 2) The conduit size is increased to the next trade size.
5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
6. Telecommunications conduit bend radius shall be six (6) times the diameter for conduits under 2" and ten (10) times the diameter for conduits over 2".
7. Rigid polyvinyl chloride conduit (PVC) runs longer than 100 feet or runs which have more than two 90° equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.
8. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the NEC.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. Seal penetrations with intumescent caulk, putty, or sheet installed per manufacturer's recommendations. All materials used to seal penetrations of firewalls and floors shall be tested and certified as a system per ASTM E814 Standard for fire tests or through-penetration fire stops as manufactured by 3M or approved equal.

7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, equal to O-Z/Gedney type EYD.
9. Horizontal conduit routing through slabs above grade:
 - a. No conduits are allowed to be routed horizontally through slabs above grade.
10. Do not route conduits across each other in slabs on grade.
11. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.
12. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
13. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
14. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.
15. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3" above finished floor (AFF).
16. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4" below ceiling and as close to the wall as possible.
17. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4" above finished floor (AFF) and as close to the wall as possible.

3.5 CONDUIT TERMINATIONS

- A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, or approved equal.
- B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.

- C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.
- D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.
- E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the NEC, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.
- F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.
- G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

3.6 UNDERGROUND CONDUIT INSTALLATION

- A. Conduit Connections:
 - 1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.
- B. Conduit Bends (Lateral):
 - 1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.
 - 2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.
- C. Conduit Elbows (vertical):
 - 1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (>600V) and 18 inches for secondary conduits (<600V). Increase radius, as required, based on pulling tension calculation requirements.

D. Conduit Placement:

1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.
3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum $f_c = 2500$ and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
4. Before the Contractor pulls any cables into the conduit he shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
8. All non-metallic conduit installed underground outside of a slab shall be rigid.

E. Horizontal Directional Drilling:

1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.
2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

F. Raceway Seal:

1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.
2. All telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault with "JackMoon" or equivalent duct seal, capable of withstanding a 10-foot head of water (5 PSI).

3.7 CONDUIT INSTALLATION SCHEDULE

- A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If This Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the NEC shall be required.
- B. The following schedule shall be adhered to unless they constitute a violation of applicable codes or are noted otherwise on the drawings. The installation of RMC conduit will be permitted in place of all conduit specified in this schedule.
1. Exposed:
 - a. Switchboards, panel feeders, etc.: EMT.
 - b. Branch Circuits (lighting, receptacles, controls, etc.): EMT.
 - c. Mechanical Equipment Feeders (pumps, AHUs, chillers, etc.): EMT.
 - d. Floor Mounted Pump Feeders: EMT with no more than 6' of PVC coated flexible metal conduit to pump.
 - e. Controls: EMT painted blue or dyed blue.
 2. Finished Spaces/Concealed: EMT.
 3. Wet or Damp Locations: RMC conduit, boxes and fittings, installed and equipped to prevent water from entering the conduit system.
 4. Corrosive Locations: PVC Coated Rigid Metal conduit, boxes and fittings installed and equipped to prevent water from entering the conduit system.
 5. In or Under Slabs on Grade:
 - a. Within 5' from the perimeter of the building: RMC
 - b. Within 5' from the perimeter of the building when passing through the perimeter of the building foundation: RMC conduit with a minimum of 3" thickness between the surface of the concrete and the nearest conduit. Concrete to be doweled into the foundation.
 6. Site Conduits:
 - a. Within 5' from the Perimeter of a Building Foundation: RMC conduit with a minimum of 3" thickness between the surface of the concrete and the nearest conduit. Concrete to be doweled into the foundation.
 - b. 5' or Greater from the Perimeter of a Building Foundation: RMC.
 - c. Under Roads, Drives, and Vehicle Traveled Ways: Concrete encased PVC with a minimum of 3" concrete cover on all sides of conduit.

7. Interior Locations:
 - a. Exposed: EMT conduit.
 - 1) Exposed Controls Conduit: EMT painted blue or dyed blue.
 - b. Concealed: EMT.
8. Hazardous Locations as Defined by the NEC: RMC conduit complete with screwed fittings and conduit seals.

3.8 BOX INSTALLATION SCHEDULE

- A. Galvanized steel boxes may be used in:
 1. Concealed interior locations above ceilings and in hollow studded partitions.
 2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
 3. Direct contact with concrete except slab on grade.
 4. Recessed in stud wall of kitchens and laundries.
- B. Cast boxes shall be used in:
 1. Exterior locations.
 2. Hazardous locations.
 3. Exposed interior locations within 8' of the highest platform level.
 4. Direct contact with earth.
 5. Direct contact with concrete in slab on grade.
 6. Wet locations.
 7. Kitchens and laundries when exposed on wall surface.

3.9 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.
- C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer and General Contractor.
- D. Locate and install to maintain headroom and to present a neat appearance.
- E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

3.10 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls.
 - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
 - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.
- C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)
- D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.
- E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- F. Provide knockout closures for unused openings.
- G. Support boxes independently of conduit.
- H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- I. Install boxes in walls without damaging wall insulation.
- J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.
- K. Position outlets to locate luminaires as shown on reflected ceiling drawings.
- L. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
- M. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

- N. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- O. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

3.11 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- B. Support pull and junction boxes independent of conduit.
- C. Do not install boxes back-to-back in walls.
 - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
 - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

3.12 EXPOSED BOX INSTALLATION

- A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.
- B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.
- C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.
- D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.
- E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)
- F. Wood, plastic, or fiber plugs shall not be used for fastenings.
- G. Explosive devices shall not be used unless specifically allowed.

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Adhesive labels, markings, nameplates, and signs
- B. Wire and cable markers
- C. Raceway, box, and wire identification
- D. Equipment short circuit current rating (SCCR) labeling
- E. Electrical equipment labeling
- F. Electrical working clearance identification
- G. Pole identification

1.2 REFERENCES

- A. ANSI C2 – National Electrical Safety Code
- B. NFPA 70 – National Electrical Code (NEC)
- C. ANSI A13.1 – Standard for Pipe Identification
- D. ANSI Z535.4 – Standard for Product Safety Signs and Labels

PART 2 - PRODUCTS

2.1 ADHESIVE MARKINGS AND FIELD LABELS

- A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).
 - 1. Label Size as follows:
 - a. Raceways: Kroy or Brother labels 1-inch (25mm) high by 12-inches (305mm) long (minimum).
 - 2. Color: As specified for various systems.
- B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch (25mm) to 2 inches (50mm) in width.
- C. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pretensioned gripping action when coiled around the cable.
- D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch (5mm) minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F (10°C to 176°C). Provide ties in specified colors when used for color coding.

- F. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.
- G. Aluminum, Wraparound Marker Bands: 1-inch (25mm) width, 0.014 (5mm) inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- H. Brass or aluminum Tags: 2" (50mm) by 2" (50mm) by .05-inch (2mm) metal tags with stamped legend, punched for fastener.
- I. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.
- J. Text Sizes:
 - 1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
 - a. Font: Normal 721 Swiss Bold
 - b. Adhesive Labels: 3/16 inch (5mm) minimum text height
 - c. Vinyl / Plastic Laminate Labels: 3/4" inch (19mm) minimum text height

2.2 NAMEPLATES AND SIGNS

- A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch (2mm) minimum thick for signs up to 20 square inches (13 square cm), or 8 inches (200mm) in length; 1/8 inch (3mm) thick for larger sizes. Labels shall be punched for mechanical fasteners.
- B. Text Sizes:
 - 1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
 - a. Text Height: 3/8 inch (10mm) minimum
- C. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch (10mm) galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- E. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- F. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.3 PRODUCT COLORS

- A. Adhesive Markings and Field Labels:
 - 1. All Labels: Black letters on white face
- B. Nameplates and Signs:
 - 1. NORMAL POWER: Black letters on white face
 - 2. EMERGENCY: White letters on red face
 - 3. GROUNDING: White letters on green face.
 - 4. CAUTION or UPS: Black letters on yellow face
- C. Raceways and Conduit:
 - 1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
 - a. Normal Power and General Distribution: Silver
 - b. Emergency Power Distribution System:
 - 1) All Emergency: Orange
 - c. Temperature Controls: Blue
 - d. Ground: Green
 - e. Low Voltage and Telephone: Purple
 - f. Clock, Sound, Security System, and Intercom: Black
- D. Box Covers:
 - 1. Box cover colors shall match conduit colors listed above.
- E. Conductor Color Identification: Refer to Part 3 for additional information.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.
- B. Electrical System Color Chart: This Contractor shall furnish and install framed 8" x 12" charts of the color-coded identification scheme used for the electrical system in all electrical rooms and next to the main fire alarm panel.
- C. Install identification devices in accordance with manufacturer's written instruction and requirements of NEC.
- D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

- E. Circuit Identification: Tag or label conductors as follows:
1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
 2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.
 3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- F. Apply warning, caution and instruction signs as follows:
1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operating Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch (10mm) high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- G. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.
- H. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- I. Install ARC FLASH WARNING signs on all power distribution equipment per Section 26 05 73.
- J. Circuits with more than 600V: Identify raceway and cable with "DANGER—HIGH VOLTAGE" in black letters 2 (50mm) inches high on orange background at 10'-0 foot (3m) intervals.
1. Entire floor area directly above conduits running beneath and within 12 inches (305mm) of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to conduits concealed within wall.
 3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.

- K. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 (150mm) to 8 (205mm) inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches (405mm); provide a second plastic line marker to mark each edge of the trench when 16 inches (405mm) of width is exceeded. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

3.2 LIGHTING CONTROL AND RECEPTACLE COVER PLATES

- A. Product:
 - 1. Adhesive labels and field markings
 - 2. Nameplates and signs
- B. Identification material to be a clear, 3/8-inch (10mm) Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.
- C. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. "C1A #24").

3.3 CONDUIT AND EXPOSED CABLE LABELING

- A. Product:
 - 1. Adhesive labels and field markings
- B. Conduit Identification: Pre-printed, flexible, self-adhesive vinyl labels with legend at 25 foot (7.5 meter) intervals to identify all conduits run exposed or located above accessible ceilings. Conduits located above non-accessible ceiling or in floors and walls shall be labeled within 3 feet of becoming accessible. Labels for multiple conduits shall be aligned. Refer to color requirements in Part 2 when applicable in addition to the following:
 - 1. 1000 Volt or less Normal/Emergency Power: Indicate feeder identification and voltage.
 - 2. Grounding: Indicate "GROUND" and equipment and designation.
 - 3. Security System: Indicate "Security".
 - 4. Telephone System: Indicate "Telephone".
- C. Blank conduit ends or outlet boxes for future extension of system shall have permanent identification marker indicating purpose of conduit or box and where the raceway originated.

3.4 BOX LABELING

- A. Products:
 - 1. Adhesive labels and field markings
- B. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch (10mm) Kroy tape or Brother self-laminating vinyl label, letters/numbers color coded same as conduits. In rooms that are painted out, provide labeling on inside of cover.

- C. All junction, pull, and connection boxes shall be identified as follows:
 - 1. For power and lighting circuits, indicate system voltage and identity of contained circuits (“120V, 1LA1-3,5,7”).
 - 2. For other wiring, indicate system type and description of wiring (“FIRE ALARM NAC #1”).

3.5 CONDUCTOR COLOR CODING

- A. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.
- B. All wires and cables shall be color coded by the manufacturer.
- C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches (76mm) from the termination and spaced at 3- inches (76mm) centers. Tighten to a snug fit, and cut off excess length.
- D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.
- E. Conductors shall be color coded as follows:
 - 1. 120/240 Volt, 3-Wire:
 - a. A-Phase – Black
 - b. B-Phase – Red
 - c. Neutral – White
 - d. Ground Bond – Green
 - 2. 208Y/120 Volt, 4-Wire:
 - a. A-Phase – Black
 - b. B-Phase – Red
 - c. C-Phase – Blue
 - d. Neutral – White
 - e. Ground Bond – Green
 - 3. 480Y/277 Volt, 4-Wire:
 - a. A-Phase – Brown
 - b. B-Phase – Orange
 - c. C-Phase – Yellow
 - d. Neutral – Gray
 - e. Ground Bond – Green

4. 120 Volt, 2-Wire Isolated (Ungrounded) Power System:
 - a. A-Phase – Orange with distinctive colored stripe other than white, green or gray along the entire length of the conductor
 - b. B-Phase – Brown with distinctive colored stripe other than white, green or gray along the entire length of the conductor
 - c. Ground Reference – Green
5. 120/208 Volt, 3-Wire, Isolated (Ungrounded) Power System:
 - a. A-Phase – Orange with distinctive colored stripe other than white, green or gray along the entire length of the conductor
 - b. B-Phase – Brown with distinctive colored stripe other than white, green or gray along the entire length of the conductor
 - c. C-Phase – Yellow with distinctive colored stripe other than white, green or gray along the entire length of the conductor
 - d. Ground Reference – Green
6. 60 to 1500 Volt, Direct Current DC Power System:
 - a. Positive Polarity: Red or black with permanent red stripe marked along the entire length. Provide shrink wrap sleeves at terminations indication (POS, POSITIVE, or POS (+)).
 - b. Negative Polarity: Black. Provide shrink wrap sleeves at terminations indication (NEG, NEGATIVE, or NEG (-)).
7. Isolated Equipment Ground Conductors: Green with colored distinctive yellow stripe along the entire length of the conductor.

3.6 CONTROL EQUIPMENT IDENTIFICATION

- A. Products:
 1. Nameplates and signs
- B. Provide identification on the front of all control equipment such as combination starters, starters, VFDs, contactors, motor control centers, etc.
- C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.
- D. Labeling shall include:
 1. Equipment type and contract documents designation of equipment being served.
 2. Location of equipment being served if it is not located within sight.
 3. Voltage and phase of circuit(s).
 4. Panel and circuit number(s) serving the equipment.
 5. Method of automatic control, if included ("AUTO CONTROL BY FCMS").
 6. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.

7. Date of fault current study, refer to one-line diagram

EXHAUST FAN EF-1
("LOCATED ON ROOF")
480V, 3-PHASE
FED FROM "1HA1-1"
AUTO CONTROL BY FCMS
22,000 AMPS AVAILABLE FAULT CURRENT
DATE OF STUDY: 1 JAN 2017

3.7 EQUIPMENT CONNECTION IDENTIFICATION

- A. Products:
1. Nameplates and signs
- B. Provide identification for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.
- C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.
- D. Labeling shall include:
1. Equipment type and contract documents designation of equipment being served
 2. Location of equipment being served if it is not located within sight.
 3. Voltage and rating of the equipment.
 4. Panel and circuit numbers(s) serving the equipment
 5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
 6. Date of fault current study; refer to one-line diagram

UNIT HEATER UH-1
("LOCATED IN STORAGE ROOM 200")
480V: 3-PHASE
FED FROM "1HA1-1"
22,000 AMPS AVAILABLE FAULT CURRENT
DATE OF STUDY: 1 JAN 2017

3.8 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

- A. Products:
1. Nameplates and signs
- B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.

1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.
2. Exterior Equipment: The identification material shall be engraved vinyl labels.
3. Labeling shall include:
 - a. Equipment type and contract documents designation of equipment.
 - b. Voltage of the equipment.
 - c. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
 - d. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").

DISTRIBUTION PANEL DP-H1
 480Y/277V
 FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELEC ROOM)

4. Provide the following on a separate label, installed below the label above:
 - a. Available fault current; refer to one-line diagram or panel schedules
 - b. Date of fault current study; refer to one-line diagram

22,000 AMPS AVAILABLE FAULT CURRENT
 DATE OF STUDY: 1 JAN 2017

C. Service Equipment Label: A separate nameplate for the service entrance equipment and include:

1. Nominal system voltage
2. Maximum available fault current; refer to one-line diagram for values
3. Clearing time of overcurrent protection devices based on available fault current. Refer to calculations and report from Section 26 05 73 for value.
4. Date of fault current study; refer to one-line diagram
5. Date of label

480Y/277V
 39,800 AMPS AVAILABLE FAULT CURRENT
 0.07 SECOND CLEARING TIME
 DATE OF STUDY: 1 JAN 2017
 DATE OF LABEL: 4 JUL 2017

D. Arc Energy Reduction Label:

1. Provide a separate engraved plastic laminate label centered at the top of each vertical section of the electrical gear indicating the following when applicable.
 - a. Label: "This equipment is designed with a system listed below".

- b. Applicable Systems:
 - 1) Zone-selective interlocking system for selective coordination and arc energy reduction
 - 2) Differential relaying system for selective coordination and arc energy reduction
 - 3) Arc energy reducing maintenance switch
 - 4) Energy reducing active arc flash mitigation system

E. Nominal System Voltage Label:

- 1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

F. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1").

G. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 26 05 00 for other requirements.

3.9 INDUSTRIAL CONTROL PANEL IDENTIFICATION

A. Products:

- 1. Nameplates and signs

B. Provide identification on the front of all industrial control panels and similar equipment. Labels shall be visible on the exterior of the gear and correspond to the one-line and/or schematic diagram nomenclature.

- 1. Interior equipment: The identification material shall be engraved plastic-laminated labels.
- 2. Labeling shall include:
 - a. Equipment type and contract documents designation of equipment.
 - b. Manufacturer / Assembler of industrial control panel
 - c. Voltage, phase, frequency, full load current of each supply circuit
 - d. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
 - e. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").

INDUSTRIAL CONTROL PANEL ICP-1
ABC COMPANY

480V, 3PHASE, 60HZ, 60A (PANEL E1-1 LOCATED IN ELEC 123)
120V, 1PHASE, 60HZ, 20A (PANEL E2-1 LOCATED IN ELEC 123)

22,000 SHORT CIRCUIT RATING

- C. Nominal System Voltage Label:
 - 1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used shall be permanently posted on the interior of the door or cover of the industrial control panel.
- D. Schematic Diagram: Provide a laminated copy of the industrial control panel schematic wiring diagram. Post the diagram on the inside cover of the control panel.
- E. Service Equipment Label: Refer to Electrical Distribution Equipment - Service Equipment Label of this specification if applicable for additional requirements.

3.10 TRANSFORMER EQUIPMENT IDENTIFICATION

- A. Products:
 - 1. Nameplates and signs
- B. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label.
- C. Labeling shall include:
 - 1. Equipment type and contract documents designation of equipment
 - 2. Name of the upstream equipment.
 - 3. Voltage and rating of the equipment.
 - 4. Location of the upstream equipment if it is not located within sight.

TRANSFORMER TR-15
 480V: 208Y/120V 15KVA
 FED FROM SWITCHBOARD "SB-1" (LOCATED IN ELEC 123)

3.11 ELECTRICAL WORKING CLEARANCE IDENTIFICATION

- A. Products:
 - 1. Safety Yellow paint and custom stencils
- B. Provide custom identification of electrical equipment working clearances in all areas.
- C. Identification shall include a painted rectangular box (on the finished floor) in front of the electrical equipment to define the code-required working clearance. Provide additional diagonal stripping inside the rectangle box. All painted stripping shall be safety yellow paint with 3 inch (76mm) wide stripes.
 - 1. Width of area: Width of equipment or as required by code
 - 2. Depth of area: Depth as required by code

3.12 POLE IDENTIFICATION

- A. Product:
 - 1. Adhesive labels and field markings
 - 2. Nameplates and signs

- B. Lighting poles, bollards and overhead distribution poles shall be individually identified with a unique number, for maintenance purposes. Apply the vinyl label number above the hand hole cover or 24" (610mm) above grade. Bollards may be identified with a number applied inside the luminaire that is visible from the exterior.

END OF SECTION

SECTION 26 05 73

POWER SYSTEM STUDY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Low voltage distribution system power study.
- B. Short-circuit analysis and report.
- C. Selective coordination analysis and report.
- D. Arc-flash hazard analysis and report.

1.2 RELATED SECTIONS

- A. Section 26 05 00 - Basic Electrical Requirements
- B. Section 26 24 13 - Switchboards
- C. Section 26 24 16 - Panelboards
- D. Section 26 33 53 - Static Uninterruptible Power Supply

1.3 SUBMITTALS

- A. Analyses shall be performed by an agent authorized by the manufacturer of equipment specified in the related specification sections and shall bear the seal/signature of the licensed Professional Engineer who performed the analysis.
- B. The input for the power system study shall be based on the contract documents, with estimated conductor lengths provided by the Electrical Contractor. IMEG will provide a preliminary Power Tools for Windows project file for information, if requested.
- C. Documentation of the analyses shall be submitted in a bound booklet format and shall accompany the shop drawing submittals for equipment provided under the related work specification sections. These shop drawings will not be reviewed without this documentation. Submit a sample arc-flash hazard label for Owner review and approval prior to printing.
- D. Power system study project model shall be submitted on electronic media for review and the Owner's operating and maintenance records.

1.4 SCOPE

- A. Provide a power system study of the electrical system shown on the plans. The study shall include arc-fault analysis, selective coordination analysis and arc flash hazard analysis.
- B. Contractor is required to provide a fully coordinated system for the essential electrical system and the associated normal side of each transfer switch and all other locations indicated on the one line diagram. Contractor shall provide overcurrent protective devices with the appropriate models, frame sizes, trip units, etc. as required to provide a selectively coordinated system.

PART 2 - PRODUCTS

- 2.1** Power systems study shall be completed in Power Tools for Windows (**PTW**) **8.0** or later version or pre-approved equivalent program.

PART 3 - EXECUTION

3.1 SHORT-CIRCUIT ANALYSIS

- A. Provide a complete short-circuit analysis from the utility service to and including the entire building distribution as shown on the drawings.
- B. Analysis shall include the entire distribution system from the point of connection to the utility power source to the distribution panels and branch circuit panelboards.
- C. Documentation shall be made in one-line diagram form showing the magnitude and location of each calculated fault. Fault current calculations shall be made at the main bus of each switchboard, distribution panel, and branch circuit panel. A summary of the fault currents available shall also be submitted.

3.2 SELECTIVE COORDINATION ANALYSIS

- A. Provide a complete selective coordination analysis, comparing time/current curves of the protective devices to be installed to assure complete selectivity between main and downstream devices for code-required branches and branches identified on one-line drawings. Overcurrent protective devices serving the essential electrical system shall selectively coordinate for the period of time that a fault's duration extends beyond 0.01 second. Overcurrent protective devices serving the normal shall selectively coordinate for the period of time that a fault's duration extends beyond 0.01 second.
- B. The analysis shall include primary protective device, secondary main switchboard device(s), switchboard branch feeder devices, generator breaker, distribution panel, panelboard main devices, and branch feeder devices.
- C. The coordination plots provided shall indicate graphically the coordination proposed for the system on full-size log forms and shall define the types of protective devices selected, together with proposed time dial and pickup settings required. The plots shall include titles, representative one-line diagrams, legend, complete parameters for transformer(s), and complete operating bands for circuit breaker trip devices, fuses, etc.
 - 1. The long-time region of the coordination plots shall designate the pickups required for the circuit breakers.
 - 2. The short-time region shall indicate the magnetizing in-rush and ASA-withstand-transformer parameter, the circuit breaker, short-time and instantaneous trip devices, fuse-manufacturing tolerance bands, significant symmetrical fault currents, etc.
 - 3. Each primary protective device required for the transformer shall be selected so the characteristics or operating band is within the transformer parameters, which shall include a parameter equivalent to 58% of the withstand point to afford protection for secondary line-to-ground faults. The transformer damage curve shall be included for the transformer when the selected protective device is not within the associated parameters.





4. Molded case circuit breakers shall be separated from each other and the associated primary protective device by a 16% current margin for coordination and protection in the event of secondary line-to-line faults.
 5. Include zone selective interlocking, differential relaying, and other selective coordination technology in the study when required by other specification sections.
 6. The protective device characteristics or operating bands shall be suitably indicated to reflect the actual symmetrical fault currents sensed by the device.
 7. The drawings and specifications indicate the general requirements for motors, motor-starting equipment, and medium-voltage and low-voltage equipment, but additional specific requirements of equipment furnished shall be determined in accordance with the results of the coordination study.
 - a. The study shall include verification of equipment ratings and settings. The Contractor shall keep the study up-to-date with any project changes which affect the study and submit the revised study for review. A final electronic copy shall be submitted with the record drawings.
- D. Provide summary table of adjustable overcurrent protective devices settings for the operating and maintenance manual.





3.3 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, unit substations, motor-control centers, panelboards, busway, and splitters) where work could be performed on energized parts.
- C. Safe working distances shall be based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit analysis and coordination study models. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
- E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared, and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

- F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
1. Fault contribution from induction motors should not be considered beyond 3 to 5 cycles.
 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- G. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- H. Include Arc Energy Reduction (AER) analysis in the study when required by other specification sections.
- I. When performing incident energy calculations on the line side of a main breaker (as required per the above), the line side and load side contributions must be included in the fault calculation.
- J. Miscoordination should be checked among all devices within the branch containing the immediate protective device upstream of the calculation location, and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section.
- L. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
- M. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchboards, panelboards, and other locations in the electrical distribution system where work could be performed on energized parts.
- N. The label shall include the incident energy calculated in the analysis and the hazard category or appropriate personal protective equipment (PPE) required to perform maintenance on the system when energized. Labels shall be vinyl or laminated, with a self-adhesive backing.
- O. Examples showing the minimum required information follow:

RFB No

	 WARNING 	
Arc-Flash Hazard and Shock Hazard		
78.6 in - Arc-Flash Protection Boundary 10.5 cal/cm ² - Incident Energy Flash Hazard at 18 inches		Category 3 Arc-Flash Hazard Risk Category
Appropriate PPE Required for both Arc-Flash and Shock Hazards: Refer to NFPA 70E-2009 for table 130.7(C)(10) for PPE required for given arc flash hazard/risk category when working within the arc flash protection boundary		
480 Vac - Shock Hazard with covers/doors open 42 in - Limited Approach Boundary 12 in - Restricted Approach Boundary 1 in - Prohibited Approach Boundary	Shock Hazard	
Equipment Bus: ATS# 1 Protective Device: CB-OSD4-P1 VIA ATS#1		
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	 DANGER 	
Arc-Flash Hazard and Shock Hazard		
285.4 in - Arc-Flash Protection Boundary 75.4 cal/cm ² - Incident Energy Flash Hazard at 36 inches		Dangerous! Arc-Flash Hazard Risk Category
Appropriate PPE Required for both Arc-Flash and Shock Hazards: No FR Category Found Arc flash incident energy exceeds the rating of category 4 PPE Do not work on live!		
13800 Vac - Shock Hazard with covers/doors open 60 in - Limited Approach Boundary 26 in - Restricted Approach Boundary 7 in - Prohibited Approach Boundary	Shock Hazard	
Equipment Bus: 15KV SWITCH HVL (USS-1 BUS A) Protective Device: FEED FROM CITY OF AMES		
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- P. A list of all hazard categories and the corresponding PPE requirements shall be posted in the main electric room, engineering office, or other location. The list shall be plastic laminate or typewritten and housed in a plastic frame.

3.4 ADJUSTMENTS

- A. Manufacturer's authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study.
- B. Wherever the arc flash incident energy exceeds Arc Flash Category 2 (i.e. $> 8 \text{ cal/cm}^2$), provide options for adjusting breaker trip times, if possible, to reduce energies to Category 2 or below.

3.5 TRAINING

- A. Provide four hours of Owner training to explain the implications of arc-flash requirements and work permit procedure.

END OF SECTION

SECTION 26 09 16

ELECTRICAL CONTROLS AND RELAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Relays
- B. Pushbutton Operators
- C. Control Power Cabinets

PART 2 - PRODUCTS

2.1 CONTROL RELAYS

- A. Mount relays in separate NEMA 4 enclosure or in control terminal cabinet.
- B. **[R-#]: Industrial AC Control Relay:**
 - 1. Modular construction, replaceable convertible contacts, 600-volt A.C. contacts, 10-amp continuous rating.
 - 2. Approved Manufacturers: Square D Type X Class 8501, General Electric, Cutler Hammer, Siemens.
- C. **[R-#]: Power Relay:**
 - 1. Visible contacts, coil burden less than 10 V.A., 600-volt A.C. contacts, 2 normally open contacts, 30-amp continuous contacts electrically held.
 - 2. Approved Manufacturers: Square D Type C Class 8501 CO, Cutler Hammer, General Electric, Siemens.
- D. **[R-#]: General Purpose Relay:**
 - 1. Continuous duty coil, 1 N.O. and 1 N.C. contacts, electrically held, 12-amp, 240 volt rated contacts. Provide compatible plug-in base socket.
 - 2. Approved Manufacturers: Square D Class 8501 Type K, Cutler Hammer, General Electric, Siemens.

2.2 [CPC]: CONTROL POWER CABINET

- A. Provide a 12"x8"x4" screw cover NEMA 1 enclosure, single pole specification grade 20-amp switch in a single gang box, fuse block, fuses and equipment for interface of temperature control system. Mount above accessible ceiling.
- B. Approved Manufacturers:
 - 1. Enclosure - Hoffman A-SE12X8X4, Weigmann, Hammond Manufacturing
 - 2. Fuseholders - Bussman NDNLDF-WH, Mersen, Littelfuse
 - 3. Neutral Block - Bussman NDNV4-WH, Mersen, Littelfuse

2.3 [ES]: EMERGENCY STOP

- A. Red mushroom head, N.C. contact, turn to release, provide engraved nameplate to read “Emergency Shutoff”.
 - 1. Approved Manufacturers: Square D XAL K178H7, Cutler Hammer, General Electric, Siemens.

2.4 [EPO]: EMERGENCY POWER OFF

- A. Mushroom head, (1) N.O. (1) N.C. contacts, 120 volt, turn to release, provide engraved nameplate to read “Emergency Shutoff”. Provide guarded enclosure cover to protect from accidental operation.
 - 1. Approved Manufacturers: Square D 9001 XB5AS8445 - KYG1Y, Cutler Hammer, General Electric, Siemens 52PA2W2A.

2.5 [FA-LA]: LAMP ANNUNCIATOR

- A. Four indicators across and one indicator down. Surface mount, 125 volt. Supply with lamp test, lamp reset, and acknowledge buttons. Provide with 1/4” character height.

2.6 [PB]: MOMENTARY PUSHBUTTON

- A. Non-illuminated, round 1-3/8” diameter mushroom button, (1) normally open, (1) normally closed contact. Contacts rated 10 amps continuous. Provide 2-1/4” square engraved nameplate with white background and black letters.
 - 1. Approved Manufacturers: Square D Class 9001- SKR4RH13 button, (2) KA1 contacts - KN100WP nameplate.

2.7 [ST]: SHUNT TRIP

- A. Trips breaker electrically using a remote 2-wire control source. Verify voltage with application prior to ordering.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate with Mechanical Division 23 in connection of control conduit into control terminal cabinet.
- B. Install line voltage thermostats for single phase motors. provided by Division 21/22/23.
- C. Provide remote control connection to remote devices.

END OF SECTION

SECTION 26 09 33

LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Line and low voltage standalone lighting controls
- B. Emergency transfer devices
- C. Distributed lighting control
- D. Central lighting controls
- E. Digital addressable lighting interface (DALI)
- F. Architectural dimmer rack and accessories
- G. DC dimming systems
- H. Time switches

1.2 RELATED WORK

- A. Section 1 91 00 - Commissioning
- B. Section 23 09 00 - Facility Management Control System (FMCS)
- C. Section 26 51 00 - Lighting

1.3 QUALITY ASSURANCE

- A. Manufacturers shall be regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. All components and assemblies are to be factory pre-tested prior to delivery and installation.
- C. Comply with NEC as applicable to electrical wiring work.
- D. Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.
- E. Panels and accessory devices are to be UL listed under UL 916 Energy Management Equipment. Panels and accessories used for control of life safety and critical branch circuits shall be listed under UL 924 Emergency Lighting and Power Equipment.
- F. All assemblies are to be in compliance with FCC emissions standards specified in Part 15 Subpart J for Class A applications.

1.4 REFERENCES

- A. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference
- B. FS W S 896 Switch, Toggle
- C. International Energy Conservation Code (IECC)
- D. NEMA WD 1 - General Color Requirements for Wiring Devices
- E. NEMA WD 7 - Occupancy Motion Sensors
- F. NFPA 70 - National Electrical Code (NEC)
- G. UL Standard 916 Energy Management Equipment

- H. UL 924 - Emergency Lighting and Power Equipment
- I. UL 1472 – Solid-State Dimming Controls

1.5 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Submit a comprehensive package including devices, hardware, software, product specification, finishes, dimensions, installation instructions, warranty, system software requirements.
- C. Provide floor plan showing location, orientation, and coverage area of each control device, sensor, and controller/interface. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer-approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.
- D. Submit a list of devices and equipment that will be installed for each sequence of operation.
- E. Submit project specific control wiring diagrams showing all equipment, line voltage, and control wiring requirements for all components including, but not limited to, dimmers, relays, low voltage switches, occupancy sensors, control stations, and communication interfaces and programming instructions for each sequence of operation. Include network cable specification and end-of-line termination details, if required.

1.6 EXTRA STOCK

- A. Provide extra stock under provisions of Section 26 05 00.
- B. Sensors, Controls, Power Supplies, and Relays: Five (5) percent of quantity installed. Minimum of two (2) of each configuration and type.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit project record documents under provisions of Section 26 05 00.
- B. Accurately record location of all controls and devices. Include description of switching sequences and circuiting arrangements.

1.8 OPERATION AND MAINTENANCE DATA

- A. Submit emergency, operation, and maintenance data under provisions of Section 26 05 00. Data shall also include the following:
 - 1. Schedule for routine maintenance, inspection, and calibration of all lighting control devices and system components. Recommended schedule for inspection and recalibration of sensors.
 - 2. Complete narrative describing intended operation and sequence for each control scenario and system component, updated to reflect all changes resulting from commissioning of systems. Narrative shall indicate recommended settings for devices where applicable.
 - 3. Replacement part numbers for all system components.

- B. Identify installed location and labeling for each luminaire controlled by automated lighting controls.

1.9 SYSTEM DESCRIPTION

- A. Performance Statement: This specification section and the accompanying lighting design documents describe the minimum material quality, required features, and operational requirements of the lighting control system (LCS). These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the performance required of the system, as presented in these documents, the Contractor and system manufacturer/vendor are solely responsible for determining all equipment, wiring, and programming required for a complete and operational system.

1.10 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative. Project closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 1 for detailed commissioning requirements.
- B. This project will have selected building systems commissioned. The Contractor is responsible to execute commissioning. The commissioning process, equipment, and systems to be commissioned are defined in Division 1.
- C. The Contractor shall notify the Architect/Engineer and Owner's Representative ten (10) working days prior to scheduled commissioning date.
- D. The commissioning process requires meeting attendance. Refer to Division 1 for meeting requirements.
- E. The system shall be functionally tested by a factory-authorized engineer and comply with the Sequence of Operation. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system.

1.11 WARRANTY

- A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of commissioning.
- B. Occupancy, vacancy, daylight sensors and controls shall have a five (5) year warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LIGHTING CONTROLS

- A. All items of material having a similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications.

- B. Color of lighting controls and sensors shall match the receptacle wiring devices specified in the space.
- C. The functions described in the lighting sequence of operation shall dictate the actual lighting control device required to accomplish the functions described for the space.

2.2 LIGHTING CONTROL STATION

- A. **[SW]** The lighting control station shall contain the controls required by the lighting sequence of operation in a common coverplate. The controls may consist of switches, dimmers, occupancy sensors, pushbuttons, etc.
 - 1. In spaces where the wall control station is shown in multiple locations, the sequence of operation shall be the same at all locations, unless noted otherwise.
 - 2. The controls supplier shall prepare control station shop drawings showing arrangement of controls, dimensioned elevations, wiring diagram, and recommended backboxes. The shop drawing submittal should be identified with the lighting sequence that the station provides. Submit data sheets on the switches, dimmers, sensors, buttons, etc. contained in the control station.

2.3 DEVICE COLOR

- A. All switch, lighting controls, and coverplate colors shall be the same as wiring devices, unless indicated otherwise.

2.4 COVERPLATES

- A. All switches and lighting controls shall be complete with coverplates that match material and color of the wiring device coverplates in the space.
- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 26 05 53.
- D. Plate-securing screws shall be metal with head color matching the wall plate finish.

2.5 WALL SWITCHES

- A. Refer to Electrical Symbols List for device type.
- B. **[SW-1P]:** Single Pole Switch:
 - 1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
 - 2. Approved Manufacturers: Hubbell HBL1221, Leviton 1221-2, Pass & Seymour PS20AC1, Cooper AH1221.
- C. **[SW-1P-060]:** Spring Wound Local Timer Switch:
 - 1. 125-volt, 20-amp rated. 0 to 60-minute off delay.
 - 2. Approved Manufacturers: Paragon SWPD60M, Tork A560M, Mark-Time 9008.

- D. **[SW-1P-ADJ]:** Local Timer Switch:
1. User adjustable timeout, 120/277-volt, 800/1200 watt rating. No minimum load requirement. Flashes lights one minute before timeout.
 2. Approved Manufacturers: Watt Stopper TS-400, Hubbell Automation TD200.
- E. **[SW-1P-EX]:** Explosion Proof Single Pole Switch:
1. 120/277-volt, 20-amp maintained contact. Toggle handle. Suitable for use in Class 1, Division 1 areas.
 2. Wet location listed, suitable for use outdoors.
 3. Approved Manufacturers: Appleton EDSC175-F2, Crouse Hinds, Killark.
- F. **[SW-3W-EX]:** Explosion Proof Three Way Switch
1. 120/277-volt, 20-amp maintained contact. Toggle handle. Suitable for use in Class 1, Division 1 areas.
 2. Wet location listed, suitable for use outdoors.
 3. Approved Manufacturers: Appleton EDSC175-F3W, Crouse Hinds, Killark.
- G. **[SW-1P-LH]:** Lighted Handle Single Pole Switch:
1. 120 volt maintained contact. Toggle handle. Light on when contact open (switch off). Side and back wired.
 2. Approved Manufacturers: Hubbell HBL1221ILC, Leviton 1221-LHC, Pass & Seymour PS20AC1-CSL, Cooper 2221LTW.
- H. **[SW-1P-M]:** Momentary Contact Single Pole Switch:
1. 120/277-volt, 20 amp. Three position, two circuit. Center off toggle spring return handle.
 2. Approved Manufacturers: Hubbell HBL1557, Leviton 1257, Pass & Seymour 1251, Cooper 1995.
- I. **[SW-1P-PL]:** Red Pilot Light Single Pole Switch:
1. 120 volt maintained contact. Toggle handle. Pilot light on when contact closed (switch on). Side and back wired.
 2. Approved Manufacturers: Hubbell HBL1221PL, Leviton 1221-PLR, Pass & Seymour PS20AC1-RPL, Cooper AH1221PL.
- J. **[SW-1P-WP]:** Weatherproof Single Pole Switch:
1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired. Provide with weatherproof coverplate.

2. Approved Manufacturers: Hubbell1221/HBL1795, Leviton 1221-2, Taymac MM180, Pass & Seymour PS20AC1/CA1-GL, Cooper 2221.
- K. **[SW-3W-WP]:** Weatherproof Three Way Switch:
1. 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired. Provide with weatherproof coverplate.
 2. Approved Manufacturers: Hubbell1223/HBL1795, Leviton 1223-2, Taymac MM180, Pass & Seymour PS20AC1/CA1-GL, Cooper 2223.
- L. **[SW-2P]:** Two Pole Switch:
1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
 2. Approved Manufacturers: Hubbell HBL 1222, Leviton 1222-2, Pass & Seymour PS20AC2, Cooper 2222.
- M. **[SW-3W]:** Three-way Switch:
1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
 2. Approved Manufacturers: Hubbell 1223, Leviton 1223-2, Pass & Seymour PS20AC3, Cooper AH1223.
- N. **[SW-4W]:** Four-way Switch:
1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
 2. Approved Manufacturers: Hubbell 1224, Leviton 1224-2, Pass & Seymour PS20AC4, Cooper AH1224.
- O. **[SW-A-TPCO]:** Three Position-Center Off Switch:
1. 120/277-volt, 20-amp, 2 pole maintained contact. Toggle handle, side and back wired.
 2. Approved Manufacturers: Hubbell HBL1386, Leviton 1286, Pass & Seymour 1226, Cooper 2226.

2.6 LOCAL DAYLIGHTING CONTROLS

- A. **[SW-LS-PC]:** Standalone Exterior Photo Sensors:
1. Sensor shall be within a weatherproof enclosure, with design operation in temperatures of -30°F to +130°F. Sensor shall have threaded stem for box mounting, with knuckle to permit aiming of receptor after installation. Sensor shall be mounted facing north.
 2. Sensor shall contain an integral switching contactor rated for 277-volt operation, with loads of up to 1,800 VA. Contacts shall be configured for zero-crossing closure to provide 100,000 cycle minimum operation.

3. Sensor shall detect changes in daylight levels to provide triggering of exterior lighting equipment based on the sequence of operation.
4. Sensor shall be field configurable at the device or via handheld wireless remote controller. Configurable settings shall include:
 - a. Ambient sensitivity range of 5 to 1,500 foot-candles.
 - b. Adjustable setpoint.
 - c. Deadband adjustment by percentage of setpoint.
 - d. Time delay of up to five minutes.
5. Sensor shall be equipped with a lens cover that can be applied for system testing during daylight conditions.
6. Approved Manufacturers: Paragon, Tork, Intermatic.

2.7 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.
 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied, with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes. Vacancy sensors require a manual switch operation to turn lights on and off, with a time delay for turning lights off when unoccupied.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13-amp tungsten at 120 VAC, and for 1 hp at 120 VAC. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.
 - c. Time Delay and Sensitivity Adjustments: Recessed and concealed.
 5. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Power Supply and Slave Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2" knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.

8. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.
 9. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.
 10. Warranty: Five (5) year warranty.
- B. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. **[SW-VS-D] or [SW-OC-D]:** 360 Degree Coverage Pattern:
 - a. Frequency greater than 40 KHz. Dual sensing verifications (requires both technologies to activate), either technology maintains on status. Integrated ambient light level sensor (2 to 200 FC range), adjustable sensitivity and time delay, integrated isolated relay contact. Sensor shall control all circuits in area, unless noted otherwise. Initial settings: ambient sensor 40 FC.
 - b. Approved Manufacturers: Watt Stopper DT 300 Series, Hubbell OMNI-DT2000 or ATD2000C, Greengate OAC-DT, Leviton OSC##-MOW.
 2. **[SW-VS-D-W] or [SW-OC-D-W]:** Wall Mounted on Adjustable Swivel Mount:
 - a. Wall or ceiling sensor with adjustable settings to allow manual on/auto off or auto on/auto off. Integrated ambient light level sensor (2 to 100 FC range).
 - b. Approved Manufacturers: Watt Stopper DT-200 Series, Hubbell LODTRP, Leviton OSM12--M series.
 3. **[SW-O]:** Wall Switch:
 - a. Wall switch with manual on/auto off. 120/277 VAC load rating of 0-800 W for ballast, LED or tungsten. 5-, 15-, 30-minute adjustable OFF delay. Coverage of minor motion in 12' x 15' pattern.
 - b. Approved Manufacturers: Watt Stopper DW-100 Series, Hubbell LHMTS, Leviton OSSMT series.
 4. **[SW-O2]:** Wall Switch:
 - a. Multi-relay wall switch with manual on/auto off for two separate loads. 120/277 VAC load relay rating of 0-800 W for ballast, LED or tungsten. 5-, 15-, 30-minute adjustable OFF delay. Coverage of minor motion in 12' x 15' pattern.
 - b. Approved Manufacturers: Watt Stopper DW-200 Series, Hubbell LHMTD, Leviton OSSMD series.
 5. Sensitivity Adjustment: Separate for each sensing technology.

6. Detection Coverage:
 - a. Task Areas: Detect occupancy anywhere in an area based on hand motion.
 - b. Circulation Areas: Detect occupancy anywhere in an area based upon half-step walking motion.
- C. Mask sensors where necessary to prevent nuisance switching from adjacent areas.
- D. PIR Type: Detect occupancy by sensing a combination of heat and movement in area of coverage.
 1. **[SW-OC-P-HA]:** High Bay - Aisle Coverage Pattern:
 - a. 20' to 40' mounting height. Minimum 1.3:1 walking motion coverage pattern to height ratio. Adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all luminaires in area. Initial settings: Time delay 10 minutes.
 - b. Approved Manufacturers: Watt Stopper HB-300 Series, Hubbell FHB 140 or HMHB series, Leviton OSFHU, Greengate OEF-P.
 2. **[SW-OC-P-HB]:** High Bay - 360 Degree Coverage Pattern:
 - a. 20' to 40' mounting height. Minimum 1.3:1 walking motion coverage pattern to height ratio. Adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all luminaires in area.
 - b. Approved Manufacturers: Watt Stopper HB-300 Series, Hubbell FHB 140 or HMHB series, Leviton OSFHU, Greengate OEF-P.
 3. **[SW-O]:** Wall Switch Occupancy Sensor:
 - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (10 to 150 FC range), adjustable sensitivity and time delay, no minimum load requirements, manual or auto on operation, Initial settings: 10 minutes, ambient sensor 40 FC.
 - b. Approved Manufacturers: Watt Stopper PW-100 Series, Sensor Switch WSX, Hubbell LHIRS1 or AP1277, Leviton ODS15, Greengate OSW-P-0451.
 4. **[SW-O2]:** Dual Wall Switch Occupancy Sensor:
 - a. Passive infrared, zero crossing circuitry. Switches control two separate circuits or relays. Integrated ambient light sensor (10 to 150 FC range), adjustable sensitivity and time delay, no minimum load requirements, manual or auto on operation, Initial settings: 10 minutes, ambient sensor 40 FC.
 - b. Approved Manufacturers: Watt Stopper PW-200 Series, Sensor Switch WSD-2, Hubbell LHIRD2 or AP127712, Leviton ODS, Greengate OSW-P-0451.

5. **[SW-OC-P-P]:** Ceiling Mounted - 360 Degree Coverage Pattern:
 - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC Range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: ambient sensor 40 FC.
 - b. Approved Manufacturers: Watt Stopper CI Series, Sensor Switch CM-9, Hubbell Automation Omni-IR, Leviton OSC Series, Greengate OMR-P Series.
 6. **[SW-OC-P-P2]:** Ceiling Mounted - 100 Degree Coverage Pattern:
 - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC Range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: ambient sensor 40 FC.
 - b. Approved Manufacturers: Watt Stopper WPIR Series, Sensor Switch CM-9, Hubbell LOIRWV or ATD1600W.
 7. **[SW-OC-P-W]:** Wall Mounted - 100 Degree Coverage Pattern:
 - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: Ambient sensor 40 FC.
 - b. Approved Manufacturers: Watt Stopper WPIR Series, Sensor Switch CM-9, Hubbell LOIRWV or ATD1600W.
 8. With daylight filter and lens to afford coverage applicable to space to be controlled.
- E. Ultrasonic Type: Ceiling mounting. Detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. **[SW-OC-U]:** 360 Degree 20' x 20' Hand Motion Coverage Pattern:
 - a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated 1-amp relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
 - b. Approved Manufacturers: Watt Stopper WT-1100 series, Hubbell OMNI-US or ATU series, Leviton OSC series, Greengate ODC-U series.
 2. **[SW-OC-U2]:** 35' x 30' Hand Motion Coverage Pattern:
 - a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
 - b. Approved Manufacturers: Watt Stopper WT-2200 series, Hubbell OMNI-US or ATU series, Leviton OSC series, Greengate ODC-U series.

3. **[SW-OC-U-A]: 360 Degree Two-Sided Corridor Coverage Pattern:**
 - a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
 - b. Approved Manufacturers: Watt Stopper WT-2250 Series, Hubbell OMNI-US or ATU series, Greengate ODC-U Series.
4. **[SW-OC-U-W]: Wall Mounted:**
 - a. Wall switch with adjustable settings to allow manual on/auto off or auto on/auto off.
 - b. Approved Manufacturers: Watt Stopper UW-100 Series, Hubbell AU1277I,
5. Crystal controlled with circuitry that causes no detection interference between adjacent sensors.

2.8 TIME SWITCH

- A. **[TC-7]:** Time switch, 7-day, 2 channel, electronic, two SPDT 15-amp contacts, two separate programs with 16 setpoints available, LCD display, 12 or 24-hour format, minimum 100 hours carry-over, UL listed.
 1. Approved Manufacturers: Paragon EC72, Tork DTS 200A, Intermatic ET70215C.
- B. **[TC-1]:** Astronomical time switch, 7-day, 1 channel, electronic, one SPDT 5-amp contact, LCD display, 12 or 24-hour format, minimum 100 hours carryover, UL listed.
 1. Approved Manufacturers: Paragon EC71ST, Tork DWZ100A, Intermatic ET70115C.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings.
- B. All wiring shall be installed in conduit.

- C. All branch load circuits shall be live tested before connecting the loads to the lighting control panel.

3.3 SUPPORT SERVICES

A. Testing:

1. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.
2. Verify occupancy/vacancy and daylight sensor operation is correct after furniture and equipment is installed in each area. Make adjustments to sensor settings and time delays to allow proper operation.
3. Verify occupancy/vacancy sensors are located to provide complete coverage for the area served with no nuisance switching.
 - a. Relocate sensors or provide additional sensors as necessary to provide adequate coverage.
 - b. Mask occupancy sensors where necessary to prevent nuisance switching from adjacent areas.

B. Training:

1. Manufacturer shall provide competent factory-authorized technician to train Owner personnel in the operation, maintenance and programming of the lighting control system. Submit training plan with notification seven (7) days prior to proposed training dates.

3.4 SYSTEM COMMISSIONING

- A. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 09 00, General Commissioning, for further details.
- B. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 09 00, General Commissioning, for system verification tests and commissioning requirements.
- C. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 01 09 00, General Commissioning, for Contractor training requirements.

END OF SECTION

SECTION 26 20 00

SERVICE ENTRANCE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Arrangement with Utility Company for permanent electric service
- B. Underground service entrance

1.2 RELATED SECTIONS AND WORK

- A. Refer to the One-Line Diagram for additional information.

1.3 QUALITY ASSURANCE

- A. Utility Company: Madison Gas and Electric.
- B. Install service entrance in accordance with Utility Company's rules and regulations.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 26 05 00.
- B. Submit Utility Company prepared drawings (if applicable).

1.5 SYSTEM DESCRIPTION

- A. System Voltage: 480Y/277 volts, three phase, four-wire, 60 Hertz.

PART 2 - PRODUCTS

2.1 METERING EQUIPMENT

- A. Meter: Furnished by the Utility Company.
- B. Meter Base: Furnished by the Contractor, as approved by the Utility Company. (Manufacturers: Milbank, Superior, Duncan, or Anchor).
- C. [MC-1]: Exterior Mounted Metering Cabinets: Furnished and installed by the Contractor to Utility Company's specifications. Conduit and conductors between metering cabinets and instrumentation shall be by the Contractor. Connections as required by the Utility Company.

2.2 IDENTIFICATION

- A. Provide a permanent plaque or sign denoting all services, feeders, and branch circuits supplying the building or structure and the area served by each. Install plaque or sign at each service disconnecting means.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Make arrangements with Utility Company to obtain permanent electric service to the Project.
- B. Primary distribution equipment and pad-mounted transformers shall be furnished and installed by the Utility Company.
- C. Primary conductors shall be furnished, installed, and terminated by the Utility Company. Primary conduit shall be furnished and installed by the Contractor, as shown on the drawings, to the Utility Company's requirements.
- D. Underground: Install service entrance conduits in concrete envelope from Utility Company's pad mounted transformer to meter cabinet and building service entrance equipment. Utility Company will connect service conductors to transformer secondary lugs.
- E. Concrete Pad for Transformer: Furnished and installed by the Contractor to Utility Company's specifications.

END OF SECTION

SECTION 26 22 00

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Dry type two winding transformers [TR-#]

1.2 REFERENCES

- A. NEMA - ST 1 - Specialty Transformers
- B. NEMA ST 20 - Dry Type Transformers for General Applications
- C. ANSI/IEEE C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers
- D. ANSI/IEEE C57.12.91 - Test Code for Dry Type Distribution and Power Transformers
- E. Department of Energy 10 CFR Part 431 – Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.
- F. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
- G. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, loss data, efficiency at 35, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect products under provisions of Section 26 05 00.
- B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
- C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 - PRODUCTS

2.1 DRY TYPE TWO WINDING TRANSFORMERS

A. Dry Type Transformers: NEMA ST 20, factory-assembled, air-cooled dry type transformers; ratings as shown on the drawings. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.

B. Insulation system and average winding temperature rise for rated KVA as follows:

<u>Ratings</u>	<u>Class</u>	<u>Rise (degree C)</u>
Less than 15	185	As shown on the drawings
15 or higher	220	As shown on the drawings

C. Case temperature shall not exceed 40°C rise above ambient at its warmest point.

D. Winding Taps, Transformers Less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

E. Winding Taps, Transformers 15 KVA and Larger: Two (2) 2-1/2% below and two (2) 2-1/2% above rated voltage, full capacity taps on primary winding.

F. Sound Levels: Average audible sound level shall not exceed the values given below when tested to NEMA ST 20 standards:

Equivalent Winding kVA Range	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
0-9	40	40	67	45
9.01-30.00	45	45	67	50
30.01-50.00	45	48	67	50
50.01-150.00	50	53	67	55
150.01-300.00	55	58	67	57
300.01-500.00	60	63	67	59
500.01-700.00	62	65	67	61
700.00-1000.00	64	67	67	63

G. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

H. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.

I. Coil Conductors: Continuous windings with terminations brazed or welded.

J. Enclosure: NEMA ST 20; Type 1. Provide lifting eyes or brackets.

K. Isolate core and coil from enclosure using vibration-absorbing mounts.

- L. Nameplate: NEMA TP 3; Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 ACCESSORIES

- A. Electronic Isolation Shield:
 - 1. Provide electrostatic winding shield with separate insulated grounding connection as shown on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set transformer plumb and level.
- B. Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

3.2 FIELD QUALITY CONTROL

- A. Check for damage and tight connections prior to energizing transformer.
- B. Measure primary and secondary voltages and make appropriate tap adjustments. Adjustments shall be made at completion of project and at approximately 6 months following project acceptance when requested by the Owner.

END OF SECTION

SECTION 26 24 13

SWITCHBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Main and distribution switchboards: [SB-#]

1.2 RELATED SECTIONS AND WORK

- A. Refer to the One-Line Diagram for size, rating, and configuration.

1.3 REFERENCES

- A. ANSI C12 - Code for Electricity Metering
- B. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments
- C. ANSI C57.13 - Requirements for Instrument Transformers
- D. NEMA AB 1 - Molded Case Circuit Breakers
- E. NEMA KS 1 - Enclosed Switches
- F. NEMA PB 2 - Dead Front Distribution Switchboards
- G. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or less

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.
- C. Submit manufacturer's instructions under provisions of Section 26 05 00.

1.5 SPARE PARTS

- A. Keys: Furnish four each to the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under provisions of Section 26 05 00.
- B. Deliver in 48-inch maximum width shipping splits, unless approved otherwise by both the Contractor and Architect/Engineer, individually wrapped for protection, and mounted on shipping skids.

- C. Store and protect products under provisions of Section 26 05 00.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 26 05 00.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Approved Manufacturers:
 - 1. Square D Class 2700 QED-2, QMB, I-Line, Powerstyle
 - 2. General Electric
 - 3. Siemens
 - 4. Cutler Hammer

2.2 RATINGS

- A. Definitions:
 - 1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. Refer to Section 26 05 53 for additional requirements.
 - 2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.
- B. The switchboards for this project shall be fully rated.

2.3 SWITCHBOARD CONSTRUCTION AND RATINGS

- A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard assembly conforming to NEMA PB2, and complete from incoming line terminals to load-side terminations.
- B. Switchboard electrical ratings and configurations as shown on the drawings.
- C. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials used.

- D. Main Section Devices: Individually mounted and compartmented.
- E. Distribution Section Devices: Group mounted.
- F. Auxiliary Section Devices: Individually mounted and compartmented.
- G. Bus Material: Aluminum with tin plating, sized in accordance with NEMA PB 2.
- H. Bus Connections: Bolted, accessible from front only for maintenance. Plug-on connections may be utilized with Architect/Engineer's pre-approval by addenda.
- I. Bus bars shall be fully isolated, braced for minimum ampere rms symmetrical rating as indicated on drawings.
- J. The bus shall extend the full height of the distribution sections to provide space for future breakers.
- K. Provide a 1 X 1/4-inch copper ground bus through the length of the switchboard.
- L. Enclosure shall be NEMA PB 2; Type 1 - General-Purpose. Sections shall align at front and rear.
- M. Switchboard Height: NEMA PB 2; 92 inches, excluding floor sills, lifting members and pull boxes.
- N. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
- O. Pull Box: Same construction as switchboard, size as shown on the drawings. Top and sides shall be removable. Insulating, fire-resistive bottom with separate openings for each circuit to pass into switchboard.
- P. Future Provisions: In addition to the spare devices shown, provide a minimum of 15 inches of fully equipped space for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on the drawings.
- Q. Suitable for use as service entrance equipment.

2.4 SWITCHING, OVER-CURRENT PROTECTIVE DEVICES, AND ARC ENERGY REDUCTION

- A. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. **Provide breaker interrupting ratings as indicated on the plans. Where necessary to meet interrupting ratings, breakers shall be provided with automatically resetting current limiting elements in each pole.**
- B. Solid State Molded Case Circuit Breakers: **(All breakers identified on plans as solid-state with 2,500 ampere frame sizes and below.)** Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with a sealable clear cover. Provide stationary mounting. Ground fault sensing shall be breaker integral with circuit breaker.

- C. Solid-State Insulated Case Circuit Breakers: **(All breakers identified on plans as solid state with frame sizes above 2,500 ampere.) Provide insulated case switch with two-step stored energy closing. Provide manual charging handle, and electric charging motor where indicated as electrically operated.** Provide with rating plug as required on drawings and electronic circuits for true rms current sensing, timing, and tripping for fully adjustable time current characteristics including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip settings shall be field programmable with a sealable clear cover. Ground fault sensing shall be summation type integral to breaker. Provide stationary mounting. **Provide breaker interrupted ratings as indicated on the plans.**
- D. Arc Energy Reduction:
 - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
- E. Arc Energy Reduction with Selective Coordination:
 - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
 - 2. The following arc energy reduction system options are acceptable:
 - a. Zone-selective interlocking with permanent arc energy reduction
 - b. Differential relaying with permanent arc energy reduction
 - c. Listed energy-reducing active arch flash mitigating system

2.5 INSTRUMENTS AND SENSORS

- A. Current Transformers: ANSI C57.13; 5 ampere secondary, bar or window type, with single secondary winding, unless otherwise required for application, and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- B. Potential Transformers: ANSI C57.13; 120-volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- C. Ground Fault Sensor: Zero sequence type.
- D. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.
- E. **[DPM]:** Digital AC Power Monitor. Capable of measuring, calculating and directly displaying; Volts (L-L, L-N), Amps, KW, KWH. Monitor shall be true RMS measurement with programmable set-up parameters. All set-up parameters data shall be stored in non-volatile memory to protect from power outages.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install switchboard in locations shown on the drawings, in accordance with manufacturer's written instructions and NEMA PB 2.1.
- B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- C. Install fuses in each switch.

3.2 FIELD QUALITY CONTROL

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each. Test voltage shall be 1000 volts, and minimum acceptable value for insulation resistance is 2 megohms.
- C. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Tightness shall be in accordance with manufacturer's recommended values.
- D. Physically test key interlock systems to ensure proper function.

3.3 ADJUSTING AND CLEANING

- A. Adjust all operating mechanisms for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.
- C. Provide time/current trip curves for all adjustable protection devices that require setting. Also provide curves and equipment information for associated new and existing fixed devices that require coordination with new protection devices. Submit time/current curves in hard copy or electronic format.
- D. Adjust trip and time delay settings to values as scheduled, or as instructed by the Architect/Engineer.
- E. Where two levels of ground fault are provided, test ground fault circuit breakers to prove selective coordination in accordance with manufacturer's directions. Provide testing documentation with Operating & Maintenance Manual submittals.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Service and distribution panelboards: [DP-#]
- B. Lighting and appliance branch circuit panelboards: [Panel '###']
- C. Fusible branch circuit panelboards: [Panel '###']
- D. Load centers: [Panel '###']

1.2 RELATED SECTIONS AND WORK

- A. Refer to the One-Line Diagram and Panel Schedules for size, rating, and configuration.

1.3 REFERENCES

- A. NEMA AB 1 - Molded Case Circuit Breakers
- B. NEMA FU 1 – Low voltage cartridge fuses
- C. NEMA KS 1 - Enclosed Switches
- D. NEMA PB 1 - Panelboards
- E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
- F. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment
- G. UL 248 – Low-Voltage Fuses
- H. UL 67 - Panelboards

1.4 SUBMITTALS

- A. Submit shop drawings for equipment and component devices under provisions of Section 26 05 00.
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
- C. Selective coordination study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.

1.5 SPARE PARTS

- A. Keys: Furnish four (4) each to the Owner.
- B. Fuses: Furnish 10% or a minimum of three (3) spare fuses of each type and rating installed to the Owner.

- C. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

PART 2 - PRODUCTS

2.1 RATINGS

- A. Definitions:
 - 1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 26 05 53 for additional requirements.
 - 2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.
- B. The panelboards for this project shall be fully rated.

2.2 MAIN AND DISTRIBUTION PANELBOARDS

- A. General
 - 1. Approved Manufacturers:
 - a. Square D QMB, I-Line
 - b. General Electric Spectra ADS
 - c. Siemens F2, P4
 - d. Cutler Hammer PRL4, PRL5
- B. Panelboards: NEMA PB 1; type as shown on the drawings.
- C. Enclosure: NEMA PB 1; Type 1.
- D. Provide cabinet front with hinged trim on door to allow access to wiring gutters without removal of trim and flush lock. Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- F. All spaces shown on the one-line diagram shall be fully prepared spaces for future breakers.
- G. Minimum Integrated Short Circuit Rating: 100,000 amperes rms symmetrical for 240-volt panelboards; 50,000 amperes rms symmetrical for 480-volt panelboards, or as shown on the drawings.
- H. Fusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- I. Fuse Clips (Switches 600 Amperes and Smaller): Provide with Class 'R' rejection clips. Fuse Clips (601 Amperes and Larger): Designed to accommodate Class 'L' fuses.

- J. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
- K. Molded Case Circuit Breakers with Current Limiters: Provide circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.
- L. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- M. Solid State Molded Case Circuit Breakers: **(All breakers identified on plans as solid-state with 1,200 ampere frame sizes and below.)** Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with a sealable clear cover.
- N. Arc Energy Reduction:
 - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
 - 2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch at the entrance to the electrical room.
- O. Suitable for use as service entrance equipment.
- P. **[DPM]:** Digital AC Power Monitor. Capable of measuring, calculating and directly displaying; Volts (L-L, L-N), Amps, KW, KWH. Monitor shall be true RMS measurement with programmable set-up parameters. All set-up parameters data shall be stored in non-volatile memory to protect from power outages.

2.3 BRANCH CIRCUIT PANELBOARDS

- A. General
 - 1. Approved Manufacturers:
 - a. Square D NQ, NF
 - b. General Electric AQ, AE
 - c. Siemens P1
 - d. Cutler Hammer PRL1, PRL2
- B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.
- C. Enclosure: NEMA PB 1; Type 1.
- D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

- E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.
- G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.
- H. Minimum Integrated Short Circuit Rating: As shown on the drawings.
- I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.
- J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.
- K. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

2.4 FUSIBLE BRANCH CIRCUIT PANELBOARDS

- A. General
 - 1. Approved Manufacturers:
 - a. Bussmann
 - b. Littelfuse
 - c. Mersen MFCP
- B. Provide cabinet front with concealed hinge and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- C. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- D. Overcurrent protective devices shall be UL listed, with voltage, amperage, number of poles, and short-circuit current rating as shown on the panelboard schedule. Multi-pole branch circuit protection devices shall trip on an overcurrent of any pole to prevent single-phasing of the load.
- E. Fuse holder shall be finger-safe with trim installed. Fuses shall only be removable when terminals are not energized.
- F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future fuse units.

- G. All multiple-section panelboards shall have the same dimensional backbox and cabinet front size.
- H. Minimum Integrated Short Circuit Rating: As shown on the drawings.
- I. Branch fuse disconnect shall have visible ON/OFF indication, blown fuse indicating lights, and permanently installed lockout means.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.
- B. Height: 6 feet to handle of highest device.
- C. Provide filler plates for unused spaces in panelboards.
- D. Provide typed circuit directory for each branch circuit panelboard. Label each circuit with the type of load and the name and number of the area served. Revise directory to reflect circuit changes required to balance phase loads.
- E. Stub five (5) empty one-inch conduits to accessible location above ceiling out of each recessed panelboard.
- F. Install fuses in fusible switch assemblies.

3.2 FIELD QUALITY CONTROL

- A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

END OF SECTION

SECTION 26 24 19
MOTOR CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual motor starters
- B. Magnetic motor starters
- C. Combination magnetic motor starters
- D. Solid-state reduced voltage motor starters (soft starters)

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule and One-Line Diagram for rating and configuration.

1.3 REFERENCES

- A. ANSI/UL Standard 508. Standard for Industrial Control Equipment
- B. FCC Rules and Regulations, Part 15, Subpart J- Radio Frequency Interference
- C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service
- D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)
- E. FS W-P-115 - Power Distribution Panel
- F. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted
- G. IEEE Standard 519-1981 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters
- H. NEMA AB 1 - Molded Case Circuit Breakers
- I. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies
- J. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- K. NEMA KS 1 - Enclosed Switches
- L. NEMA PB 1 - Panelboards
- M. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or less

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 26 05 00.

- B. Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; wiring diagrams that differentiate between manufacturer-installed and field-installed wiring; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.
- C. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and over-current protective devices.
- D. Submit manufacturer's instructions under provisions of Section 26 05 00.

1.5 SPARE PARTS

- A. Keys: Furnish four (4) each to the Owner.
- B. Fuses: Furnish three (3) spare fuses of each type and rating installed to the Owner.
- C. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 26 05 00.
- B. Deliver in 60-inch maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.
- C. Store and protect products under provisions of Section 26 05 00.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from fumes, dirt, water, construction debris, traffic, and physical damage.
- E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 26 05 00.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

PART 2 - PRODUCTS

2.1 MANUAL MOTOR STARTERS

- A. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay, and toggle operator.

- B. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, and toggle operator.
- C. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, and toggle operator.
- D. Enclosure: NEMA ICS 6; Type 1.

2.2 MAGNETIC MOTOR STARTERS

- A. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- B. Full Voltage Starting: Non-reversing type, unless otherwise indicated.
- C. Coil Operating Voltage: 120 volts, 60 Hertz, obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating, and control devices, plus 100% spare capacity.
- D. Size: NEMA ICS 2; size as shown on the drawings.
- E. Overload Relay:
 - 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
- F. Enclosure: NEMA ICS 6; Type 1.
- G. Combination Motor Starters: Combine motor starters with disconnect switch in common enclosure. Provide with disconnecting means as indicated on drawings.
- H. Auxiliary Contacts: NEMA ICS 2; two normally open, field convertible contacts in addition to seal-in contact.
- I. Pushbuttons: NEMA ICS 2; START/STOP in front cover.
- J. Indicating Lights: NEMA ICS 2; RUN: red in front cover.
- K. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.
- L. Relays: NEMA ICS 2.
- M. Control Power Transformers: 120 volt fused secondary, fused primary, minimum VA as scheduled:
 - Size 1 - 100 VA
 - Size 2 - 100 VA
 - Size 3 - 150 VA
 - Size 4 - 300 VA
 - Size 5 - 300 VA
 - Size 6 - 300 VA

- N. Provide phase loss protection relay with contacts to de-energize the starter for each starter serving motors 5 HP or greater.

2.3 SOLID-STATE REDUCED VOLTAGE MOTOR STARTERS (SOFT STARTERS)

- A. Soft Starters: ANSI/UL Standard 508. Used with NEMA Design B, AC induction motors to reduce in-rush current and mechanical shocks associated with starting and stopping motors.
- B. Operation: The soft starter shall utilize a thyristor (SCR) bridge to control the starting and stopping of the motor. A microprocessor shall monitor the current and control the phasing of the SCRs. The soft starter shall provide torque control for linear acceleration without external feedback independent of motor load or motor application.
- C. Torque ramp: Adjustable (by keypad) from 1 to 60 seconds.
- D. Shorting Contactor: A shorting contactor shall be supplied with all soft starters rated above 40 amps. The shorting contactor shall close after the current is below 130% of motor full-load amps at the nominal voltage. The shorting contactor shall open on a stop command to allow a deceleration ramp, if applicable.
- E. Status & Diagnostics: Door-mounted keypad for display of soft starter, motor, and fault statuses.
- F. Motor Protection against Solid-State Component Failure: Provide an isolation contactor that opens when the motor is stopped or when the controller detects a fault condition such as a shorted thyristor.
- G. Over-Current Protection Device / Power Disconnect: Integral molded case disconnect switch and in-line fuse block for RK type power fuses (up to 600 amps). Short circuit current rating shall be 65,000 AIC minimum or as indicated on drawings.
- H. Overcurrent Condition: The soft starter shall be capable of supplying 300% of rated full load current for 30 seconds at maximum ambient temperature.
- I. Electronic Protective Features: Thermal overload protection, phase reversal protection, stall protection, locked rotor protection, and underload protection. The display shall also indicate a starter thermal fault, phase fault, frequency fault, external fault, maximum start time exceeded, serial link fault, and internal failure.
- J. Controls: The control circuitry shall be fed internally from the line supply, completely independent of the power circuit and separate from the control logic. The control circuitry shall operate at 120 VAC via an integral control power transformer.
- K. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.
- L. Input: Remote control start/stop signal, and one logic input for force to freewheel, indication of external fault, force to local control, or remote overload reset.
- M. Outputs: Isolation contactor status, torque ramp status, overload pre-alarm, fault alarms, and one field convertible auxiliary contact. One analog output shall be available for 4-20mA indication of motor current, torque, thermal state, or power factor.

- N. Current and Horsepower Ratings: As indicated in the Starter/Disconnect Schedule on the drawings.
- O. Input/Output Voltage: As indicated in the Starter/Disconnect Schedule on the drawings. The controller shall be capable of operating between -15% to +10% of nominal voltage rating.
- P. Environmental Characteristics: Ambient Air Temperature: 0°C to 40°C; Maximum Relative Humidity: 93% (non-condensing); Minimum Elevation without Derating: 3300 feet.
- Q. Enclosure: NEMA ICS 6; Type 12, with provisions for padlocking the door.

2.4 CONTROLLER OVER-CURRENT PROTECTION AND DISCONNECTING MEANS

- A. Molded Case Thermal-Magnetic Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole. NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- B. Non-fusible Switch Assemblies: Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- C. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Provide with Class 'R' rejection clips. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions on concrete bases.
- B. Install fuses in fusible switches.
- C. Select and install heater elements in motor starters to match installed motor characteristics.
- D. Set field-adjustable switches and circuit-breaker trip ranges.
- E. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
- F. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Device plates and box covers
- B. Modular connectors
- C. Receptacles
- D. Pendant cord/connector devices
- E. Cord and plug sets
- F. Cord reel

1.2 QUALITY ASSURANCE

- A. Provide similar devices from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC Article 100, by a testing agency to Authorities Having Jurisdiction and marked for intended use.
- C. Comply with the NEC.

1.3 REFERENCES

- A. DSCC W-C-896F – General Specification for Electrical Power Connector
- B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet
- C. NEMA WD 1 – General Color Requirements for Wiring Devices
- D. NEMA WD 6 – Wiring Devices – Dimensional Requirements
- E. NFPA 70 - National Electrical Code (NEC)
- F. UL 498 – Standard for Attachment Plugs and Receptacles
- G. UL 943 – Standard for Ground Fault Circuit Interrupters

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.
- C. Submit manufacturer occupancy sensor coverage patterns applicable to this project. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.

1.5 COORDINATION

- A. Receptacles for Owner Furnished Equipment: Match plug configurations.
- B. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 DEVICE COLOR

- A. All switch, receptacle, outlet, and coverplate colors shall be gray, unless indicated otherwise.

2.2 COVERPLATES

- A. All switches, receptacles, and outlets shall be complete with the following:
 - 1. #302 stainless steel coverplates in finished spaces where walls are finished.
 - 2. #302 stainless steel coverplates in unfinished spaces for flush boxes.
 - 3. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.
- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 26 05 53.
- D. Plate securing screws shall be metal with head color matching the wall plate finish.

2.3 RECEPTACLES

- A. Refer to Electrical Symbols List for device type.
- B. Devices that are shaded on the drawings shall be red.
- C. **[REC-DUP]:** NEMA 5-20R Duplex Receptacle:
 - 1. 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap with integral ground contacts.
 - 2. Approved Manufacturers: Hubbell 5362, Leviton 5362, Pass & Seymour 5362A, Cooper AH5362.
- D. **[REC-DUP-GFI]:** NEMA 5-20R Ground Fault Duplex Receptacle:
 - 1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.
 - 2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
 - 3. Approved Manufacturers: Hubbell GF20L, Leviton GFNT2, Pass & Seymour 2097, Cooper SGF20.
- E. **[REC-DUP-GFI-R]:** Remote Ground Fault Device:
 - 1. Ground fault device for remote downstream receptacles. 125-volt, 20 amp. Test and reset buttons in impact resistance thermoplastic face.

2. Approved Manufacturers: Hubbell GFBF20, Leviton 6895, Pass & Seymour 2085, Cooper VGFD20.
- F. **[REC-DUP-WP]:** NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face. Provide NEMA 3R rated while-in-use cast aluminum cover.
 2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
 3. Approved Manufacturers: Hubbell GFTR20/(RW57300) WP826, Leviton GFWT2/(5977-CL) M5979, Pass & Seymour 2097TRWR/(WIUC10-C) WIUCAST1, Cooper WRS GF20/(WIU-1) WIUMV-1.
- G. **[REC-DUP-XP]:** NEMA 5-20R Explosion Proof Duplex Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type, Class 1, Division 1 rated. Spring-loaded cover with gasket. Mount in cast box with threaded openings.
 2. Approved Manufacturers: Appleton EFSC175, Crouse-Hinds ENRC21201, Killark UGR5-20231.
- H. **[REC-USB]:** NEMA 5-20R Receptacle with USB Charger:
1. 125-volt, 20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Type A USB charging rated at 5VDC 2.1A. Mounted in double gang backbox.
 2. Approved Manufacturers: Hubbell USB20X2, Pass & Seymour TR5362USB, Cooper TR7766.
- I. **[REC-ARC]:** NEMA 5-20R Receptacle with Arc Fault Circuit Interrupts
1. 125-volt, 20 amp, 3-wire grounding type hospital grade, arc fault circuit interrupter receptacle with test and reset buttons in impact resistant thermoplastic face.
 2. Approved Manufacturers: Leviton AFTR2.
- J. **[REC-SIM-520R]:** NEMA 5-20R Simplex Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL5361, Leviton, 5361, Pass & Seymour 5361, Cooper 5361.
- K. **[REC-SIM-530R]:** NEMA 5-30R Simplex Receptacle:
1. 125-volt, 30 amp, 3-wire grounding type, phenolic face.
 2. Approved Manufacturers: Hubbell HBL9308, Leviton 5371, Pass & Seymour 3802, Cooper 5716N.

- L. **[REC-SIM-550R]**: NEMA 5-50R Simplex Receptacle:
1. 125-volt, 50 amp, 3-wire grounding type, phenolic face.
 2. Approved Manufacturers: Hubbell HBL9360, Cooper 1253.
- M. **[REC-SIM-620R]**: NEMA 6-20R Simplex Receptacle:
1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL5461, Leviton 5461, Pass & Seymour 5871, Cooper 5461.
- N. **[REC-SIM-630R]**: NEMA 6-30R Simplex Receptacle:
1. 250-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL9330, Leviton 5372, Pass & Seymour 3801, Cooper 5700N.
- O. **[REC-SIM-650R]**: NEMA 6-50R Simplex Receptacle:
1. 250-volt, 50 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL9367, Leviton 5374, Pass & Seymour 3804, Cooper 5709N.
- P. **[REC-SIM-720R]**: NEMA 7-20R Simplex Receptacle:
1. 277-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour 7621.
- Q. **[REC-SIM-730R]**: NEMA 7-30R Simplex Receptacle:
1. 277-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL9315, Leviton 9730-A, Pass & Seymour, Cooper 5795N.
- R. **[REC-SIM-750R]**: NEMA 7-50R Simplex Receptacle:
1. 277-volt, 50 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL9365, Leviton 9750-A, Pass & Seymour, Cooper.
- S. **[REC-SIM-1420R]**: NEMA 14-20R Simplex Receptacle:
1. 125/250-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL8410, Pass & Seymour 3820, Cooper 5759.

- T. **[REC-SIM-1430R]:** NEMA 14-30R Simplex Receptacle:
1. 125/250-volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face. Flush mounted at +24 AFF.
 2. Approved Manufacturers: Hubbell HBL9430A, Leviton 278, Pass & Seymour 3864, Cooper 5744N.
- U. **[REC-SIM-1450R]:** NEMA 14-50R Simplex Receptacle:
1. 125/250-volt, 50 amp, 3-pole, 4-wire grounding type with thermoplastic face. Flush mounted at +4" AFF.
 2. Approved Manufacturers: Hubbell HBL9450A, Leviton 279, Pass & Seymour 3894, Cooper 5754N.
- V. **[REC-SIM-1460R]:** NEMA 14-60R Simplex Receptacle:
1. 125/250-volt, 60 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL9460A, Leviton 9460, Pass & Seymour, Cooper 9460N.
- W. **[REC-SIM-1520R]:** NEMA 15-20R Simplex Receptacle:
1. 250-volt, 20 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL8420, Leviton, Pass & Seymour, Cooper.
- X. **[REC-SIM-1530R]:** NEMA 15-30R Simplex Receptacle:
1. 250-volt, 30 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL8430A, Leviton 8430, Pass & Seymour 5740, Cooper 8430N.
- Y. **[REC-SIM-1550R]:** NEMA 15-50R Simplex Receptacle:
1. 250-volt, 50 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL8450A, Leviton 8450, Pass & Seymour 5750, Cooper 8450N.
- Z. **[REC-SIM-1560R]:** NEMA 15-60R Simplex Receptacle:
1. 250-volt, 60 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL9460A, Pass & Seymour 5760, Cooper 8460N.
- AA. **[REC-SIM-L520R]:** NEMA L5-20R Simplex Receptacle, Locking Type:
1. 125-volt, 20 amp, 2-pole, 3-wire grounding type with impact resistant thermoplastic face.

2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour L520, Cooper CWL520R.
- BB. **[REC-SIM-L530R]**: NEMA L5-30R Simplex Receptacle Locking Type:
1. 125-volt, 30 amp, 2-pole, 3-wire grounding type with impact resistant thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour L530, Cooper CWL530R.
- CC. **[REC-SIM-L620R]**: NEMA L6-20R Locking Type Simplex Receptacle:
1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL2320, Leviton 2320, Pass & Seymour L620R, Cooper CWL620R.
- DD. **[REC-SIM-L630R]**: NEMA L6-30R Locking Type Simplex Receptacle:
1. 250-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL2620, Leviton 2620, Pass & Seymour L630R, Cooper CWL630R.
- EE. **[REC-SIM-L720R]**: NEMA L7-20R Locking Type Simplex Receptacle:
1. 277-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL2330, Leviton 2330, Pass & Seymour L720R, Cooper CWL720R.
- FF. **[REC-SIM-L730R]**: NEMA L7-30R Locking Type Simplex Receptacle:
1. 277-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL2630, Leviton 2630, Pass & Seymour L730R, Cooper CWL730R.
- GG. **[REC-SIM-L1420R]**: NEMA L14-20R Locking Type Simplex Receptacle:
1. 125/250-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL 2410, Pass & Seymour L1420, Cooper CWL1420R.
- HH. **[REC-SIM-L1430R]**: NEMA L14-30R Locking Type Simplex Receptacle:
1. 125/250-volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL 2710, Leviton 2710, Pass & Seymour L1430R, Cooper CWL1430R.

- II. **[REC-SIM-L1520R]**: NEMA L15-20R Locking Type Simplex Receptacle:
1. 250-volt, 20 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL2420, Leviton 2420, Pass & Seymour L1520R, Cooper CWL1520R.
- JJ. **[REC-SIM-L1530R]**: NEMA L15-30R Locking Type Simplex Receptacle:
1. 250-volt, 30 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL2720, Leviton 2720, Pass & Seymour L1530R, Cooper CWL1530R.
- KK. **[REC-SIM-L1620R]**: NEMA L16-20R Locking Type Simplex Receptacle:
1. 480-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL2431, Pass & Seymour L1620R, Cooper CWL1620R.
- LL. **[REC-SIM-L1630R]**: NEMA L16-30R Locking Type Simplex Receptacle:
1. 480-volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell HBL2730, Leviton 2730, Pass & Seymour L1630R, Cooper CWL1630R.
- MM. **[REC-SIM-L2120R]**: NEMA L21-20R Locking Type Simplex Receptacle:
1. 120/208Y 3 phase 20-amp 5 wire grounding type.
 2. Approved Manufacturers: Hubbell HBL2510, Cooper CWL2120R, Pass & Seymour L2120R.
- NN. **[REC-SIM-L2130R]**: NEMA L21-30R Locking Type Simplex Receptacle:
1. 120/208Y 3 phase 30-amp 5 wire grounding type.
 2. Approved Manufacturers: Hubbell HBL2750, Cooper CWL2130R, Pass & Seymour L2130R.
- OO. **[REC-SIM-XP]**: NEMA 5-20R Explosion Proof Simplex Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type, Class 1, Division 1, Group C rated. Factory sealed, dead end.
 2. Approved Manufacturers: Appleton CPE1-2375, Crouse-Hinds CPS152201, Killark KRS-215-220.
- PP. **[REC-TAMP]**: NEMA 5-20R Tamper Resistant Duplex Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.

2. Approved Manufacturers: Hubbell BR20TR, Leviton TBR20, Pass & Seymour TR5362, Cooper TRBR20.
 3. Provide decorative style duplex tamper resistant receptacles in public spaces where walls are finished.
 4. Approved Manufacturers: (Decorative), Hubbell DR20TR, Leviton TDR20, Pass & Seymour TR2635.
- QQ. **[REC-TAMP-GFI]:** NEMA 5-20R GFI Tamper Resistant Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type tamper-resistant with test and reset buttons in impact resistant thermoplastic face.
 2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
 3. Approved Manufacturers: Hubbell GFTR20, Cooper TRSGF20, Pass & Seymour 2097TR, Leviton GFTR2.
- RR. **[REC-TAMP-QUAD]:** NEMA 5-20R Double Duplex Tamper Resistant Receptacle:
1. Consists of two duplex tamper resistant receptacles, double gang box, plaster ring and faceplate.
 2. Approved Manufacturers: Refer to Tamper Resistant Receptacle above.
- SS. **[REC-DUP-O]:** NEMA 5-20R Plug Load Controlled Duplex Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap. Bottom half of duplex shall be split circuit wired and controlled by remote relay. Controlled receptacle shall have permanent NEMA approved and NEC 2014 compliant marking on face of device.
 2. Approved Manufacturers: Pass & Seymour 5362H, Leviton 5362-1P, Hubbell, Cooper.
- TT. **[REC-QUAD-O]:** NEMA 5-20R Plug Load Controlled Duplex Receptacle:
1. Consists of two duplex tamper resistant receptacles, double gang box, plaster ring and faceplate.
 2. Approved Manufacturers: Refer to Plug Load Controlled Duplex Receptacles above.
- UU. **[REC-QUAD]:** NEMA 5-20R Double Duplex Receptacle:
1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.
 2. Approved manufacturers: Refer to Duplex Receptacle above.
- VV. **[REC-QUAD-GFI]:** NEMA 5-20R Double Duplex GFI Receptacle:
1. Consists of two duplex GFI receptacles, double gang box, plaster ring and faceplate.

2. Approved Manufacturers: Refer to Duplex GFI Receptacle above.
- WW. **[REC-QUAD-USB]:** NEMA 5-20R Double Duplex USB Receptacle:
1. Consists of two duplex USB receptacles, double gang box, plaster ring and faceplate.
 2. Approved Manufacturers: Refer to USB Receptacle above.
- XX. **[REC-QUAD-WP]:** NEMA 5-20R Weatherproof Ground Fault Quad Receptacle:
1. Consists of two duplex, GFI receptacles. Double gang box. Provide NEMA 3R rated while-in-use cast aluminum cover.
 2. Approved Manufacturers:
 - a. Receptacle: Refer to GFCI Receptacle above.
 - b. Cover: Intermatic WP1030MXD, Pass & Seymour WIUCAST2, Thomas & Betts Red Dot 2CKU.
- YY. **[REC-XR#]:** 600-volt, 60 amp, 3-pole, 4-wire Locking Type Simplex Receptacle for X-ray Isolated Power Equipment:
1. Black nylon or polycarbonate face. Cast aluminum surface mounted box, 45° angle adapter, weather protective lift cover on receptacle.
 2. Approved Manufacturers: Hubbell HBL26410-RECP/HBL26401-BOX/HBL26404-ADAPTER, Pass & Seymour 26420/26401/26404, Cooper 26420/26401/26404.
- ZZ. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.
- AAA. Side wired devices shall have four binding screws that are undercut for positive wire retention.
- BBB. Ground fault circuit interrupter (GFCI) receptacles shall comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.
- CCC. Isolated ground receptacles shall have the equipment ground contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from the mounting strap.
- DDD. Integral surge suppression receptacles with integral surge suppression shall comply with the following:
1. Category A3 listed.
 2. Line to ground, line to neutral, and neutral to ground modes.
 3. Metal-oxide varistors with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 210 joules per mode.

4. Status indication: Light visible in the face of the device and audible alarm to indicate device is no longer active or in service.
5. Distinctive symbol on device face to denote SPD-type device.
6. Device shall be blue with stainless coverplate.
7. NEMA 5-20R duplex receptacle, 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap.
 - a. Approved Manufacturers: Hubbell HBL5362SA, Leviton, Pass & Seymour, Cooper.

EEE. Hazardous (Classified) location receptacles shall comply with NEMA FB 11.

2.4 PENDANT CORD/CONNECTOR DEVICES

- A. Description: Matching, locking type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, heavy-duty grade or refer to Details as shown on drawings.
 1. Body: Nylon with screw-open cable gripping jaws and provisions for attaching external cable grip.
- B. External Cable Grip: Woven wire mesh type made of high strength galvanized steel wire stand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.5 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 1. Cord: Rubber-insulated, stranded copper conductors, with Type SOW-A jacket; with green insulated grounding conductor and equipment rating ampacity plus a minimum of 30 percent.
 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection, FS/UL listed.

2.6 CORD REELS

- A. **[CR-1]**: 50' 3#12 AWG type 'SOW-A' cord with adjustable ball stop. 120 volt, NEMA 5-20R, simplex receptacle connector, rated 16 amps continuous.
 1. Approved Manufacturers:
 - a. Daniel Woodhead 92433, 9521 w/ Hubbell 5369CY
 - b. Appleton RL153L
 - c. Hubbell HBL HBL45123C20

- B. **[CR-2]:** 25' 3#16 AWG type 'SJOW-A' cord with adjustable ball stop. Two 120-volt NEMA 5-15R receptacles mounted in cast outlet box, rated 10 amps.
 - 1. Approved Manufacturers:
 - a. Daniel Woodhead 925
 - b. Appleton RL2510
 - c. Hubbell HBLC25163C

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install light switches, dimmers, and convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.
- B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.
- C. Drill opening for poke-through fitting installation in accordance with manufacturer's instructions. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This may include X-ray or similar non-destructive means.
- D. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.
- E. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.
- F. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.
- G. Install devices and wall plates flush and level.
- H. Contractor to verify that wall dimmer ratings are achieved where a ganged installation is used.
- I. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 26 05 53 - Electrical Identification.
- J. Identify locations of power packs, control units, and relays above ceiling on record drawing.
- K. Test receptacles for proper polarity, ground continuity and compliance with requirements.
- L. Healthcare devices shall be tested in accordance with NFPA 99 6.3.3 for grounding, voltage, and impedance measurements.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fuses
- B. Spare Fuse Cabinet

1.2 REFERENCES

- A. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Types
- B. UL 198E - Class R Fuses
- C. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)
- D. NEMA FU 1 - Low Voltage Cartridge Fuses
- E. NFPA 70 – National Electrical Code

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.

1.4 EXTRA MATERIALS

- A. Provide two fuse pullers.
- B. Provide three of each size and type of fuse installed.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40°F (5°C) or more than 100°F (38°C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – FUSES

- A. Cooper Bussman
- B. Eagle Electric Mfg. Co.; Cooper Industries
- C. Mersen
- D. Tracor; Littelfuse Subsidiary

2.2 FUSES

- A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
- B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

- C. Fuses with ratings larger than 600 amperes: Class L (time delay), unless otherwise noted on the drawings.
- D. Fuses with ratings larger than 200 amperes but equal to or less than 600 amperes: Class RK-1 (time delay), unless otherwise noted on the drawings.
- E. Fuses with ratings less than or equal to 200 amperes (not including control transformer fuses): Class RK-5, unless otherwise noted on the drawings.
- F. Control transformer fuses: Class CC (time delay).
- G. Fuses for packaged equipment: Size and type as recommended by equipment manufacturer.

2.3 SPARE FUSE CABINET

- A. Cabinet: Wall-mounted, 0.05-inch- (1.27-mm-) thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses where indicated on the drawings and specifications.
- B. Install fuses in accordance with manufacturer's instruction.
- C. Install fuses in packaged equipment as required by equipment manufacturer.
- D. Install fuse with label oriented such that manufacturer, type, and size are easily read.
- E. Install spare fuse cabinet in the Main Electrical Room.

END OF SECTION

SECTION 26 28 16

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fusible switches
- B. Non-fusible switches
- C. Molded case circuit switches
- D. Molded case switches
- E. Motor disconnect switch
- F. Mechanically interlocked disconnect
- G. Enclosures

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule for rating and configuration.

1.3 REFERENCES

- A. NEMA KS 1 - Enclosed Switches

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Product Data: For each type of enclosed switch, circuit breaker, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.
- C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.5 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE AND NON-FUSIBLE SWITCHES

- A. **[FDS-#]:** Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.

- B. **[DS-#]:** Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- C. Enclosures: Type as indicated on the disconnect schedule.
- D. Accessories: As indicated on the disconnect schedule.

2.2 MOLDED CASE CIRCUIT BREAKERS AND SWITCHES

- A. **[CB-#]:** Molded Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
 - 1. Thermal Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip settings.
 - 3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t responses.
 - 4. Current Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
- B. **[CB-#]:** Molded Case Switches: Molded case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Accessories: As indicated on the disconnect schedule.

2.3 MOTOR DISCONNECT SWITCH

- A. **[DS-#]:** Rotary Switch Assemblies: Rated for making and breaking loads, rotary type enclosed switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- B. Enclosures: Type as indicated on the Disconnect Schedule.
- C. Ground lug connection provided in enclosure.
- D. Accessories: As indicated on the Disconnect Schedule.
- E. Listed UL 508 suitable for motor control.

2.4 MECHANICALLY INTERLOCKED DISCONNECT

- A. **[DSS-#]:** Switch and Plug Assemblies: Rated for making and breaking loads, enclosed switch with externally operable interlock to prevent disconnecting receptacle with switch in ON position or inserting receptacle in ON position. Padlock lockable provision to meet OSHA lockout/tagout regulations.
- B. Enclosures: Type as indicated on the Disconnect Schedule.
- C. Ground lug connection provided in enclosure.
- D. Accessories: Matching male pin and sleeve plug, two auxiliary/pilot contacts.
- E. Listed UL 2682 suitable for motor disconnect.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches where indicated on the drawings.
- B. Install fuses in fusible disconnect switches.
- C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

3.2 ADJUSTING

- A. Set field-adjustable circuit breaker trip ranges.

END OF SECTION

SECTION 26 28 21

CONTACTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General-purpose contactors
- B. Lighting contactors
- C. Enclosures

1.2 RELATED SECTIONS AND WORK

- A. Refer to Lighting Contactor Schedule.

1.3 REFERENCES

- A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- B. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies
- C. UL 508 - Industrial Control Equipment

1.4 SUBMITTALS

- A. Submit shop drawings under provisions of Section 26 05 00.
- B. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, and poles.
- C. Submit manufacturer's instructions under provisions of Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Schneider Electric
- B. Eaton Corporation
- C. G.E.
- D. ASCO

2.2 [C-#]: GENERAL-PURPOSE CONTACTORS

- A. Contactors: NEMA ICS 2 and UL 508; electrically held, 2-wire control.
- B. Coil Operating Voltage: 120 volts, 60 Hertz.
- C. Size: NEMA ICS 2; size as indicated on the drawings.
- D. Contacts: 600 volts, 60 Hertz.
- E. Enclosure: ANSI/NEMA ICS 6; Type 1.

- F. Provide solderless pressure wire terminals.

2.3 [LC-#]: LIGHTING CONTACTORS

- A. Contactors: NEMA ICS 2 and UL 508; electrically held, 2-wire control.
- B. Coil Operating Voltage: 120 volts, 60 Hertz.
- C. Contacts: As indicated on the drawings.
- D. Enclosure: ANSI/NEMA ICS 6; Type 1.
- E. Provide solderless pressure wire terminals.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction boxes: and equipment enclosures.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

END OF SECTION

SECTION 26 41 00

LIGHTNING PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Air terminals and interconnecting conductors
- B. Grounding and bonding for lightning protection

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Section 26 05 26 - Grounding and Bonding
- B. Section 26 43 00 - Surge Protection Devices

1.3 REFERENCES

- A. ANSI/NFPA 780 - Lightning Protection Code
- B. ANSI/UL 96 - Lightning Protection Components
- C. UL 96A - Installation Requirements for Lightning Protection Systems

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 26 05 00.
- B. Shop drawings shall indicate layout of air terminals, grounding electrodes, and bonding connections to structure, ground grid, and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details. Include indications for use of raceway and type, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- C. Product data shall show dimensions and materials of each component, and include indication of listing in accordance with ANSI/UL 96 or a nationally recognized testing laboratory.
- D. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL or LPI.
- E. Submit manufacturer's installation instructions under provisions of Section 26 05 00.
- F. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.
- G. Field inspection reports indicating compliance with specified requirements.

1.5 SYSTEM DESCRIPTION

- A. Lightning Protection System: System protecting all buildings and landfill gas conditioning equipment on site, consisting of air terminals on roofs, roof-mounted mechanical equipment, chimneys and stacks, parapets, bonding of structure, gas conditioning

equipment, and other metal objects; grounding electrodes; and interconnecting conductors. Class I materials shall be used for systems on structures not exceeding 75 feet in height. Class II materials shall be used for systems on structures exceeding 75 feet in height above grade.

- B. Performance Statement: This specification and the accompanying roof plans describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every air terminal, conductor, and connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all equipment and wiring required for a complete and operational system.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit project record documents under provisions of Section 26 05 00.
- B. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.
- C. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in lightning protection equipment with minimum three (3) years documented experience or who is listed by a nationally recognized testing laboratory.
- B. Installer: Authorized installer of manufacturer with minimum three (3) years documented experience.
- C. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.8 PRE-INSTALLATION CONFERENCE

- A. Convene a pre-installation conference prior to commencing work of this Section.

1.9 SEQUENCING AND SCHEDULING

- A. Coordinate work under provisions of Section 26 05 00.
- B. Coordinate the work of this Section with exterior and interior finish installations. Coordinate painting of exposed conduits to match building finish with Architect.
- C. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- D. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Heary Brothers Lightning Protection Co., Inc.
- B. Thompson Lightning Protection.
- C. Harger Lightning Protection.
- D. Robbins Lighting, Inc.
- E. Erico International Corporation.
- F. Burndy Thermoweld
- G. VFC Lightning Protection

2.2 MATERIALS

- A. All materials shall be copper and/or copper-bronze. In locations where the system components are mounted on aluminum surfaces, aluminum materials shall be used to avoid electrolytic corrosion of dissimilar metals.
- B. Components: In accordance with ANSI/UL 96 or nationally recognized testing laboratory.
- C. Air Terminals: Solid, unless otherwise indicated. Provide air terminals with safety 3/4" sphere tip. Provide swivel adapters to plumb air terminals when mounting on sloping surfaces.
- D. Air Terminal for Chimney: Lead-coated copper.
- E. Grounding Rods: Copper clad steel.
- F. Ground Plate: 18"x18"x0.032" Copper ground plate.
- G. Connectors and Splicers: Bronze, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify that field measurements are as shown on the shop drawings.
- C. Beginning of installation means installer accepts existing conditions.

3.2 PROTECTION OF SURROUNDING ELEMENTS

- A. Protect elements surrounding work of this Section from damage or disfiguration.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with ANSI/NFPA 780, UL 96A, and LPI-175.
- C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

- D. Conceal the following conductors:
 - 1. System conductors.
 - 2. Down conductors.
 - 3. Interior conductors.
 - 4. Conductors within normal view from exterior locations at grade within 200 feet (60 m) of building.
 - 5. Notify Architect/Engineer at least 48 hours in advance of inspection before concealing lightning protection components.
- E. Bond extremities of metal bodies exceeding 60 feet (18 m) in vertical length to structural steel members.
- F. Provide a ground ring electrode that meets or exceeds minimum requirements in NFPA 780.
 - 1. Bond ground terminals to ground ring electrode.
 - 2. Bond grounded metal bodies on building within 12 feet (3.6 m) of ground to ground ring electrode.
 - 3. Bond grounded metal bodies on building within 12 feet (3.6 m) of roof to interconnecting loop at eave level or above.
- G. Structures exceeding 60 feet in height: Bond lightning protection components with intermediate-level interconnection loop conductors to down conductors and other grounded media at maximum 60-foot (18-m) intervals.

3.4 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.
- C. Bi-metal transition fittings shall be used when changing between aluminum and copper conductors.

3.5 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 26 05 00.
- B. Obtain the services of Underwriters' Laboratories, Inc. to provide inspection and certification of the lightning protection system under provisions of UL 96A to obtain a UL Master Label for system.
- C. Install UL Master Label and attach to building at location directed by the Owner.
- D. Provide an inspection by an inspector certified by LPI to obtain an LPI certification.

END OF SECTION

SECTION 26 43 00

SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes materials and installation requirements for low voltage surge protection devices (SPD) for the protection of all AC electrical circuits. SPD equipment to be installed at designated service entrance equipment, distribution panels, and electronic equipment.

1.2 QUALITY ASSURANCE

- A. The specified unit shall be designed, manufactured, tested and installed in compliance with the above references. The unit shall be "Listed by Underwriters Laboratories" to UL 1449.
- B. Each unit shall be designed and manufactured by a qualified manufacturer of power conditioning equipment. The qualified manufacturer must have been engaged in the design and manufacturer of such products for a minimum of five years.

1.3 REFERENCES

- A. ANSI/IEEE C62.33 – IEEE Guide on Testing of MOV components
- B. ANSI/IEEE C62.35 – IEEE Guide on Testing of SAD components
- C. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits
- D. ANSI/IEEE C62.45 - IEEE Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits
- E. ANSI/UL 1449 Third Edition (Version 3.0) - UL Standard for Safety for Surge Protective Devices
- F. CBEMA – Computer Business Equipment Manufacturers Association
- G. IEC 664 – International Engineering Consortium, Standard for Clamping Voltage
- H. National Electrical Code 285 - Surge Protection Devices
- I. NFPA 70 - National Electrical Code
- J. UL 67 – Listed for Internal Panelboard Transient Voltage Surge Suppressors
- K. UL 96A – Devices listed as approved for secondary surge arrestors (VZCA)
- L. UL 248-1 - Fusing
- M. UL 1283 – Electromagnetic Interference Filters, Fifth Edition

1.4 SUBMITTALS

- A. Shop Drawings: Should include device dimensions, mounting requirements including wire size and over-current protection device rating, nameplate nomenclature, electrical ratings, short circuit current rating, and test results as indicated below under “Testing, Warranty and Life Expectancy” as provided by an independent test lab or a UL certified test lab for the category(ies) of suppression device(s) specified using the appropriate IEEE test wave. Product data sheets with installation instructions for each size and type of device are required. Shop drawings submitted without the testing data as required by section this section will be rejected.
- B. Fuse information: Provide fuse information if required for operation. Include size, manufacturer, time-current chart responses to UL 1449 testing requirements, maximum surge protection capability per mode and phase as limited by the fuse, and verification of repetitive surge protection device operation without system degeneration greater than 10%.

1.5 SPARE PARTS

- A. Fuses: Furnish to the Owner 3 spare fuses of each type and rating installed.

1.6 TESTING, WARRANTY AND LIFE EXPECTANCY

- A. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.
 - 1. Single pulse surge current capacity: Single pulse surge current tested in a mode at rated surge currents.
 - 2. Single pulse surge current capacity test: An initial UL 1449 defined 1.2 x 50 μ s, 6000V open circuit voltage waveform and an 8 x 20 μ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit’s suppression voltage (VPR).
 - 3. A single 8 x 20 μ s waveform pulse of maximum rated surge current per mode shall then be applied. To complete the test, another UL 1449 surge shall be applied to verify the unit’s survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.
- B. Minimum Repetitive Surge Current Capacity:
 - 1. Service entrance suppressor units should be tested repetitively at an independent lab to verify repetitive capacity.
 - 2. Minimum Repetitive Surge Current Capacity Test:
 - a. An initial UL 1449 surge defined as 1.2 x 50 μ s, 6000V open circuit voltage waveform and an 8 x 20 μ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit’s suppression voltage.

- b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges, defined as a 1.2 x 50µs 10kV or 20kV open circuit voltage waveform and an 8 x 20µs 10,000A short circuit current waveform, shall then be applied at one-minute intervals.
 - c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.
 - 3. Survival is achieved if the suppression voltage (VPR) does not vary by more than 10%.
 - 4. Proof of such testing shall be the test log generated by the surge generator.
- C. Provide UL 1449 classification white sheet pages indicating the VPR (voltage protection rating) for each SPD unit submitted for this product using the 6kV/3kA combination wave surge.
- D. Warranty: Ten (10) years. Includes workmanship, installation and programming.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- A. General: The unit shall provide transient voltage suppression, surge current diversion and high-frequency noise attenuation, when connected in parallel to the facilities distribution system. The unit MCOV shall not be less than 115% of the nominal system voltage. Operating frequency shall be for a 60 Hz system. The unit shall provide protection in all normal modes for "wye" and "delta" systems. The short circuit current rating shall be the larger of the listed value on the drawings or as required by the equipment protected.

2.2 RATINGS

- A. **[SPD-#]: Service Entrance Suppressors:**
 - 1. For 277/480-volt, 3 phase, 4 wire, type 2, category C3 unit.
 - a. Surge current capacity: 100,000/200,000 amps per protection mode/phase
 - b. Nominal Discharge Current: 20 kA.
 - c. Mounting: Refer to the drawings.
 - d. Voltage Protection Rating: Refer to requirements below.
 - e. Components: Minimum component size of 20mm metal oxide varistors (MOV).
 - f. Disconnect: Surge-rated disconnect with 200,000 SCCR.
 - 2. Approved Manufacturers:
 - a. Square D Surelogic EMA Series
 - b. Siemens TPS3 Series

- c. Cutler Hammer SPD Series
- d. Current Technology Current Guard Plus
- e. Emerson Network Power 560 Series
- f. LEA International LSS Series

B. **[SPD-#]: Secondary Distribution Suppressors:**

1. For 277/480-volt, 3 phase, 4 wire, type 2, category B3/C1 unit.
 - a. Surge current capacity: 100,000/200,000 amps per protection mode/phase
 - b. Nominal Discharge Current (I_N): 20 kA.
 - c. Mounting: Refer to the drawings.
 - d. Voltage Protection Rating: Refer to requirements below.
 - e. Components: Minimum component size of 20mm metal oxide varistors (MOV).
2. Approved Manufacturers:
 - a. Square D Surgelocic EMA Series
 - b. Siemens/APT TPS3 Series
 - c. Cutler Hammer SPD Series
 - d. Current Technology Current Guard Plus
 - e. Emerson Network Power 510 Series
 - f. LEA International CFS Series

C. **Voltage Protection Rating:**

1. Protection modes and UL 1449 voltage protection rating for surge suppression units per each mode (L-N, L-L, L-G, and N-G as appropriate).
 - a. 277/480 Volt, 3 phase, 4 wire. 1200 Volt L-N, L-G, N-G and 1800 Volt L-L
 - b. 480 Volt, 3 phase, 3 wire. 2000 Volt L-G, L-L
 - c. 120/208 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L

D. **Critical Load Protection – Fixed Equipment:**

1. For 120-volt, 1 phase, 3 wire, type 3, category A3 unit.
 - a. Surge current capacity (I_N): 15,000/30,000 amps per protection mode/phase
 - b. Mounting: External, NEMA 12 enclosure
 - c. Components: Nonmodular units composed of 20mm Metal Oxide Varistors (MOV). Series inductors, SAD, or selenium cells may be used in addition to MOVs.

- d. Protection modes and UL 1449 clamping voltage: 475 Volt L-N, L-G, and N-G.
- E. EMI/RFI Noise Rejection or Filtering:
 - 1. Each unit shall include a UL1283 first order, high-frequency filter for noise filtering between 10 KHz and 100 MHz.
- F. Indication:
 - 1. Each unit shall include solid-state indicators with externally mounted LED visual status indicators that indicate on-line status of each protection mode of the unit.
 - 2. Each unit shall include an audible alarm with silencing switch to indicate when protection has failed.
 - 3. Provide each service entrance secondary distribution and critical load type unit(s) with a transient counter.
 - 4. Each unit shall contain form "C" contacts for remote indication of an alarm status.
- G. Fuses:
 - 1. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit.
 - 2. Fuses shall be rated 200, 000 AIC minimum interrupting capacity.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine equipment for size and type of surge protection device to be used to ensure physical compatibility.
- B. Inspect surge protection device for any signs of physical damage due to shipping or handling before installing surge protection device.

3.2 INSTALLATION

- A. Mounting Location:
 - 1. The unit shall be installed as close as practical to the panel and transformer secondary lugs in accordance with applicable national/Local Electrical Codes and the manufacturer's recommended installation instructions. Connect the unit to the transformer or switchboard or panel using a conduit nipple. Flush mount the unit in the front of the switchboard. Mount unit directly across from the breaker or disconnect serving it.
 - 2. If internal surge protection device is specified, device shall be installed in a barrier compartment isolated from other components.

B. Connections:

1. Contractor shall provide wire and circuit breakers sized per the approved manufacturer's requirements. Maximum lead length from protected bus to surge protection device shall be per manufacturer's requirements, but no greater than 5'-0".
2. The surge protection unit shall be isolatable from the electrical distribution system via 3 pole circuit breaker mounted in the switchboard/panelboard. Single phase 120-volt units shall be hardwired without a disconnecting means.
3. Neutral and ground shall not be bonded together at secondary panelboard locations.

C. Additional Locations: Critical Load Protection – Fixed Equipment (120 Vac):

1. Install an A3 hard-wired or plug-in surge protection device between each of the following equipment items and its power supply conductors.
 - a. Phone switch
 - b. Intercom master
 - c. Building management system master
 - d. Security system master
 - e. Telephone switch
 - f. TV head

D. General:

1. Check unit for proper operation of protection and indication under start-up.
2. Check unit to ensure all MOVs for each mode of protection are operational. Verify integral fuse links are operational and have not melted.
3. Surge suppression devices shall not be installed ahead of the main service disconnect(s).
4. Install fuses in all fuse holders and fused disconnects internal to the surge protection unit. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit. External fusing of the surge protection device is not allowed.
5. Coordinate location of surge protection device to allow adequate clearances for maintenance.
6. Manufacturer service phone number shall be posted on the front of the surge protection device.

END OF SECTION

SECTION 26 51 00

LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Interior luminaires and accessories
- B. Exterior luminaires and accessories
- C. Lamps
- D. Ballasts
- E. Poles

1.2 REFERENCES

- A. ANSI C78.377-2008 – Specifications for the Chromaticity of Solid State Lighting Products
- B. ANSI C82.4 - High-Intensity Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
- C. ANSI C82.6 - Ballasts for HID Lamps - Method Measurement
- D. ANSI C82.11 - High Frequency Fluorescent Lamp Ballasts
- E. ANSI C82.77-2002 – Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment
- F. IEEE C2 - National Electrical Safety Code
- G. NEMA LE 2 - H-I-D Lighting System Noise Criterion (LS-NC) Ratings
- H. UL 935 – Standard for Fluorescent Lamp Ballasts

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Submit product data sheets for luminaires, lamps, ballasts, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with fixtures listed in ascending order, and with each luminaire's associated lamp, ballast, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.
- C. Submit lens product data, dimensions and weights if not included in product data sheet submittal.
- D. Include outline drawings, support points, weights, and accessory information for each luminaire type.
- E. Submit utility rebate forms, where offered at project location, with rebate items completed.

- F. LED luminaire submittals shall include photometric report per IESNA LM-79-08 for the latest generation system being furnished, including independent testing laboratory name, report number, date, luminaire model number, input wattage, luminaire, and light source specifications. Manufacturer origin of LED chipset and driver shall be submitted.
- G. For all LED luminaires specified as dimmer controlled, submit dimmer device data that is approved by manufacturer of submitted luminaire and that Contractor proposes to furnish and install. Contractor is responsible for verifying that installed dimming controls are compatible with and approved by the luminaire manufacturer.

1.4 EXTRA STOCK

- A. Provide extra stock under provisions of Section 26 05 00.
- B. LED Light Engines or Modules: Three (3) percent of quantity installed, minimum of one (1) of each size and type.
- C. Lenses: Three (3) percent of quantity installed, minimum of one (1) of each size and type.
- D. Ballasts and LED Drivers: Three (3) percent of quantity installed, minimum of one (1) of each size and type.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site. Store and protect under provisions of Section 26 05 00.
- B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.
- C. Handle site lighting poles carefully to prevent breakage and damage to finish.

1.6 WARRANTY

- A. Fluorescent ballasts shall carry a three-year warranty from date of Substantial Completion. HID ballasts shall carry a two-year warranty from date of Substantial Completion. Dimming electronic ballasts shall have a five year warranty.
- B. Emergency fluorescent ballast shall have a five-year warranty from date of substantial completion.
- C. Fluorescent lamps shall carry a two-year warranty from date of Substantial Completion.
- D. HID lamps shall carry a one-year warranty from date of Substantial Completion.
- E. Light emitting diode (LED) light engines and drivers shall have a five-year warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Lensed Fluorescent Troffers: Provide hinged frames with latches and 0.125-inch thick virgin acrylic lenses. Prismatic lenses shall have depth of no less than 0.080", KSH12 or equal. Other lenses as scheduled.

- B. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.
- C. Parabolic Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction. Provide ballast covers to separate inboard/outboard lamps when multi-level switching is indicated, so light does not spill into unlit cells.
- D. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified.
- E. Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings.
- F. Self-Powered Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings. One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- G. Self-Powered Emergency Lighting Units: One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- H. HID Luminaires: Pre-wired, with integral ballast.
- I. Painted reflector surfaces shall have a minimum reflectance of 90%.
- J. All painted components shall be painted after fabrication.

2.2 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Listed for wet or damp location as scheduled. Fountain and pool luminaires shall be listed for submersible location to meet depth specified.
- B. Provide low temperature ballasts or LED drivers, with reliable starting to -20°F.
- C. In-grade luminaires shall have lamp/optic separation to prevent surface temperature from exceeding 115°F. Compartment separation of wire entry and control gear/lamp chamber.

2.3 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

- A. Light emitting diodes used in interior applications shall have a minimum color rendering index (CRI) of 80. Light emitting diodes used in exterior applications shall have a minimum color rendering index (CRI) of 70. Color temperature of the luminaires shall be as noted on the luminaire schedule.

- B. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.
- C. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.
- D. LED Driver:
 - 1. Solid state driver with integral heat sink. Driver shall have overheat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 20%. Surge suppression device for all exterior luminaires.
 - 2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type.
 - 3. Driver shall have a minimum of 50,000 hours rated life.

2.4 ACCEPTABLE MANUFACTURERS - POLES

- A. Manufacturer of Luminaire.
- B. Valmont Poles.
- C. U. S. Pole Company.
- D. KW Industries

2.5 LIGHTING POLES

- A. Metal Poles: Square straight aluminum lighting pole with anchor base.
- B. Laminated Wood Poles: Raceway type lighting pole; pressure treat with alkaline copper quaternary preservative.
- C. Wind Load: 100 MPH velocity, with 1.3 gust factor with luminaires and brackets mounted.
- D. Hand Hole: 2 x 4 inches with removable weatherproof cover installed at manufacturer's standard location. Provide matching gasketed cover plate.
- E. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole. Grout between anchor plate and concrete base with non-shrink grout after pole is plumbed.
- F. Vibration Damper: Canister or snake type second mode vibration damper internal to the pole as recommended by pole manufacturer. Provide additional pole top damper for first mode vibration on single-head poles where recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Securely fasten luminaires to the listed and labeled ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members. If ceiling framing is not listed for luminaire size or weight, support luminaires independent of ceiling grid with a minimum of two (2) #12 gauge wires located on diagonal corners.

- B. Install recessed flanged luminaires to permit removal from below. Use manufacturer-supplied plaster frames and swing gate supports. Support luminaires independent of ceiling with a minimum of two (2) #12 gauge wires located on diagonal corners.
- C. Support surface-mounted luminaires directly from building structure. Install luminaires larger than eight square feet (8 ft²) or weighing more than 30 pounds independent of ceiling framing.
- D. Support suspended or pendant mounted luminaires independent of ceiling grid with a minimum of two #12 gauge wires. Suspension assembly and anchors shall be capable of supporting 300 pounds dead load at each suspension point.
- E. Install lamps in lamp holders of luminaires.
- F. Adjust aimable luminaires to obtain lighting levels on objects and areas as directed to obtain desired lighting levels.
- G. Parabolic louvers and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.
- H. Industrial Pendant Luminaires: Use hangers rated 500 pounds minimum or provide safety chain between ballast and structure. Provide safety chain between reflector and ballast.
- I. Luminaire Pole Bases: Sized and constructed as indicated on the drawings. Project anchor bolts 2 inches minimum above base. Install poles plumb with double nuts for adjustment. Grout around pole anchor base.
- J. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

3.2 ADJUSTING AND CLEANING

- A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.
- B. Touch up luminaire and pole finish at completion of work.

3.3 LUMINAIRE SCHEDULE

- A. As shown on the drawings.

END OF SECTION

SECTION 27 05 00

BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Communications Systems Requirements specifically applicable to Division 27 sections, in addition to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

- A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the Communications Systems as shown on the drawings and specified herein.
- B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make their portion of the Communications Systems a finished and working system.
- C. Description of Systems include but are not limited to the following:
 - 1. Complete Structured Cabling System including, but not limited to:
 - a. Data backbone cabling and terminations.
 - b. Data horizontal cabling and terminations.
 - c. Information outlets (IOs) including faceplates, jacks and labeling.
 - d. Equipment racks, cabinets, cable management and equipment.
 - e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks.
 - f. Cabling pathways.
 - g. Grounding and Bonding
 - h. Testing
 - 2. Mounting and patching of wireless access points provided by others.
 - 3. Low Voltage Communications Wiring (less than +120VAC) as specified and required for proper system control and communications.
 - 4. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
 - 5. Firestopping of penetrations as described in Section 26 05 03.

1.3 DIVISION OF WORK BETWEEN ELECTRICAL AND COMMUNICATIONS CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
 2. "Electrical Contractor" shall also refer to the Contractor listed in Division 27 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
 3. "Technology Contractor" as referred to herein refers to the Contractors listed in Division 27 of this Specification.
 4. Low Voltage Technology Wiring: The wiring (less than 120VAC) associated with the Technology Systems, used for analog and/or digital signals between equipment.
 5. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation and mounting of the telecommunications/technology outlet. Rough-in shall include conduit from the information outlet backbox to above the lay-in ceiling the nearest cable tray. Where surface mounted backboxes are required, conduit shall be routed to above the lay-in ceiling the bottom of the exposed structural joists the nearest cable tray.
- C. General:
1. The purpose of these specifications is to outline typical Electrical and Technology Contractor's work responsibilities as related to technology systems including telecommunications rough-in, audio/visual systems rough-in, conduit, cable tray, power wiring, and low voltage communications and technology wiring. The prime contractor is responsible for all divisions of work.
 2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the technology drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the technology drawings but required for the successful operation of the systems shall be the responsibility of the Technology Contractor and included in the Contractor's bid.

3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of technology systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
4. Where the Electrical Contractor is required to install cable tray that will contain low voltage technology wiring, the installation shall not begin until the Technology Contractor has completed a coordination review of the cable tray shop drawing.
5. This Contractor shall establish electrical and technology utility elevations prior to fabrication and installation. The Technology Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
 - a. Lighting Fixtures
 - b. Gravity Flow Piping, including Steam and Condensate
 - c. Sheet Metal
 - d. Electrical Busduct
 - e. Cable supports, including 12” access space
 - f. Sprinkler Piping and other Piping
 - g. Conduit and Wireway
 - h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the “Suggested Matrix of Scope Responsibility” to be provided by the Electrical Contractor.
2. Responsible for Communications Systems grounding and bonding.
3. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Technology Contractor’s Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the “Suggested Matrix of Scope Responsibility.”
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the technology bonding system.

5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.4 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5” and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5” and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.5 QUALITY ASSURANCE

- A. Telecommunications Structured Cabling System Standards:
 1. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:
 - a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling

- b. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises
 - 1) C.1 - Commercial Building Telecommunications Standard
 - 2) C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 - 3) C.3 - Optical Fiber Cabling Components Standard
 - 4) C.4 - Broadband Coaxial Cabling and Components Standard
 - c. ANSI/TIA-569-C - Telecommunications Pathways and Spaces
 - d. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure
 - e. ANSI/TIA-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - f. ANSI/TIA-758-B - Customer-Owned Outside Plant Telecommunications Standard
 - g. ANSI/TIA-862-A - Building Automation Systems Cabling Standard
 - h. ANSI/TIA-942-A - Telecommunications Infrastructure Standard for Data Centers
 - i. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - j. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding
 - k. NFPA 70 (NEC) - National Electrical Code (Current Edition)
 - l. UL 444 - Standard for Safety for Communications Cable
- B. Refer to individual sections for additional Quality Assurance requirements.
- C. Qualifications:
- 1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
 - 2. The installing Contractor shall be certified by the manufacturer of the structured cabling system. Certification of Contractor shall have been in place for a minimum of one (1) year prior to bidding this project. Documentation of certification is required at the time of bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.
 - 3. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.

4. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
5. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.
6. The Contractor shall obtain the services of a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) for the project. The RCDD or CNIDP shall perform the following tasks on the project:
 - a. Review contractor's submittals and stamp the submittals stating the submittals compliance with the contract documents.
 - b. Provide written and dated confirmation of an observation of the contractor's installation activities no less than every [2 weeks] [month] during the construction period.
 - c. Provide a final written and dated confirmation of a final construction review prior to testing.
 - d. Review final testing of system and indication that the documented results or transmittal of the results stating the test results compliance with the contract documents.
7. The Contractor shall have certified BICSI installation technicians or CNet CNIT (Certified Network Infrastructure Technician) on staff to perform the following tasks on the project:
 - a. Act as the field superintendent or job foreman with the responsibility of monitoring the daily work of each technician.
 - b. Oversee all testing and termination of cabling.
8. The Contractor shall have certified BICSI Installer 2 or CNet CNCI (Certified Network Cabling Installer) on staff to perform the following tasks:
 - a. Installation and termination of copper cable.
 - b. Installation and termination of optical fiber.
9. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
 - a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.
 - b. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 - c. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic systems on the project.

- d. A technical resume of experience for the Contractor's project manager and on-site installation supervisor assigned to this project.
- e. Resume and certification of the RCDD or CNIDP for the project as required by the form at the end of this specification section.
- f. Resume and certification of the BICSI installation technician or CNet CNIT for the project.

D. Compliance with Codes, Laws, Ordinances:

- 1. Conform to all requirements of Madison, Wisconsin's Codes, Laws, Ordinances and other regulations having jurisdiction.
- 2. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
- 3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
- 4. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.
- 5. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
- 6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

E. Permits, Fees, Taxes, Inspections:

- 1. Procure all applicable permits and licenses.
- 2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
- 3. Pay all applicable charges for such permits or licenses that may be required.
- 4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
- 5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.

6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. Pay any charges by the service provider related to the service or change in service to the project.
8. All equipment and materials shall be as approved or listed by the following (unless approval or listing is not applicable to an item by all acceptable manufacturers):
 - a. Factory Mutual
 - b. Underwriters' Laboratories, Inc.

F. Examination of Drawings:

1. The drawings for the technology systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

H. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.
2. Field conditions that will result in telecommunications drops that exceed the length limitations identified in the contract documents shall be brought to the attention of the Architect/Engineer prior to installation. The cost of reworking cabling that is too long, that was not brought to the written attention of the Architect/Engineer will be borne entirely by the Contractor.
3. This Contractor shall provide the Architect/Engineer with written documentation of any cabling drops that will not be able to use the cable tray (where cable tray is available) due to the resulting cabling lengths. This documentation shall be submitted prior to installation and installation shall not commence until approved by the Architect/Engineer.

1.6 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

<u>Referenced Specification Section</u>	<u>Submittal Item</u>
27 05 03	Through Penetration Firestopping
27 05 26	Communications Bonding
27 05 28	Interior Communications Pathways
27 05 43	Exterior Communications Pathways
27 05 53	Identification and Administration
27 11 00	Communication Equipment Rooms
27 13 00	Backbone Cabling Requirements
27 15 00	Horizontal Cabling Requirements
27 17 10	Testing

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:
1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Description of items submitted and relevant specification number
 - e. Notations of deviations from the contract documents
 - f. Other pertinent data
 2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Description of item submitted (using project nomenclature) and relevant specification number
 - g. Notations of deviations from the contract documents
 - h. Other pertinent data
 - i. Provide space for Contractor's review stamps
 3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
 4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
 5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.

- c. The Contractor shall provide proof of RCDD or CNIDP review on the submittal.
 - d. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - e. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - f. **The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 27 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 27 XX XX.description.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

1.7 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
 1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
 2. Submit in Excel format.
 3. Support values given with substantiating data.

- C. Preparation:
 - 1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
 - 2. Break down all costs into:
 - a. Material: Delivered cost of product with taxes paid.
 - b. Labor: Labor cost, excluding overhead and profit.

1.8 CHANGE ORDERS

- A. A detailed material and labor take-off shall be prepared for each change order along with labor rates and mark-up percentages. Change orders with inadequate breakdown will be rejected.
- B. Change order work shall not proceed until authorized.

1.9 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
 - 1. Firestopping, including mechanical firestop systems.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
- B. Store materials on the site to prevent damage.
- C. Keep fixtures, equipment and materials clean, dry and free from deleterious conditions.

1.11 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.12 WARRANTY

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 27 may require additional warranty requirements for specific equipment or systems.
- B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In

this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.

- C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.13 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.14 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.
- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

- 2.1** Cable Jacket Rating: This project requires all inside plant cable jackets to carry a plenum rating. Refer to individual sections.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 05 33. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.
- C. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

- A. General:
 - 1. Refer to specific Division 27 sections for further requirements.
 - 2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
 - 3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
 - 4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.

5. All communications cable tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.
- B. Protection of cable from foreign materials:
1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
 2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
 2. Refer to the end of this specification section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
 3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.
- C. Before final payment will be authorized, this Contractor must have completed the following:
1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
 2. Submitted bound copies of approved shop drawings.

3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
5. Submitted testing reports for all systems requiring final testing as described herein.
6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; submit receipt to Architect/Engineer prior to final payment being approved.
8. Provide System Assurance Warranty certificate for the telecommunications system.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div27.contractor.YYYYMMDD

b. Transmittal file name: O&Mtransmittal.div27.contractor.YYYYMMDD

5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as “1 of 2”, “2 of 2”, etc.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title “Operation and Maintenance Instructions”, title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect’s/Engineer’s shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.
- E. Refer to the individual specification sections for minimum hours of instruction time for each system.
- F. Operating Instructions:
 - 1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the Communications Systems.
 - 2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM COMMISSIONING

- A. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.
- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.
- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- C. This Contractor shall maintain at the job site, a separate and complete set of technology drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record actual routing of all conduits sized 2" or larger.
- E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

END OF SECTION

STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

To assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

1. All cabling pathways (cable tray, ladder rack, conduit sleeves, etc.) are installed and all cabling has been pulled through them.
2. All mechanical firestop products are installed and all other penetrations have been sealed.
3. All telecommunications jacks are installed in the faceplates.
4. All telecommunications cabling is pulled and at least 75% of all jacks have been terminated at the jack and at the telecom room.
5. Telecommunications testing is in progress and at least 25% of testing has been completed.
6. Telecommunications labeling has been provided on at least 25% of each type of component requiring a label.
7. All telecommunications related grounding is complete.
8. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.
9. All access control system equipment, including card readers, conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational.

The project will be ready for final jobsite observation prior to the requested date of the observation according to the above list of requirements.

Prime Contractor: _____ By: _____

Requested Observation Date _____ Today's Date: _____

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

Telecommunications – Proof of Certification

There are specific Contractor qualification requirements for this project as defined in Section 27 05 00, which may include Manufacturer Certification and RCDD or CNIDP credentials. This Proof of Certification document, and the supporting documentation require herein, is required to be submitted at the time of bid to show compliance with the requirements of 27 05 00.

Statement of Compliance:

The named Contractor’s base bid is a structured cabling solution from the connectivity manufacturer _____. Named Contractor is trained and certified, under the named manufacturer’s formal certification program to provide and install all materials and work required by this project. Further, said Contractor is authorized, by the named manufacturer, to offer all product, labor and system assurance warranties required for this project by these contract documents.

The certification of this named manufacturer is valid, current and in effect as of the bid day of this project, the _____ day of _____, 20____.

The named Contractor is not employing any other sub-contractor on the telecommunications portion of this project that does not also meet this certification requirement.

Contractor Company Name: _____

Authorized Representative: (print) _____

Date: _____ Manufacturer Certification Number (if any): _____

If this project requires RCDD certification, complete the following:

RCDD or CNIDP Name: _____ RCDD #: _____ Expiration: _____

Submit the following with the bid:

- This form.
- Proof of Manufacturer Certification indicated above.
- Proof of RCDD or CNIDP status.

SECTION 27 05 26

COMMUNICATIONS BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Bonding Conductors
- B. Bonding Connectors
- C. Grounding Busbar (TMGB and TGB)
- D. Rack-mount Telecommunications Grounding Busbar

1.2 RELATED WORK

- A. Section 26 05 33 – Conduit and Boxes
- B. Section 26 05 13 – Wire and Cable
- C. Section 26 05 26 – Grounding and Bonding
- D. Section 26 41 00 – Lightning Protection Systems
- E. Section 27 05 00 – Basic Communications Systems Requirements
- F. Section 27 05 03 – Through Penetration Firestopping
- G. Section 27 11 00 – Communication Equipment Rooms
- H. Section 27 05 28 – Interior Communication Pathways
- I. Section 27 05 53 – Identification and Administration

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.
- B. Communications bonding system component, device, equipment, and material manufacturer(s) shall have a minimum of five (5) years documented experience in the manufacture of communications bonding products.
- C. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be listed by Underwriters' Laboratories, Inc.

1.4 REFERENCES

- A. ANSI/IEEE 1100 – Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
- B. ANSI/TIA/EIA 568-C – Commercial Building Telecommunications Cabling Standard
- C. ANSI/TIA/EIA 569-A – Commercial Building Standard for Telecommunications Pathways and Spaces
- D. ANSI/TIA/EIA 606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- E. ANSI/TIA/EIA 758 – Customer Owned Outside Plant
- F. ANSI-J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- G. IEEE 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
- H. IEEE 837 – IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding

- I. NFPA 70 – National Electrical Code
- J. NFPA 780 – Standard for the Installation of Lightning Protection Systems
- K. UL 96 – Lightning Protection Components
- L. UL 96A – Installation Requirements for Lightning Protection Systems
- M. UL 467 – Grounding and Bonding Equipment

1.5 SUBMITTALS

- A. Submit product data and shop drawings under provisions of Section 27 05 00 and Division 1.
- B. Provide manufacturer’s technical product specification sheet for each individual component type. Submitted data shall show the following:
 - 1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item, including construction, materials, ratings, and all other parameters identified in Part 2 - Products.
 - 2. Manufacturer's installation instructions indicating application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- C. Provide CAD-generated, project-specific system shop drawings as follows:
 - 1. Provide a system block diagram indicating system configuration, system components, interconnection between components, and conductor routing. The diagram shall clearly indicate all wiring and connections required in the system. When multiple devices or pieces of equipment are required in the exact same configuration (e.g., multiple identical equipment racks or sections of ladder tray), the diagram may show one device and refer to the others as “typical” of the device shown. The diagram shall list room numbers where system equipment will be located.
 - 2. Installation details for all system components.
- D. Provide system checkout test procedure to be performed at acceptance.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under the provisions of Section 27 05 00.
- B. Store and protect products under the provisions of Section 27 05 00.
- C. Contractor shall exercise care to prevent corrosion of any products prior to installation. Corroded products shall not be acceptable for use on this project.

1.7 SYSTEM DESCRIPTION

- A. This section describes the requirements for the furnishing, installation, adjusting, and testing of a complete turnkey communications bonding system, including connection to the electrical ground grid.

- B. Performance Statement: This specification section and the accompanying drawings are performance based, describing the minimum material quality, required features, operational requirements, and performance of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made, or every feature and function that must be configured. Based on the equipment constraints described and the performance required of the system as presented in these documents, the Contractor is solely responsible for determining all components, devices, equipment, wiring, connections, and terminations required for a complete and operational system that provides the required performance.
- C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor.
- D. Basic System Requirements:
 - 1. A complete communications bonding infrastructure is required for this project. Refer to the drawings and the requirements of ANSI-J-STD-607-A and NFPA 70 for complete information.
 - 2. The bonding system shall include, but not be limited to, the following major components:
 - a. Bonding Conductor for Telecommunications (BCT)
 - b. Telecommunications Main Grounding Busbar (TMGB)
 - c. Telecommunications Bonding Backbone (TBB)
 - d. Telecommunications Grounding Busbar(s) (TGB)
 - e. Rack mount Telecommunications Grounding Busbar(s)
 - f. Bonding Conductor(s) (BC)
 - g. Bonding Connectors
 - h. Bonding system labeling and administration as defined in Section 27 05 53.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 27 05 00.
- B. Provide final system block diagram showing any deviations from approved shop drawing submittal.
- C. Provide floor plans that document the following:
 - 1. Actual locations of system components, devices, and equipment.
 - 2. Actual conductor routing.
 - 3. Actual system component, device, equipment, and conductor labels.
- D. Provide statement that system checkout test, as outlined in the approved shop drawing submittal, is complete and test results were satisfactory.
- E. Complete all operation and maintenance manuals as described below.

1.9 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 27 05 00.

- B. Submitted data shall include:
 - 1. Approved shop drawings.
 - 2. Descriptions of recommended system maintenance procedures, including:
 - a. Inspection
 - b. Periodic preventive maintenance
 - c. Fault diagnosis
 - d. Repair or replacement of defective components

PART 2 - PRODUCTS

2.1 BONDING CONDUCTORS

- A. Bare Copper:
 - 1. Annealed uncoated stranded conductor.
 - 2. Minimum size 6 AWG.
- B. Insulated Copper:
 - 1. Annealed uncoated stranded conductor.
 - 2. Insulation:
 - a. PVC insulation with nylon outer jacket.
 - b. Rated \geq 600 volts.
 - c. Green.
 - 3. Minimum size 6 AWG.
- C. All bonding conductors shall be listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose and for installation in the space in which they are installed.
- D. Bonding Conductor Sizing
 - 1. All Communications bonding system conductors shall be sized by length as follows:

Length Linear ft (m)	Size (AWG)
Less than 13 (4)	6
14 - 20 (4 - 6)	4
21 - 26 (6 - 8)	3
27 - 33 (8 - 10)	2
34 - 41 (10 - 13)	1
42 - 52 (13 - 16)	1/0
53 - 66 (16 - 20)	2/0
Greater than 66 (20)	3/0

- 2. The BCT shall be the same size as the TBB or larger.

2.2 BONDING CONNECTORS

- A. Acceptable Types:
 - 1. Two-hole compression lug
 - 2. Exothermic weld
 - 3. Irreversible compression
- B. Connectors shall be provided in kit form and selected per manufacturer's written instructions.
- C. Connectors shall comply with IEEE 837 and UL 467 and be listed for use for specific types, sizes, and combinations of conductors and connected items.

2.3 GROUNDING BUSBAR (TMGB AND TGB)

- A. Features:
 - 1. Wall-mount configuration.
 - 2. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
 - 3. Hole patterns compliant with BICSI recommendations and ANSI-J-STD-607-A standards.
 - 4. Predrilled holes.
 - 5. Integral insulators.
 - 6. Stainless steel offset mounting brackets.
- B. Specifications:
 - 1. Material: Electrolytic tough pitch copper bar with tin plating.
 - 2. Minimum Dimensions: 1/4" thick x 4" high x 12" long.
 - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
 - 3. Hole pattern shall include:
 - a. A minimum of 15 sets of 5/16" holes, 5/8" on center, to accommodate "A" spaced 2-hole compression lugs.
 - b. A minimum of three (3) sets of 7/16" holes, 1" on center, to accommodate "C" spaced 2-hole compression lugs.

2.4 RACK-MOUNT TELECOMMUNICATIONS GROUNDING BUSBAR

- A. Features:
 - 1. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
 - 2. Predrilled holes.
 - 3. Mounts in a standard 19" equipment rack.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 3/16" thick x 3/4" high x 19" long.
 - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
3. Hole pattern shall include:
 - a. A minimum of eight (8) 6-32 tapped lug mounting holes on 1" centers.
 - b. A minimum of two (2) pairs of 5/16" diameter holes spaced 3/4" apart.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Bonding Requirements:

1. The communications bonding system shall be a complete system. Contractor shall furnish and install all necessary miscellaneous components, devices, equipment, material, and hardware, including, but not limited to, lock washers, paint-piercing washers, hex nuts, compression lugs, insulators, mounting screws, lugs, etc., to provide a complete system.
2. A licensed electrician shall perform all bonding.
3. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Main Cross Connect and Service Entrance Room Bonding Requirements:

1. Locate the TMGB in the service entrance room unless otherwise noted on the drawings.
2. The location of the TMGB shall be the shortest practical distance from the telecommunications primary lightning protection devices.
3. Bond the telecommunications primary protectors to the TMGB. Maintain a minimum 1 foot (300 mm) separation of the bonding conductor from all DC power cables, switchboard cable, and high frequency cable.

C. Telecommunications Main Ground Bar (TMGB) Requirements:

1. Install TMGB such that it is insulated from its support with a minimum 2" standoff.

2. Bond the TMGB to the electrical service ground via the BCT.
 - a. A minimum of 1 foot (300 mm) separation shall be maintained between the BCT and any DC power cables, switchboard cable, or high frequency cables.
3. TMGB shall be bonded to all electrical panels located in the same room or space as the TMGB or in an immediately adjacent space within 20 linear feet of the TMGB. TMGB shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TMGB.
4. TMGB shall be bonded to accessible metallic building structure located within the same room or space as the TMGB.
5. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TMGB, shall be bonded to the TMGB.
6. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TMGB, shall be bonded to the TMGB.

D. Telecommunications Ground Bar (TGB) Requirements:

1. Provide a TGB in each telecommunications equipment room.
2. Install TGB such that it is insulated from its support with a minimum 2” standoff.
3. Bond each TGB to the TMGB via the TBB.
 - a. A minimum of 1 foot (300 mm) separation shall be maintained between the TBB and any DC power cables, switchboard cable, or high frequency cables.
 - b. The TBB may be routed from TGB to TGB or as a radial feed to each TGB as the layout requires.
4. When there are multiple telecommunications equipment rooms on each floor in buildings containing more than five stories, the TGBs on the same floor shall be bonded together horizontally using a grounding equalizer (GE) on the first, last, and every third intermediate floor. GE conductors shall be the same size as the TBB.
5. If more than one (1) TGB is provided within the same room or space, they shall all be bonded together via a BC the same size as the TBB.
6. TGBs shall be bonded to accessible metallic building structure located within the same room or space as the TGBs.

7. TGBs shall be bonded to all electrical panels located in the same room or space as the TGB or in an immediately adjacent space within 20 linear feet of the TGB. TGBs shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TGB.
 8. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TGB, shall be bonded to the TGB.
 9. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TGB, shall be bonded to the TGB.
- E. Rack-mount Telecommunications Ground Bar Requirements (RTGB):
1. Provide a rack-mount telecommunications ground bar in each equipment rack.
 2. Install RTGB such that it is electrically bonded to the rack. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between RTGB and equipment rack.
 3. Bond each RTGB to the TGB via a BC.
 4. If more than one (1) RTGB is provided within the same room or space, they shall all be bonded together via a BC.
 5. All contractor-furnished and/or contractor-installed metallic communications equipment, including, but not limited to patch panels, fiber optic distribution enclosures, splice enclosures, active electronics, uninterruptible power supplies, etc., mounted within the same equipment rack as the RTGB, shall be bonded to the RTGB. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between equipment rack and installed metallic communications equipment. Active electronics and uninterruptible power supplies shall be bonded to the RTGB via a dedicated BC for each device.
- F. Metallic Interior Communication Pathway Bonding Requirements:
1. All metallic interior continuous communication cable pathways, including, but not limited to, conduit, conduit sleeves, fire-rated cable pathway devices, cable tray, basket tray, and ladder rack, shall be bonded to the communications bonding system.
- G. Bonding Conductor Requirements:
1. Bonding conductors shall be green or marked with a distinctive green color.
 2. Bonding conductors shall be routed parallel and perpendicular to building structure along shortest and straightest paths possible. Number of bends and changes in direction should be minimized. Install and secure conductors in a manner that protects the conductors from impact and from physical or mechanical strain or damage.

3. Bonding conductors shall not be installed in metallic conduit.
4. All conductors, including, but not limited, to the BCT, TBB, GE(s), and BC(s), shall be installed splice-free. If the Contractor believes that site conditions do not allow a splice-free installation, the Contractor may request permission from the Architect/Engineer to splice a specific communications bonding system conductor.
 - a. Where documented permission to splice a conductor is granted:
 - 1) The number of splices shall be limited to as few as possible.
 - 2) Splices shall be made using exothermic welding or irreversible compression-type connections only. Splice hardware shall be listed for grounding and bonding. Solder is not an acceptable means of splicing conductors.
 - 3) Splices shall be made in telecommunications spaces in accessible locations to facilitate future inspection and maintenance.
 - 4) Splices shall be adequately supported and protected from impact and from physical or mechanical strain or damage.
5. All bonding conductors shall be labeled in accordance with the requirements of Section 27 05 53. In addition to the requirements of Section 27 05 53:
 - a. Labels shall be nonmetallic.
 - b. Labels shall be printer-generated.
 - c. Labels shall be located on conductors as close as is practical to their point of termination in a readable position.
 - d. Additionally, conductors shall be labeled as follows:
 - 1) “IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER.”
6. Interior water piping is not acceptable for use as a communications bonding system bonding conductor.
7. Metallic cable shields are not acceptable for use as communications bonding system bonding conductors.

H. Bonding Connection Requirements:

1. Make all connections in accessible locations to facilitate future inspection and maintenance.
2. Communications bonding system connections shall be made using exothermic welding, two-hole compression lugs, or other irreversible compression-type connections. The use of 1-hole lugs is prohibited, except for connections to a rack-mount telecommunications ground bar. Connection hardware shall be listed for grounding and bonding. Sheet metal screws shall not be used to make communications bonding system connections.

3. Thoroughly clean conductors before installing lugs and connectors.
4. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tool(s) recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer's recommendations.
5. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond at all connections.
6. All bonding connections shall be coated in anti-oxidant joint compound that is purpose-designed and purpose-manufactured for that use. Anti-oxidant joint compound shall be applied in accordance with manufacturer's recommendations and instructions.
7. All installed connectors on conductors installed in damp locations shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against moisture ingress. Applied heat shrink tubing shall overlap conductor's outer jacket a minimum of four (4) inches past connector and be installed in accordance with manufacturer's recommendations and instructions.

3.2 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 27 05 00.
- B. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product from a reputable manufacturer that meets the requirements of the specifications.
- C. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

3.3 ADJUSTING

- A. Adjust work under provisions of Section 27 05 00.
- B. Contractor shall make any and all adjustments to the communications bonding system necessary to ensure that the installed system meets all requirements listed herein. Modifications necessary to comply with listed requirements or to provide specified performance shall be completed by the Contractor at no additional cost to the Owner.

3.4 TESTING

- A. Test installed system under provisions of Section 27 17 10.
- B. Measure and document resistance to ground at TMGB, each TGB, each RTGB, and each electrical distribution panel bonded to the TMGB or a TGB.
 1. Measurements shall be made not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage, and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.

2. Measured resistance to ground at TMGB, each TGB, and each RTGB must not exceed 5 ohms Under no circumstances shall any point in the communications bonding system have a lower resistance to ground than that of nearby electrical distribution system components that it is bonded to.
- C. Include measurement documentation in test data submitted at completion of project under provisions of Section 27 17 10.

3.5 SYSTEM TRAINING

- A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.
1. Provide two week's advanced notice of training to the Owner and Architect/Engineer.
 2. The Architect/Engineer shall be presented with the option to attend the training.
 3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- B. At a minimum, the following training shall be conducted:
1. A course detailing the system functions and operations that a technical user will encounter. Provide training on all aspects of using the system, including making new bonding connections to the TMGB, TGB, or RTGB. Provide training on all recommended inspection, maintenance, and repair procedures for the system.

END OF SECTION

SECTION 27 05 28

INTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete cable support systems, conduits, sleeves, etc. for an interior cabling plant as shown on the drawings.

1.2 RELATED WORK

- A. Section 26 05 33 - Conduit and Boxes
- B. Section 27 05 00 - Basic Communications Systems Requirements
- C. Section 27 05 26 - Communications Bonding

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for requirements.

1.4 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code

1.5 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
 - 2. Manufacturer's installation instructions.
- B. Coordination Drawings:
 - 1. Include cable tray and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

1.6 DRAWINGS

- A. The drawings, which constitute a part of these specifications, indicate the general route of the wire mesh support systems, conduit, sleeves, etc. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Refer to Section 26 05 33 for conduit requirements for this project.

2.2 CABLE HANGERS AND SUPPORTS

- A. Provide a non-continuous cable support system suitable for use with open cable.
- B. Cable Hooks:
 - 1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.
 - 2. All cable hook mounting hardware shall be recessed to prevent damage to cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.
 - 3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use.
- C. Cable Hangers:
 - 1. Adjustable, non-continuous cable support slings for use with low voltage cabling.
 - 2. Steel and woven laminate construction, rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.
 - 3. Sling length shall be adjustable to a capacity of 425 4-pair UTP cables.
 - 4. Cabling hanger load limit shall be 100 lbs per foot.
 - 5. Manufacturer: Erico Caddy, CableCat CAT425, Arlington Fittings TI Series or approved equal.

PART 3 - EXECUTION

3.1 CABLE HOOK SUPPORT SYSTEM

- A. In areas where cabling is not supported by cable tray, ladder rack, enclosed wireway or installed in conduit, such cabling shall be supported by an approved cable hook support system.
- B. Refer to manufacturer's requirements for allowable fill capacity for selected cable hook. In no case shall a 40% fill capacity be exceeded.
- C. Cable hooks shall be securely mounted per manufacturer's instructions. In no case shall the side-to-side travel of any cable hook exceed 6".
- D. Cable hooks shall be selected based on the contractor's cable routing. Hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.
- E. Support spans shall be based on the manufacturer's load ratings. In no case shall a 5-foot span be exceeded.

- F. The resting and supporting of cabling on structural members shall not meet the requirements for cabling support specified herein.
- G. The use of tie-wraps or hook and loop type fasteners is specifically prohibited as a substitute for cable hooks specified herein.

3.2 CONDUIT AND CABLE ROUTING

- A. Refer to specification section 26 05 03 for additional requirements.
- B. All conduits shall be reamed and shall be installed with a nylon bushing.
- C. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.
- D. No conduit or sleeve containing more than two (2) cables shall exceed 40% fill ratio, regardless of length.
- E. Any conduit exceeding 90' in length or containing more than two (2) 90-degree bends shall contain a pull box sized per ANSI/TIA/EIA 569 requirements.
 - 1. A separate pull box is required for each 90' (or greater) length section.
 - 2. A separate pull box is required after any two (2) consecutive 90-degree bends.
 - 3. Pull box shall be located in an area that maintains accessibility of box, including the ability to remove box lid without removal or relocation of any other materials.
- F. Any conduit with bends totaling 90 degrees or more shall have the fill capacity derated by 15% for each 90 degrees of cumulative bend.
- G. Cables installed in any conduits that do not meet the above requirements shall be replaced at the Contractor's expense, after the conduit condition has been remedied.

3.3 ATTACHMENT TO METAL DECKING

- A. Where supports for cable trays and cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center. This 25-lb. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

END OF SECTION

SECTION 27 05 43

EXTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing exterior racks, ladders, conduits, sleeves, innerduct, etc. for an exterior cabling plant.

1.2 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.
- B. Precast Manufacturer (if applicable): Company specializing in precast concrete structures with three (3) years documented experience.

1.3 REFERENCES

- A. Section 27 05 00 – Basic Communications Systems Requirements.
- B. AASHTO HS-20 - Standard Specification for Highway Bridges.
- C. ANSI/ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- D. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
- E. ASTM A48 - Gray Iron Castings.
- F. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.

1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
 - 2. Manufacturer's installation instructions.
- B. Manhole submittal (if applicable): Indicate material specifications, dimensions, capacities, size and location of openings, reinforcing details, and accessory locations.
 - 1. Provide product data for manhole accessories.
- C. Submit shop drawings and product data under provisions of Section 27 05 00.
- D. Submit manufacturer's installation instructions under provisions of Section 27 05 00.
- E. Coordination Drawings:
 - 1. Include manholes, hand holes, and conduits 1.5" and larger in coordination files. Include all in--floor and underfloor conduit in coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

1.5 REGULATORY REQUIREMENTS

- A. Equipment and material shall be UL (Underwriters Laboratory) listed and labeled.

PART 2 - PRODUCTS

2.1 OUTSIDE PLANT CONDUIT

- A. Rigid Metallic Conduit (RMC) and Fittings:
1. Rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.
 2. Fittings and Conduit Bodies:
 - a. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
 - b. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
 - c. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
 - d. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**
 - e. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.
 3. Acceptable Manufacturers:
 - a. Allied, LTV, Steelduct, Wheatland Tube Co, O-Z Gedney, or pre-approved equal.
- B. Rigid Non-Metallic Conduit (RNC) and Fittings:
1. UL listed, NEMA TC2 and TC6 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement.
 2. Fittings: NEMA TC3 and TC9, sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
 3. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

4. Acceptable Manufacturers:
 - a. Carlon (Lamson & Sessions) Type 40, Cantex, J.M. Mfg., or pre-approved equal.

C. Fittings:

1. Sweeps: Factory manufactured RMC wrapped with 4 mil vinyl tape with a bend radius as follows:
 - a. Conduit internal diameter of 2” or less is 6 times the internal conduit diameter.
 - b. Conduit internal diameter of more than 2” is 10 times the internal conduit diameter.
2. End Caps (Plugs): Pre-manufactured and watertight. Tape is not an acceptable end cap or cover.

2.2 HAND-HOLES

A. Type:

1. Polymer concrete

B. Dimensions:

1. 24X36X 30.

C. Requirements:

1. Includes polymer concrete cover.

D. Acceptable Manufacturers

1. Quazite
2. Old Castle Precast Christy®
3. New Basis.

2.3 TEXTILE INNERDUCT

- A. Contractor shall provide and install innerduct in each conduit identified to have copper and fiber optic cable installed.
- B. Innerduct shall have an 18 gauge solid copper core tracer wire installed into each cell to allow for detection by industry standard toning equipment.
- C. Each innerduct cell shall have a pull tape installed.
- D. Acceptable Manufacturers:
 1. Maxcell or pre-approved equal.

2.4 UNDERGROUND WARNING TAPE

- A. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.
- B. Overall Thickness: 5 mils (0.125 mm).
- C. Foil Core Thickness: 0.35 mil (0.00889 mm).
- D. Orange colored tape 3-wide with 1-inch high black letters permanently imprinted with "CAUTION – BURIED COMMUNICATIONS LINE BELOW". Printing on tape shall be permanent and shall not be damaged by burial operations.
- E. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- F. Comply with ANSI Z535.1 through ANSI Z535.5.

PART 3 - EXECUTION

3.1 INSTALLATION - DUCTBANK

- A. Make duct bank installations and penetrations through foundation walls watertight.
- B. Top of duct banks shall be a minimum of 24 inches below grade, unless otherwise indicated on drawings.
- C. Assemble duct banks using non-magnetic saddles, spacers and separators. Position separators to provide 3-inch minimum separation between the outer surfaces of the ducts.
- D. Transition from non-metallic to galvanized rigid steel conduit where duct banks enter buildings, manholes, and handholes.
- E. Where ducts enter structures such as manholes, handholes, pullboxes and buildings, terminate the ducts in suitable end bells.
- F. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3-inches per 100 feet.
- G. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12 inches long and with a cross section approximately 1/4 inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand, or gravel have been left in the duct.
- H. Plug and seal empty spare ducts entering buildings and structures. Seal watertight all ducts in use entering buildings and structures.

3.2 INSTALLATION – TEXTILE INNERDUCT

- A. Provide two (2) 3-cell innerducts per 4" conduit or as recommended by the manufacturer.
- B. Install innerduct per manufacturer's guidelines.

- C. Cut and tie off innerduct and pull tape inside each communications vault or Entrance Room.

3.3 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

- 1. The Contractor shall do all necessary excavating, securing, filling, backfilling, compacting, and restoration in connection with their work.

B. Excavation:

- 1. Excavations for trenches shall be excavated to proper dimensions to permit installation and inspection of work.
- 2. Where excavations are carried in error below indicated levels, thoroughly compacted sand-gravel fill, shall be placed in such excess excavations.
- 3. Excavations shall be protected against frost action and freezing.
- 4. Care shall be exercised in excavating so as to not damage surrounding structures, equipment, and buried utilities. In no case shall any major structural footing or foundation be undermined.
- 5. Excavation shall be performed in all ground characteristics, including rock, if encountered. Each bidder shall visit the premises and determine, by actual observations, borings, or other means, the nature of the soil conditions. The cost of all such inspections, borings, etc., shall be borne by the bidder.
- 6. In the case where the trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
- 7. Where satisfactory bearing soil is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately and no further work shall be done until further instructions are given.
- 8. Mechanical excavation of the trench to line and grade of the conduit, unless otherwise indicated on the drawings.

C. Dewatering:

- 1. The Contractor shall be responsible for the furnishing, installation, operation and removal of all dewatering pumps and lines necessary to keep the excavation free of water at all times.

D. Underground Obstructions:

- 1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811. The Contractor is responsible for obtaining all utility locates for all trades on the project to determine obstructions indicated. The Contractor shall use great care in installing in the vicinity of underground obstruction.

E. Fill and Backfilling:

1. No rubbish or waste material shall be permitted in excavations for trench fill and backfill.
2. The Contractor shall provide the necessary sand for backfilling.
3. Dispose of the excess excavated earth as directed.
4. Soils for backfill shall be suitable for required stability and compaction, clean and free from perishable materials, frozen earth, debris or earth with an exceptionally high void content, and free from stones greater than 4 inches in diameter. Under no circumstances shall water be permitted to rise in unbackfilled trenches after installation has been placed.
5. All trenches shall be backfilled immediately after installation of conduit, unless other protection is directed.
6. All conduit shall be laid on a compacted bed of sand at least 3" deep. Backfill around the conduit with sand, spread in 6" layers, then compact each layer.
7. Use sand for backfill up to grade for all conduit located under building slabs or paved areas. All other conduit shall have sand backfill to 6" above the top of the conduit.
8. The backfilling above the sand shall be placed in uniform layers not exceeding 6" in depth. Each layer shall be placed, then carefully and uniformly tamped, so as to eliminate the possibility of lateral or vertical displacement.
9. Install a warning tape approximately 12 inches below finished grade over all underground duct banks. The identifying warning tape shall be as specified above.
10. Where the fill and backfilling will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
11. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

3.4 RESTORATION REQUIREMENTS

- A. Where soil and sod has been removed, it shall be replaced as soon as possible after backfilling is completed. All areas disturbed by work shall be restored to their original condition. The restoration shall include any necessary topsoiling, fertilizing, liming, seeding, or mulching,

END OF SECTION

SECTION 27 05 53

IDENTIFICATION AND ADMINISTRATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the execution and administration requirements relating to the structured cabling system and its termination components and related subsystems.
- B. Identification and labeling.

1.2 RELATED WORK

- A. Section 27 05 00 – Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.

1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Documentation of labeling scheme.

PART 2 - PRODUCTS

2.1 LABELING

- A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.
- B. Insert labels shall meet the requirements of UL 969 for legibility, defacement and general exposure.
- C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, typeface and attachment method.
- D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.
 - 1. All Code 39 bar codes shall have a ratio between 2.5:1 and 3.0:1. Provide a minimum “quiet zone” of 0.25” on each side of the bar code.
 - 2. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.

- E. Color Code: Observe the following requirements for color coding:
1. Labels on each end of a cable shall be the same color for each termination.
 2. Labels for cross-connects shall be two different colors at each termination fields, representative of the color of that field.
 3. Orange (Pantone 15C) shall be used for the demarcation point.
 4. Green (Pantone 353C) shall be used for the termination point of network connection on the facility side of the demarc.
 5. Purple (Pantone 264C) shall be used to identify the termination of cables from common equipment (PBX, computers, LANS, etc.)
 6. White shall be used to identify the first-level backbone termination in the main cross-connect.
 7. Gray (Pantone 422C) shall be used to identify the second-level backbone termination in the main cross-connect.
 8. Blue (Pantone 291C) shall be used to identify the termination of station cabling at the telecommunications closet and/or equipment room end of the cable.
 9. Brown (Pantone 465C) shall be used to identify the termination of the interbuilding backbone cable terminations.
 10. Yellow (Pantone 101C) shall be used to identify the termination of auxiliary circuits, alarms, maintenance, security, etc.
 11. Red (Pantone 184C) shall be used to identify the termination of key telephone systems.
 12. In facilities that do not contain a main cross-connect, the color white may be used to identify second-level backbone terminations.
- F. Tag all CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system:
1. (Room Number) - (Outlet Number) - (Jack Number) - (Use).
 2. "Outlet Number" shall start with 1 in each room, with additional outlets in each room numbered sequentially.
 3. "Jack Number" shall start with 1 for the upper left jack in each outlet, increasing sequentially from left to right and top to bottom across the outlet face.
 4. "Use" shall be designated by the following:
 - a. "D" for data (RJ-45)
 5. Example #1: "109-3-4-D" indicates the bottom right data jack (assuming a 4-port faceplate) in outlet #3 in Room 109.

2.2 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 27 05 00 and Division 1. Documentation shall include the items detailed in the subsections below.
2. All documentation, including hard copy and electronic forms shall become the property of the Owner.

B. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION

3.1 IDENTIFICATION AND LABELING

A. Cable Labeling: Backbone and horizontal cables shall be labeled at each end.

1. Provide additional cable labeling at each manhole and pull box.
2. Cables that are routed through multiple pathway segments shall contain reference to all pathway segments in the pathway linkage field.
3. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color, may include blue with a white stripe to indicate the higher performance class station cabling.

B. Information Outlet Labeling: Tag all voice and data jacks as defined herein.

C. Termination Hardware Labeling:

1. An identifier shall be provided at each termination hardware location or its label.

D. Grounding/Bonding Labeling:

1. The TMGB shall be labeled "TMGB." There shall be only one TMGB in the facility.
2. Label all TBB conductors connecting to the TMGB with a unique label, located at both ends of the TBB.
3. Each TGB shall be labeled with a unique label.
4. All TBB conductors connecting to the TGB shall be labeled uniquely at each end of the cable.

END OF SECTION

SECTION 27 11 00

COMMUNICATION EQUIPMENT ROOMS (CER)

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements related to furnishing and installing equipment for communication equipment rooms.

1.2 RELATED WORK

- A. Section 27 05 00 - Basic Communications Systems Requirements
- B. Section 27 05 26 - Communications Bonding
- C. Section 27 05 28 - Interior Communication Pathways
- D. Section 27 15 00 - Horizontal Cabling Requirements

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for applicable standards.

1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
 - 2. Manufacturer's installation instructions.
- B. Coordination Drawings:
 - 1. Include ladder racking, equipment racks, cable tray and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT GROUNDING

- A. Refer to specification section 27 05 26 for grounding requirements.
- B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

2.2 EQUIPMENT RACKS

- A. Where identified on the drawings in Communication Equipment Rooms, equipment racks and/or equipment cabinets shall be furnished and installed by the Contractor to house cable termination components (e.g., copper, optical fiber, coax) and network electronics.

- B. The equipment rack shall conform to the following requirements:
1. Standard TIA/EIA 19" Floor Rack:
 - a. Equipment rack shall be 84" in height, self-supporting and provide a useable mounting height of 45 rack units (RU) (1 RU = 1 ¾").
 - b. Channel uprights shall be spaced to accommodate industry standard 19" mounting.
 - c. Equipment rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per TIA/EIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
 - d. Equipment racks shall be provided with a supply of spare screws (minimum of 24).
 - e. Equipment racks shall be provided with a ground bar and #6 AWG ground lug.
 - f. Provide all mounting hardware and accessories as required for a complete installation.

2.3 CABLE MANAGEMENT – VERTICAL AND HORIZONTAL

- A. Equipment Racks:
1. Equipment racks shall be equipped with vertical and horizontal cable management hardware in the form of rings and guides. Racks shall incorporate vertical and horizontal covers, to allow an orderly, hidden, routing of copper, optical fiber, and coax jumpers from the modular patch panels and/or 110-type termination blocks to the customer provided network electronics. Vertical and horizontal cable management hardware shall be as follows:
 - a. Horizontal cable management hardware shall be 16 gauge cold rolled steel construction with six (6) pass-thru holes and seven (7) front-mounted 3.5" steel rod D-rings. Provide with cover designed to conceal and protect cable.
 - b. At a minimum, horizontal cable management hardware shall be positioned above and below (a) each grouping of two rows of jacks on modular patch panels, and (b) above and below each optical fiber patch panel and (c) each grouping of two rows of F-type connectors on coax patch panels.
 - c. Vertical cable management hardware shall provide for cable routing on front and rear of each rack and be 14" deep x 6" wide (minimum). Where multiple equipment racks are to be installed, this hardware shall be mounted between the uprights of adjacent equipment racks. Equipment rack uprights and the spacers shall be secured together per manufacturer's recommendations. Provide with cover designed to conceal and protect cable.

2. Each equipment rack shall be supplied with a minimum of 12 releasable (e.g., “hook and loop”) cable support ties.
3. Where cable termination hardware is wall-mounted, the Contractor shall be responsible for establishing a cable pathway for jumpers routed from the equipment rack(s) to the wall. This shall be in the form of slotted ducts or troughs. Routing of jumpers via the overhead cable tray or ladder rack system is NOT acceptable. The proposed method shall be included in the submittals required by this document and shall be approved by the Architect/Engineer prior to installation.

2.4 PATCH PANELS

- A. Where identified on the drawings in Communication Equipment Rooms, modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.
- B. Copper cabling shall be terminated in Communication Equipment Rooms on modular patch panels consisting of a modular connector system incorporating modular jacks meeting the specifications for the jacks detailed in Section 27 15 00. On wall-mounted panels, this interface shall be accessible from the front of the panel.
- C. The largest single modular patch panel configuration shall not exceed 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12 jacks. High-density modular patch panels will not be accepted.
- D. The modular patch panel blocks shall have the ability to seat and cut eight (8) conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Modular patch panel blocks shall be designed to maintain the cables’ pair twists as closely as possible to the point of mechanical termination.
- E. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

2.5 OPTICAL FIBER PANELS

- A. All terminated optical fibers shall be mated to simplex LC -type couplings mounted on enclosed fiber distribution cabinets. Couplings shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g., “FDDI Connector”), Biconic, FC, and MT-RJ by changing panels on which connector couplings are mounted. Refer to Section 27 15 00 for coupling requirements.
- B. The fiber distribution cabinet shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings, including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor.
- C. The fiber distribution cabinet shall be an enclosed assembly affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to conceal and protect the optical fiber couplings, connectors, and cable.

- D. Access to the inside of the fiber distribution cabinet’s enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the fiber distribution cabinet to gain entry will not be accepted.
- E. The fiber distribution cabinet’s enclosure shall provide for strain relief of incoming optical fiber cables and shall incorporate radius control mechanisms to limit bending of the optical fiber to the manufacturer’s recommended minimums or ½", whichever is larger.
- F. All fiber distribution cabinets shall provide protection to both the “facilities” and “user” side of the coupling. The fiber distribution cabinet’s enclosure shall be configured to require front access only when patching. The incoming optical fiber cables (e.g., backbone, riser, horizontal, etc.) shall not be accessible from the patching area of the panel. The fiber distribution cabinet’s enclosure shall provide a physical barrier to access such optical fiber cables.
- G. Where “Loose Buffered” cables are installed, the 250 µm coated optical fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies (“pigtailed”) or (2) the use of a “fan-out” kit. In the latter approach, individual fibers are to be secured in a protective covering, an Aramid (e.g., Kevlar™) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the “fusion” method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250 µm coated optical fibers shall not be permitted.
- H. Fiber distribution cabinets for horizontal cabling: Where optical fiber horizontal cabling is to be terminated, the enclosure shall be compliant to all the above requirements plus the enclosure shall incorporate a storage mechanism designed to allow simplified identification, access to and termination of individual optical fibers. This may be in the form of a storage cassette, tray or other appropriate mechanism.
- I. Optical Fiber Connectors (LC-type) (Multimode/Singlemode):
 - 1. LC-type Optical Fiber Connectors: Shall be used to terminate optical fiber in communication equipment rooms.
 - 2. LC-type optical fiber connector plugs shall be snap-type with an integrated pull-proof design.
 - 3. LC-type optical fiber connector plugs shall incorporate a zirconium ceramic ferrule and shall utilize a factory pre-polish end face to ensure fiber-to-fiber physical contact for low loss and reflections.
 - 4. LC-type optical fiber connector plugs shall accept 1.6mm – 2.0mm and 3.0mm outside diameter fiber.
 - 5. The average insertion loss is 0.3db for multimode and single mode connectors.
 - 6. LC-type optical fiber connector plugs shall meet the following performance criteria:

<u>Test Procedure</u>	<u>Maximum Attenuation Change</u>
Cable Retention (FOTP-6)	0.2 dB
Durability (FOTP-21)	0.2 dB

<u>Test Procedure</u>	<u>Maximum Attenuation Change</u>
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

7. Additional Performance Requirements:
 - a. Length: 2.23 inches
 - b. Operating Temperature: -40 to 85 degrees C
8. Basis of Design:
 - a. Hubbell FCLC Series

2.6 LADDER RACK

- A. Provide complete ladder rack system including metallic ladder rack, splice connectors, fastening hardware and other miscellaneous materials as required for a complete installation per manufacturer's recommendations.
- B. Steel C-Channel Stringer Style Ladder Rack:
 1. Rolled steel siderail stringer, 2" stringer height, 9" spaced welded rungs.
 2. Steel shall meet the requirements of ASTM A1011 SS Grade 33.
 3. Loading limits shall be 292 lbs/ft for 4 ft spans.

2.7 D-RINGS

- A. Rounded edge D-rings for support of cabling in vertical and horizontal configurations.
- B. EIA 310D compliant, manufactured from materials meeting UL94-V0 specifications.
- C. Provide ¼" screw holes for wall mounting.

2.8 POWER STRIPS

- A. Provide power strips on all equipment racks, unless noted otherwise. These power strips shall have the following characteristics:
 1. Standard Rack Mount:
 - a. TIA/EIA 19" equipment rack mountable.
 - b. Compliant with UL-1449 Third Edition and UL-497A.
 - c. Provide transient suppression to 12,000-A. Protection shall be in all three modes (line-neutral, line-ground and neutral-ground).
 - d. Shall meet or exceed ANSI C62 Category A3 requirements.

- e. Provide high-frequency noise suppression as follows:
 - 1) >20-dB @ 50 kHz
 - 2) >40-dB @ 150 kHz
 - 3) >80-dB @ 1 MHz
 - 4) >30-dB @ 6 to 1000 MHz
- f. Protection Modes and UL 1449 Clamping Voltage: 475 volt L-N, L-G, and N-G.
- g. Components: Nonmodular units composed of 20mm metal oxide varistors (MOV). Series inductors, SAD, or selenium cells may be used in addition to MOVs.
- h. Be equipped with a 10-foot power cord.
- i. Provide with raised floor twistlock compatible.

2.9 COPPER PATCH CORDS

A. Modular Patch Panel:

- 1. Provide Category 6 Enhanced copper patch cords for 50% of all assigned ports on the modular patch panel. Of these cords, 60% shall be 3' in length and 40% shall be 5' in length. These patch cords shall be the cross-connect between the network electronics and the horizontal RJ-45 modular patch panel. Copper patch cords shall be equipped with a 4-pair RJ-45 connector on each end.
- 2. Refer to Section 27 15 00 for cable and connector performance requirements.
- 3. Patch cords shall not be made-up in the field.
- 4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):
 - a. Hubbell HC Series

2.10 FIBER PATCH CORDS

A. Optical Fiber Patch Cords (Multimode):

- 1. Provide 50/125 μm multimode (MM) optical fiber utilizing tight buffer construction for 50% of all assigned ports on the fiber distribution cabinet. These patch cords shall be the cross-connect between the backbone fiber distribution cabinet and the Owner's network electronics (hub/switch). Optical fiber patch cords shall be equipped with a ceramic tipped LC-type connector on each end and shall be a minimum of 5 feet (1.5m) in length. Connector body shall be of materials similar to that used in the proposed couplings. Provide required lengths as determined on the plans.
- 2. Channels shall be of equal length.
- 3. Refer to Section 27 15 00 for cable and connector performance requirements.

4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):
 - a. Hubbell DFPC Series
- B. Optical Fiber Patch Cords (Singlemode):
 1. The optical fiber patch cord shall be 8.3/3 μm singlemode (SM) optical fiber, utilizing tight buffer construction. The optical fiber patch cords shall be a minimum of 5 feet (1.5m) in length.
 2. Provide 8.3/3 μm singlemode (SM) optical fiber utilizing tight buffer construction for 50% of all assigned ports on the fiber distribution cabinet. These patch cords shall be the cross-connect between the backbone fiber distribution cabinet and the Owner's network electronics (hub/switch). Optical fiber patch cords shall be equipped with a ceramic tipped LC-type connector on each end and shall be a minimum of 5 feet (1.5m) in length. Connector body shall be of materials similar to that used in the proposed couplings. Provide required lengths as determined on the plans.
 3. Channels shall be of equal length.
 4. Refer to Section 27 15 00 for cable and connector performance requirements.
 5. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):
 - a. Hubbell DFPC Series

PART 3 - EXECUTION

3.1 EQUIPMENT RACKS

- A. Equipment racks shall be furnished and installed as shown on the drawings.
- B. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. The rack shall be stabilized by extending a brace to the wall. Alternately, overhead ladder rack by which the cabling accesses the equipment rack(s) may provide this function.
- C. A space between the rack upright and the wall (approximately 4") should be provided to allow for cabling in that area. The rear of the rack should be approximately 40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40" workspace in front of the rack is also required. Locations where these guidelines cannot be followed should be brought to the attention of the Architect/Engineer for resolution prior to installation.
- D. All hardware and equipment is to be mounted between 18" and 79" above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware should be reviewed and approved by the Architect/Engineer and Site Coordinator(s) prior to installation.

- E. Equipment racks shall be equipped with cable management hardware as to allow an orderly and secure routing of optical fiber and/or copper cabling to the optical fiber distribution cabinets and/or modular patch panels. At minimum, one such horizontal jumper management panel shall be placed below each optical fiber distribution cabinet installed by the Contractor. Additional Jumper Management panels may be required pending installation of other cable types on the equipment rack.
- F. Each rack shall be grounded to the Telecommunications Ground Bar (GND) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket) directly or via an adjacent grounded equipment rack. Refer to grounding requirements below.

3.2 LADDER RACK

- A. Provide support for ladder rack on 4 ft centers.
- B. Maintain a 1.5 safety factor on all load limits specified herein.
- C. Ladder rack support shall be by 5/8" diameter threaded rod when ceiling mounted. Ladder rack requiring wall mounting shall utilize accessories supplied by the ladder rack manufacturer specifically for the purpose of wall mounting ladder rack.

3.3 D-RINGS

- A. Provide D-rings for cable routing and management in all areas where open cabling is routed along the wall in an Equipment Room.
- B. Locate D-rings on 24" centers vertically and horizontally.
- C. Securely attach D-rings to the wall as required by the manufacturer.

3.4 GROUNDING

- A. Provide a complete grounding system in accordance with the requirements of Section 27 05 26.

3.5 CROSS CONNECT INSTALLATION

- A. Bend radius of cable shall not exceed 4 times the outside cable diameter or manufacturer's recommendation, whichever is less.
- B. Cables shall be neatly bundled and dressed to their respective panels and/or blocks. Each shall be fed by an individual bundle separated and dressed to the point of cable entrance into the rack and/or frame.
- C. The cable jacket shall be maintained as close as possible to the termination point.
- D. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that is visible without removing the bundle support.

3.6 OPTICAL FIBER TERMINATION

- A. All fiber slack shall be neatly coiled within fiber splice enclosures or splice trays. No slack loops shall be allowed external to the enclosure.

- B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.
- C. Each cable shall be clearly labeled at the entrance to all enclosures.
- D. A maximum of 12 strands shall be spliced in any tray.

3.7 CONDUITS AND CABLE ROUTING

- A. Refer to Section 26 05 33 for additional requirements.
- B. Where conduits enter a telecommunications room, conduits shall be terminated on the wall where shown on the contract documents. Conduits entering the room from the floor shall extend 3" above the floor slab.
- C. Where cabling rises vertically in a telecommunications rooms, provide vertical cable management to support the cabling from floor to ceiling level.
- D. All conduits shall be reamed and shall be installed with a nylon bushing.
- E. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.

END OF SECTION

SECTION 27 13 00

BACKBONE CABLING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing backbone communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of both optical fiber and/or copper cabling.

1.2 RELATED WORK

- A. Section 27 05 00 – Basic Technology Systems Requirements.
- B. Section 27 15 00 - Horizontal Cabling Requirements.
- C. Section 27 17 20 - Support and Warranty.

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.

1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
 - 2. Manufacturer's installation instructions.

PART 2 - PRODUCTS

- 2.1 The basis of design is listed herein. Refer to Section 27 17 20 for additional acceptable manufacturers.

2.2 OPTICAL FIBER BACKBONE – OUTSIDE PLANT

- A. Duct Bank (Multimode/Singlemode):
 - 1. This optical fiber cable shall be suitable for installation in underground duct and in innerduct.
 - 2. Optical fiber cable materials shall be all dielectric (no conductive materials).
 - 3. Optical fiber cable shall be filled with a water-blocking material.

4. Outer Sheath: Polyethylene (PE). The outer sheath shall be marked with the manufacturer's name, words identifying the cable type (e.g., "Optical Fiber Cable" or "Fiber Optic Cable"), year of manufacture, and sequential length markings. The actual length of the optical fiber cable shall be within -0/+1% of the length markings. The marking shall be in a contrasting color to the cable jacket.
 5. Temperature Range:
 - a. Storage: -40°C to +70°C (no irreversible change in attenuation).
 - b. Operating: -40°C to +70°C.
 6. Humidity Range: 0% to 100%.
 7. Maximum Tensile Strength:
 - a. During Installation: 2700 Newton (600 lb. force) (no irreversible change in attenuation).
 - b. Long Term: 890 N (200 lb. force).
 8. Bending Radius:
 - a. During Installation: 20 times cable diameter.
 - b. No Load: 10 times cable diameter.
- B. Basis of Design (Multimode):
1. Corning (XXX).
- C. Basis of Design (Singlemode):
1. Corning (XXX).

2.3 OPTICAL FIBER BACKBONE PERFORMANCE

- A. OM3 Multimode (MM):
1. Fiber Type: Multimode; doped silica core surrounded by a concentric glass cladding.
 2. Index Profile: Graded Index.
 3. Transmission Windows: 850-nm and 1300-nm.
 4. Core Diameter (nom): 50- μ m (microns) \pm 2.5.
 5. Cladding Diameter: 125- μ m \pm 1.
 6. Core-clad Concentricity: \leq 1.0- μ m.
 7. Cladding Non-circularity: \leq 1.0%.
 8. Fiber Coating Diameter:
 - a. 245- μ m \pm 10 (primary coating).
 - b. 900- μ m (nominal) secondary coating (tight buffer)

c. All coatings shall be mechanically strippable without damaging the optical fiber.

9. Attenuation (maximum @ $23 \pm 5^\circ\text{C}$; backbone):

- a. @ 850-nm: 3.0 dB/km.
- b. @ 1300-nm: 1.0 dB/km.
- c. @1300-nm thru 1380-nm: 1.0dB/km

When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation over the rated temperature range of the optical cable shall not exceed 0.50 dB/km with 80% of the measured fibers not exceeding 0.25 dB/km.

10. Bandwidth (minimum):

- a. @ 850-nm: 2000 MHz*km.
- b. @ 1300-nm: 500 MHz*km.

11. No optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

B. Singlemode (SM):

- 1. Fiber Type: Singlemode; doped silica core surrounded by a concentric glass cladding.
- 2. Core Diameter: 8 to 9 μm . All optical fibers shall be of the same nominal core diameter and profile.
- 3. Cladding Diameter: $125 \pm 1.0\mu\text{m}$.
- 4. Cladding Non-circularity: $\leq 1\%$.
- 5. Core to Cladding Offset: $\leq 0.8 \mu\text{m}$.
- 6. Fiber Coating Diameter:
 - a. $245 \pm 15\mu\text{m}$ (primary coating).
 - b. 900-nm (nominal) secondary coating (tight buffer).
 - c. All coatings shall be mechanically strippable without damaging the optical fiber.
- 7. Cut-off Wavelength (cabled fiber; $\lambda_{\text{ccf}} \leq 1260\text{-nm}$.
- 8. Mode Field Diameter: 8.3 to 9.8 μm at 1300-nm; $10.5 \pm 1.0 \mu\text{m}$ at 1550-nm.
- 9. Zero Dispersion Wavelength (λ_0): $1301.5 \text{ nm} \leq \lambda_0 \leq 1321.5 \text{ nm}$.
- 10. Zero Dispersion Slope (S_0): $\leq 0.092 \text{ ps/nm}^2\text{*km}$.

11. Fiber Attenuation (maximum @ $23 \pm 5^{\circ}\text{C}$; Backbone):

- a. @ 1300-nm: 2.0 dB/km
- b. @ 1550-nm: 1.75 dB/km

When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation over the rated temperature range of the optical fiber cable shall not exceed 0.05 dB/km at 1550-nm. The magnitude of the maximum attenuation change of each individual optical fiber shall not be greater than 0.15 dB/km at 1550-nm.

12. Fiber Dispersion (maximum):

- a. @ 1285 to 1330-nm: 3.2-ps/nm*km
- b. @ 1550-nm: 18-ps/nm*km

13. No optical fiber shall show a point discontinuity greater than 0.1 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION REQUIREMENTS

- A. Cable slack shall be provided in each backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure.
- B. A minimum of 5 meters (approximately 15 feet) of slack cable (each cable if applicable) shall be coiled and secured at both ends located in the entrance room, Telecommunications Room or main equipment room, for backbone and intra-building cable.
- C. Where exposed, all backbone fiber optic cable shall be installed in protective inner duct. This includes areas where the cable is routed in cable tray and where making a transition between paths (e.g., between conduit and cable tray or into equipment racks). The inner duct should extend into the termination and/or storage enclosure(s) at system endpoints.

3.2 CROSS-CONNECTS

- A. The Owner will be responsible for all cross-connects between the data backbone cabling and network electronics and between the data network electronics and horizontal cabling.

END OF SECTION

SECTION 27 15 00

HORIZONTAL CABLING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of copper cabling.

1.2 RELATED WORK

- A. Section 27 05 00 - Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards and plenum or non-plenum cable requirements.
- B. The channel shall be required to meet the performance requirements indicated herein. The manufacturer shall warranty the performance of their system to the required performance (and not just to the Standard, should the required performance exceed the Standard).
- C. Specific components of the channel shall be required, at a minimum, to meet the Standard component requirements for that particular component.
- D. The installing contractor must be certified by the manufacturer of the structured cabling system.

1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
 - 2. Manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLE

- A. CAT 6 Enhanced Cable:
 - 1. The horizontal cable requirements must be met as well as the following channel requirements.
 - 2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.

3. Performance Tests shall be conducted using swept frequency testing through 250 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 250 MHz is not acceptable.
4. Performance data shall be characterized as “Guaranteed Headroom” and shall be warranted by the manufacturer to perform at guaranteed margins over ANSI/TIA/EIA-568-C.2. Performance data that is not warranted by the manufacturer will not be considered.
5. The structured cabling and connectivity must be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed in Section 27 17 20 as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.
6. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

Electrical Value (1 - 250 MHz)	Minimum Margin
Insertion Loss:	14.0%
NEXT:	7.0 dB
PS NEXT:	8.0 dB
ACR-F (ELFEXT):	8.0 dB
PS ACR-F (PS ELFEXT):	8.0 dB
Return Loss:	4.0 dB

7. The jacket color for CAT 6 cable shall be and blue for data applications.
8. Basis of Design:
 - a. Hubbell C6ES
 - b. Refer to Section 27 17 20 for additional acceptable manufacturers.

2.2 CONNECTORS/COUPLERS/ADAPTERS

- A. Refer to Section 27 11 00 for requirements.

2.3 FACEPLATES/JACKS

- A. CAT 6 Jacks:
 1. CAT 6 horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.

2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.
3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
4. Where standalone CAT 6 only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.
5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.
6. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall (1) match the faceplate color used for other utilities in the building or (2) when installed in surface raceway (if applicable), match the color of that raceway.
7. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:
 - a. Be a low-profile assembly.
 - b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.
 - c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.
 - d. Incorporate a shroud that protects the optical fiber couplings from impact damage.
8. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.
9. The CAT 6 modular jacks shall be non-keyed 8-pin modular jacks.
10. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.
11. CAT 6 modular jacks shall be pinned per TIA-568A.

12. CAT 6 termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:
 - a. ANSI/TIA/EIA-568-A-5
 - b. ANSI/TIA/EIA-568A
 - c. ISO/IEC 11801
 - d. IEC 603-7
 - e. FCC PART 68 SUBPART F
13. The color for CAT 6 jacks shall be blue for data applications. Alternately, a color-coded bezel or icon may be used to identify the CAT 6 modular jack.

2.4 COPPER WORK AREA CORDS

A. RJ-45:

1. Provide the same quantity of Category 6 copper work area cords as copper patch panel cords specified in Section 27 11 00. Copper work area cords shall be equipped with an 8-pin modular RJ-45 connector on each end.
2. Work area cords shall be 10' in length.
3. Manufacturer of copper patch cable shall be the same as the manufacturer of the horizontal copper cable.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION REQUIREMENTS

A. Horizontal Cabling:

1. The maximum horizontal cable drop length for Data UTP shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing horizontal cabling in a fashion so as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Architect/Engineer prior to installation. Changes to the contract documents shall be approved by the Architect/Engineer.
2. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellum grips may be used to spread the strain over a longer length of cable.
3. Manufacturer's minimum bend radius specifications shall be observed in all instances.
4. Horizontal cabling installed as open cabling shall be supported at a maximum of 5' between supports. Refer to the specifications for required cable supports.

5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable ties is strictly prohibited.
6. The maximum conduit fill for horizontal cabling shall not exceed 40% regardless of conduit length.
7. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.
8. A coil of 3 feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook, bridle ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each horizontal cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
9. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:
 - a. Twelve (12) inches from power lines of <5-kVa.
 - b. Eighteen (18) inches from high-voltage lighting (including fluorescent).
 - c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
 - d. Thirty-nine (39) inches from transformers and motors.
10. Information outlets shown on floor plans with the subscript "W" are intended to be used for wall mounted telephones. Back boxes for wall mounted telephones shall not be located within 12" vertically, or horizontally, from any light switches, power receptacles, nurse call devices, thermostats, or any other architectural element that would otherwise prevent the installation of a wall mounted telephone on the mating lugs.

B. Cable Terminations - Data UTP:

1. Modular patch panels shall be designed and installed in a fashion as to allow future horizontal cabling to be terminated on the panel without disruption to existing connections.
2. If the "last" patch (per rack) is greater than 50% utilized, one additional patch panel shall be provided for future use.
3. At information outlets and modular patch panels, the Contractor shall ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for data cables. The cable jacket shall be removed only to the extent required to make the termination.

END OF SECTION

SECTION 27 17 10

TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the testing requirements relating to the structured cabling system and its termination components and related subsystems.

1.2 RELATED WORK

- A. Section 27 05 00 – Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.

1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work, the Contractor shall submit:
 - 1. Complete information on testing procedure as described herein.
 - 2. Test plan summary for each cable type to be tested including equipment to be used, setup, test frequencies or wavelengths, results format, etc.

PART 2 - PRODUCTS

2.1 TESTING COPPER

- A. General Requirements:
 - 1. Perform acceptance tests as indicated below for each sub-system (e.g., backbone, horizontal, etc.) as it is completed.
 - 2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
 - 3. Visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
 - 4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.

5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove the wiring connections are correct.
6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results in their native format.
7. All cabling shall be 100% fault-free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
 - 1) Horizontal Cable:
 - a) CAT 6 Cable:
 - 1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.
 - 2) Horizontal cable shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.
 - 3) CAT 6 horizontal cable shall be tested to 250 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Basic Link" including cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:
 - a) Wire Map
 - b) Length
 - c) NEXT Loss (Pair-to-Pair)
 - d) NEXT (Power Sum)
 - e) ELFEXT (Pair-to-Pair)
 - f) ELFEXT (Power Sum)
 - g) Return Loss
 - h) Attenuation
 - i) Propagation Delay
 - j) Delay Skew

- 4) The maximum length of horizontal cable shall not exceed 295 feet (90m), which allows 33 feet (10 m) for technology equipment and modular patch cords.
- 5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.
- 6) CAT 6 horizontal cable testing shall be performed using a test instrument designed for testing to 250 MHz or higher. Test records shall verify, "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.
- 7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

2.2 TESTING FIBER

A. General Requirements:

1. Perform acceptance tests as indicated below for each optical fiber sub-system (e.g., backbone, horizontal, etc.) as it is completed.
2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
3. Visually inspect all optical fiber cabling and termination points to ensure that they are complete and conform to the standards defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.

5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove that the optical fiber connections are correct.
6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results.
7. All optical fiber cabling shall be 100% fault-free unless noted otherwise. If any optical fiber cable is found to be outside the specification defined herein, that optical fiber cable and the associated connector(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
9. The optical fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, provide cable manufacturer's test report for each reel of cable provided. These test reports shall include manufacturer's on-reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.
 - a. On-the-reel bandwidth performance as tested at the factory. Factory data shall be provided upon request.
 - b. The testing noted for optical fiber cabling utilizes an Optical Time Domain Reflectometer (OTDR). However, the Contractor may submit to the Architect/Engineer for pre-approval of alternate fiber optic testing equipment.
 - c. Tests Prior to Installation:
 - 1) The Contractor, at their discretion and at no cost to the Owner, may perform an attenuation test with an OTDR at 850-nm or 1300-nm on each optical fiber of each cable reel prior to installation. Supply this test data to the Architect/Engineer prior to installation.
 - d. Tests After Installation:
 - 1) Upon completion of cable installation and termination, the optical fiber cabling shall be tested to include:
 - a) Optical Attenuation ("Insertion Loss" Method):
 - (1) Optical Attenuation shall be measured on all terminated optical fibers in one direction of transmission using the "Insertion Loss" method

measurement in accordance with the TIA/EIA 526-14, Method B, and be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made. Multimode optical fibers shall be tested at 850 ± 30 nm. Singlemode optical fibers (if applicable) shall be tested at 1300 ± 20 nm.

- (2) Attenuation of optical fibers shall not exceed the values calculated as follows:

$$\text{Attenuation (max.)} = 2 * C + L * F + S \text{ dB}$$

Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers), and F is the maximum allowable optical fiber loss (in dB/km). S is the total splice loss (# of splices * maximum attenuation per splice).

b) Verification of Link Integrity (OTDR):

- (1) All optical fibers shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multimode optical fibers shall be tested at 850-nm and 1300-nm (nominal). Singlemode optical fibers (if applicable) shall be tested at 1310-nm and 1550-nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used. Access jumpers used for testing shall match the type and core diameter of the fiber optic strand under test.
- (2) Set OTDR's test variables to the manufacturer's published backscatter coefficient and velocity of propagation figure for the specific strand of fiber under test. OTDR's range should be set to approximately 1.5 times the length of the strand under test, pulse width should be optimized for the length of the fiber optic strand under test, and number of averages should be adjusted to approximately 120 seconds per wavelength.
- (3) OTDR traces revealing a point discontinuity greater than 0.2 dB in a multimode optical fiber or 0.1 dB in a singlemode optical fiber (if

applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that optical fiber by the Owner. The installation of that optical fiber cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that optical fiber cable and the associated terminations shall be replaced at the expense of the Contractor.

2.3 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, submit as-builts per the requirements of Section 27 05 00 and Division 1. Documentation shall include the items detailed in the subsections below.
2. All documentation, including hard copy and electronic forms, shall become the property of the Owner.
3. The Architect/Engineer may request that a 10% random field retest be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Architect/Engineer, including a 100% retest. This retest shall be at no additional cost to the Owner.

B. Copper Media Test Data:

1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package. The Contractor shall furnish this information in electronic form (USB thumb drive). The thumb drive shall contain the electronic equivalent of the test results as defined by the bid specification and be in the tester's native format as well as summaries of each test in pdf format. Provide a licensed copy of the software required to view and print the data that is provided in a proprietary format. Furnish one (1) copy of the data and display (if applicable) software.

C. Optical Fiber Media Test Data:

1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. OTDR traces of individual optical fiber "signatures" obtained as specified above shall be provided to the Architect/Engineer in electronic form for review. Trace files shall be so named as to identify each individual optical fiber by location in the cable system and optical fiber number or color. Where traces are provided in

electronic form, provide along with the above documentation, one (1) licensed copy of software that will allow for the display of OTDR traces provided. The software shall run on a Microsoft Windows-based personal computer.

D. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION

SECTION 27 17 20

SUPPORT AND WARRANTY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes support and warranty requirements relating to the structured cabling system and related subsystems.

1.2 RELATED WORK

- A. Section 27 05 00 – Basic Technology Systems Requirements.

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.

PART 2 - PRODUCTS

2.1 MANUFACTURER REQUIREMENTS

- A. The Basis of Design for all structured cabling components is listed in the individual Division 27 sections. Alternative acceptable manufacturers will not be accepted for this project.

- 1. Exceptions:
 - a. Optical fiber.

- B. Additional acceptable manufacturers for horizontal cabling:

- 1. Commscope
- 2. Hubbell/Mohawk
- 3. Panduit
- 4. Belden

- C. Additional acceptable manufacturers for optical fiber:

- 1. Commscope
- 2. Panduit
- 3. Belden

2.2 WARRANTY

- A. A twenty-five (25) year Product Installation Warranty and System Assurance Warranty shall be provided for the structured cabling system as described in the contract documents.

- B. The Product Installation Warranty shall cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).
- C. The system assurance warranty shall cover the failure of the wiring system to support the application it was designed to support, as well as additional applications introduced in the future by recognized standards or user forums that use the TIA/EIA 568A component and link/channel specifications for cabling.
- D. Upon successful completion of the installation and subsequent inspection, the Owner shall be provided with a numbered certificate from the manufacturing company registering the installation.

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION

SECTION 28 05 00

BASIC ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Safety and Security System Requirements (herein referred to Security) specifically applicable to Division 28 sections, in addition to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 REFERENCES

- A. OSHPD - Office of State Wide Health Planning and Development (California)
- B. CCR California Code of Regulation
- C. CBC California Building Code
- D. CFC California Fire Code
- E. CEC California Electric Code
- F. CMC California Mechanical Code
- G. CPC California Plumbing Code
- H. California Title 24 - Building Energy Efficiency Standards
- I. SCAQMD Southern California Air Quality Management Division

1.3 SCOPE OF WORK

- A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the security systems as shown on the drawings and specified herein.
- B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make their portion of the security systems a finished and working system.
- C. Description of systems include but are not limited to the following:
 - 1. Electronic access control system
 - 2. Electronic intrusion detection system
 - 3. Video surveillance
 - 4. Fire detection and alarm
 - 5. Low voltage security wiring (less than +120VAC) as specified and required for proper system control and communications.
 - 6. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".

7. Firestopping of penetrations of fire-rated construction as described in Specification Section 28 05 03 Division 7.

1.4 WORK SEQUENCE

- A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.
- B. Itemize all work and list associated hours and pay scale for each item.

1.5 DIVISION OF WORK BETWEEN ELECTRICAL AND SECURITY CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
 1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
 2. "Electrical Contractor" shall also refer to the Contractor listed in Division 28 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
 3. "Security Contractor" as referred to herein refers to the Contractors listed in Division 28 of this Specification.
 4. Low Voltage Security Wiring: The wiring (less than 120VAC) associated with the Security Systems, used for analog and/or digital signals between equipment.
- C. General:
 1. The purpose of these Specifications is to outline typical Electrical and Security Contractor's work responsibilities as related to security systems including back boxes, conduit, cable tray, power wiring and low voltage security wiring. The prime contractor is responsible for all divisions of work.
 2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Security Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Security Drawings but required for the successful operation of the systems shall be the responsibility of the Security Contractor and included in the Contractor's bid.

3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Security systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Security Contractor has convened to determine the exact location and requirements of the installation.
4. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Security Wiring, the installation shall not begin until the Security Contractor has completed a coordination review of the cable tray shop drawing.
5. This Contractor shall establish Electrical and Security utility elevations prior to fabrication and installation. The Security Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
 - a. Lighting Fixtures
 - b. Gravity Flow Piping, including Steam and Condensate
 - c. Sheet Metal
 - d. Electrical Busduct
 - e. Cable Trays, including 12” access space
 - f. Sprinkler Piping and other Piping
 - g. Conduit and Wireway
 - h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the “Suggested Matrix of Scope Responsibility” to be provided by the Electrical Contractor.
2. Assumes all responsibility for providing and installing cable tray.
3. Responsible for Security Systems grounding and bonding.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Security Contractor’s Responsibility:

1. Assumes all responsibility for the low voltage security wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the “Suggested Matrix of Scope Responsibility.”
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of security equipment which is required to be bonded to the telecommunications bonding system.

5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5” and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5” and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
2. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the installation, termination, testing, and placing into operation electronic security devices shall be individually trained by the manufacturer.

3. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
4. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of electronic security devices and have personnel adequately trained in the use of such tools and equipment.
5. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
 - a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

B. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of Madison, Wisconsin's Codes, Laws, Ordinances and other regulations having jurisdiction.
2. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.
5. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

C. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.

5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. All equipment, and materials shall be as approved or listed by the following: (Unless approval or listing is not applicable to an item by all acceptable manufacturers.)
 - a. Factory Mutual
 - b. Underwriters' Laboratories, Inc.

D. Examination of Drawings:

1. The drawings for the Security Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

E. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

F. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.8 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

<u>Referenced Specification Section</u>	<u>Submittal Item</u>
28 13 00	Electronic Access Control
28 23 00	Video Surveillance

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Architect/Engineer

- d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
3. Composition:
- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

- 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. **The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 28 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 28 XX XX.description.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

D. Paper Copy Submittal Procedures:

1. Paper copies are acceptable where electronic copies are not provided.
2. The Contractor shall submit ten (10) paper copies of each shop drawing.
3. Each set shall be bound in a three-ring binder or presentation binder. Copies that are loose or in pocket folders are not acceptable.

1.9 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:
 - a. Material: Delivered cost of product with taxes paid.
 - b. Labor: Labor cost, excluding overhead and profit.

1.10 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
- B. Change order work shall not proceed until authorized.

1.11 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
 - 1. Firestopping, including mechanical firestop systems.

1.12 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
- B. Store materials on the site to prevent damage.
- C. Keep fixtures, equipment and materials clean, dry and free from harmful conditions.

1.13 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.14 WARRANTY

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 28 may require additional warranty requirements for specific equipment or systems.
- B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.
- C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.15 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.16 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.
- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.1 REFER TO INDIVIDUAL SECTIONS

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 05 33. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.
- C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.
- D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

- A. General:
 - 1. Refer to specific Division 28 sections for further requirements.
 - 2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
 - 3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
 - 4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
- B. Protection of cable from foreign materials:
 - 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
 1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
 2. Refer to the end of Section 27 05 00 for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
 3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.
- C. Before final payment will be authorized, this Contractor must have completed the following:
 1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
 2. Submitted bound copies of approved shop drawings.
 3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
 4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
 5. Submitted testing reports for all systems requiring final testing as described herein.
 6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.

7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site insert address here; submit receipt to Architect/Engineer prior to final payment being approved.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div28.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div28.contractor.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, _____ paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.
2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2"12mm thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.

12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.

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- D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- E. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.
- F. Refer to the individual specification sections for minimum hours of instruction time for each system.
- G. Operating Instructions:
 1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the security systems.
 2. If the Contractor does not have Engineers and/or Technicians on staff that can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM COMMISSIONING

- A. The security systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.

- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.
- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- C. This Contractor shall maintain at the job site, a separate and complete set of Security Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record actual routing of all conduits sized 2" or larger.
- E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

3.10 SPECIAL REQUIREMENTS

- A. In accordance with LEED EQc4.1, Low-Emitting Materials - Adhesives and Sealants, all adhesives and sealants used on the interior of the building must comply with the following requirements:
1. Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.
 2. Aerosol adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

3.11 CONSTRUCTION WASTE MANAGEMENT

- A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).
1. This Contractor shall coordinate with the **General Contractor Construction Manager** to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.
 2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor's scope of work. The Contractor shall provide this information to the **General Contractor Construction Manager** so that it can be incorporated with similar information from all other contractors for the project.
 - a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the **General Contractor Construction Manager** to establish the preferred calculation method and report the results accordingly.
 - b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.
 3. At a minimum, **50% 75%** of the construction and demolition debris for this project must be recycled or salvaged.

END OF SECTION

SECTION 28 13 00

ELECTRONIC ACCESS CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Server
- B. Client Workstations
- C. Field Control Hardware
- D. Application Software
- E. Access Control Graphical User Interface
- F. Credentials and Badging
- G. Portal Devices

1.2 RELATED WORK

- A. Section 08 71 00 – Door Hardware
- B. Section 26 05 13 – Wire and Cable
- C. Section 26 05 33 – Conduits and Boxes
- D. Section 27 05 26 – Communications Bonding
- E. Section 27 05 28 – Interior Communication Pathways
- F. Section 27 05 43 – Exterior Communication Pathways
- G. Section 27 05 53 – Identification and Administration
- H. Section 27 15 00 - Horizontal Cabling Requirements
- I. Section 28 05 00 – Basic Electronic Safety and Security System Requirements.
- J. Section 28 23 00 – Video Surveillance
- K. Section 28 31 00 - Fire Detection and Alarm Systems.

1.3 QUALITY ASSURANCE

- A. Manufacturer: The manufacturer shall have a minimum of ten (10) years documented experience in the development and manufacture of access control software and hardware. The software developer shall be, at a minimum, a Microsoft Silver Certified Integrator and Partner for those systems that reside in a Microsoft environment.
- B. Contractor:
 - 1. Shall be a factory-authorized installation, service and support company specializing in the selected manufacturer's product, with demonstrated prior experience of a minimum of ten (10) years installing, programming and supporting the selected manufacturer's system.
 - 2. Shall have been in business for a minimum of ten (10) years and shall have installed a minimum of three (3) similar or larger sized systems. Contractor shall have a minimum of two (2) service technicians who are certified in the proposed manufacturer's system.
 - 3. Shall have as a regular, full time employee a minimum of one employee with the following certification(s) or education Should more than one certification be required, one employee may maintain multiple certifications.

- a. A certification of RCDD from BICSI or CNIDP from CNet.
- C. Material:
- 1. All material which is Contractor furnished shall be new, unused and free from defects.
 - 2. Where more than one of any specified item of equipment or material is used, all such items shall be the same product from the same manufacturer.

1.4 REFERENCES

- A. International Building Code
- B. NFPA 70 - National Electrical Code.
- C. The BOCA National Building Code
- D. UL 294 - Standard for Access Control Systems.
- E. UL 365 – Standard for Police Station Connected Burglar Alarm Units and Systems.
- F. UL 464 – Standard for Audible Signal Appliances.
- G. UL 603 – Standard for Power Supplies for Use with Burglar Alarm Systems.
- H. UL 609 - Standard for Local Burglar Alarm Units and Systems
- I. UL 634 – Standard for Connectors and Switches for Use with Burglar Alarm Systems.
- J. UL 827 – Standard for Central Station Alarm Services.
- K. UL 1076 – Standard for Proprietary Burglar Alarm Units and Systems.
- L. UL 1449 – Standard for Surge Protective Devices.
- M. UL 1635 – Standard for Digital Alarm Communicator Systems.
- N. UL 1638 – Standard for Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling.
- O. UL 1778 – Uninterruptible Power Systems.

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 28 05 00.
- B. Product Data Submittal: Provide manufacturer’s technical product specification sheet for each individual component type. Submitted data shall show the following:
 - 1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item.
 - 2. All component options and accessories specific to this project.
 - 3. Electrical power consumption rating and voltage.
 - 4. Heat generation for all power consuming devices.
 - 5. Wiring requirements.
 - 6. Server processor(s), workstation configurations, total and available disk space, and memory size.
 - 7. All network bandwidth, latency and reliability requirements.
 - 8. Backup/archive system size and configuration.

9. Submit two of each type of credential to be used (access card, key fob, etc.).
- C. System Drawings: Project-specific system CAD drawings shall be provided as follows:
1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as “typical” of the device shown. The diagram shall list room numbers where each controller will be located. This block diagram shall be provided in Adobe PDF.
 2. Provide a schedule of all controllers and the doors/points each controller controls. This schedule shall be provided in Adobe PDF.
 3. Provide schedules describing each system input location by an architecturally familiar reference, e.g., Door 312A. The architectural door schedule shall be used as the basis. These schedules shall be provided in Adobe PDF
- D. Submit sample format of site specific programming guides to be used for system planning/programming conference with Owner. These guides shall be provided in Adobe PDF.
- E. So that required Owner personnel are present at the planning/programming conference required in Part 3 of this section, submit meeting agenda for the conference a minimum of two weeks prior to the conference.
- F. Submit detailed description of Owner training to be conducted at project end, including specific training times. Refer to Part 3 of this section for details.
- G. IP Addresses: Contractor shall provide to Owner, in a documented transmittal and in Microsoft Excel format, the names and locations of devices which require an IP address. An authorized representative of the Owner shall furnish the addresses for the associated devices in Microsoft Excel format in a documented transmittal. Should Owner change the IP address structure after approval of the list, Owner may be responsible for additional fees involved with reprogramming.
- H. Quality Assurance:
1. Provide materials documenting experience requirements of the manufacturer and Installing Contractor. Provide documentation of the training and other applicable certifications of the Contractor.
 2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.

1.6 SYSTEM DESCRIPTION

- A. This section describes the furnishing, installation, programming and commissioning of a complete, turnkey access control system. The terms “access control system” and “security management system”, or SMS, may be used interchangeably herein.

- B. The company, manufacturer, and product names used in this section are for identification purposes only. All trademarks and registered trademarks are the property of their respective owners.
- C. Performance Statement: This section and the accompanying access control-specific design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming, and miscellaneous equipment required. The Contractor shall be responsible for determining quantities of materials required for a complete and operational system. Floor plan drawings and schedules have been developed to aid the Contractor in determining device quantities and installation locations, but, where discrepancies between floor plans and schedules arise, the greater number shall govern.
- D. Basic System Description:
1. The access control system shall provide the following functionality:
 - a. Electronic control access to designated areas.
 - b. Validation of cardholder credentials by use of personnel database, card formats. The system shall compare the time, location, and unique credentials of an attempted entry with information stored in the database.
 - c. Access to designated areas will be validated only when a user's credential has a valid number for its facility and the number is valid for the current time and for the reader where it is used.
 - d. The system software shall access the hardware that validates the person and monitors the security of a building by use of intelligent system controllers, reader interfaces, locks, readers, inputs and outputs. When access has been validated, a signal to the portal locking device shall be activated to enable alarm free access at that location.
 - e. The system shall be configured by use of application software.
 - f. The system shall monitor activities using operator monitoring software which includes graphical maps which display alarms, status and activity.
 - g. The system shall differentiate and restrict administrative and operational access through use of password authentication.
 - h. The system shall report on various aspects of the system by use of reports, both default and customizable. Reports shall be able to be printed.
 - i. The system shall have the capability to report alarms both audibly and visually.
 - j. The system shall control hardware from the monitoring station by use of manual actions and events.

- k. The system shall provide record and data management by use of journals. There shall be a full audit trail.
 - l. The system shall allow for data to be imported from other products by use of database migration tools. These products may include Human Resources databases for name and/or time and attendance information, information from previous access control systems consisting of badge numbers from credentials that will be re-used, Microsoft Excel spreadsheets, or other systems as defined herein.
 - m. The system shall allow access using a web interface or a mobile application for use on the iOS and Android operating systems.
- E. Integrations, Software Development Kit (SDK) and Application Programming Interface (API):
- 1. The manufacturers of the systems that are integrated shall make an SDK available to other manufacturers.
 - 2. Prior to the release of this section, the manufacturers of the systems that are to be integrated shall have made available to each other all APIs to perform the specific integrated functions required in this section.
 - 3. The integrations shall be completed and tested, and shall have been implemented on at least one system of similar size prior to the release of this section. The integrations shall not be accomplished for the first time for this project unless written pre-approval has been granted by Owner to Contractor prior to bid deadline.
 - 4. During the warranty period, should a new API or version of software be released by the SMS manufacturer or any of the manufacturers of systems or devices that are integrated, that API or version of software shall be installed in the appropriate system or device defined in this section at no charge to Owner. Should any loss of functionality in the integration be exposed through this installation, as compared to the accepted system, Contractor shall correct the functionality at no charge to Owner.
 - 5. Any and all development costs for specified functionality or inter-system integrations shall be included in the Contractor's bid. No additional costs or fees for the integrations shall be charged to Owner from the time of notice to proceed through system acceptance.

1.7 OWNER FURNISHED MATERIAL

- A. Telephone service
- B. Data circuit / internet service
- C. Active telephone service equipment, such as key system, PBX or VOIP switch equipment
- D. Active computer network equipment:
 - 1. Routers
 - 2. Servers
 - 3. Switches
 - 4. Hubs

5. Wireless access points
 6. Uninterruptible power supplies for Owner furnished products
- E. Active computer equipment:
1. SMS server – refer to Part 2 for details
 2. SMS workstation(s) – refer to Part 2 for details
 3. Uninterruptible power supplies for Owner furnished products
- F. Credentials:
1. RFID Tags

1.8 LICENSING REQUIREMENTS

- A. All user licenses required for system operation shall be included in the Contractor's bid. User licenses shall include server and workstation software, network controllers, card readers, printers, badging stations, and any other licensing that is required by the manufacturer for operation of any system component.
1. Licenses shall be provided on a one-to-one basis. One license shall be provided for each device requiring a license. In the event the manufacturer requires the purchase of a block of licenses, license blocks provided shall be no greater than what is required for the number of devices in this project. Contractor shall document the number of remaining licenses in the project record documents and Operations and Maintenance data.
 2. In addition to the licensing requirements listed above, provide licensing and configuration of system administration/operation software for 2 workstations. The workstation licenses shall be concurrent use seats, and the client software shall be able to be loaded on an unlimited number of workstations at no extra cost to the Owner. Contractor shall install client software on the same number of machines as licenses provided. As part of the training, Contractor shall demonstrate to Owner how to install client software on additional workstations.
 3. All Contractor-furnished software shall contain a perpetual, permanent license in which no other fees beyond the single payment for the work of this section are required in order to use the proposed software indefinitely. Owner understands that, after the initial warranty period has expired, maintenance and technical support fees may be required annually, quarterly, or monthly in order to receive software updates and technical support. However, it remains the option of Owner to purchase or decline this service. If Owner chooses to discontinue or never purchase this service, the software shall continue to be legally licensed for use. All software shall be the latest version released, and all Contractor-furnished servers and workstations shall be current on all patches and updates for all software on the machines at the time of acceptance of the associated systems.
 4. The SMS shall require only a single license key present on the server for the SMS to operate. The key shall be a physical device or a software key. License keys shall not be required at the client workstations.

1.9 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 28 05 00.

- B. Provide final system block diagram showing any deviations from shop drawing submittal.
- C. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.
- D. Provide schedules documenting:
 - 1. Controllor installation locations including specific door numbers being controlled.
 - 2. All terminal block wiring, including cable numbers.
- E. Warranty: Submit written warranty and complete all Owner registration forms.
- F. Complete all operation and maintenance data manuals as described below.

1.10 OPERATION AND MAINTENANCE DATA

- A. Submit documents under the provisions of Section 28 05 00.
- B. Manuals: Final copies of the manuals shall be delivered within 30 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system, and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. Manuals shall be submitted in electronic format only, Adobe PDF. The manuals shall consist of the following:
 - 1. Hardware Manual: The manual shall describe all equipment furnished including:
 - a. General description and specifications.
 - b. Installation and check out procedures.
 - c. System and equipment layout and electrical schematics to the control board and field device level. For multiple devices wired identically, only one wiring diagram is required per door configuration, to be labeled "TYPICAL".
 - d. Alignment and calibration procedures.
 - e. Manufacturers repair parts list indicating sources of supply.
 - 2. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
 - a. Definition of terms and functions.
 - b. System use and application software.
 - c. Initializations, startup, and shutdown procedures.
 - d. Reports generation.
 - e. Details on forms customization and field parameters.
 - 3. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:
 - a. Computers and peripherals.
 - b. Log in/Log out procedures.

- c. Use of system, command, and applications software.
 - d. Recovery and restart procedures.
 - e. Graphic alarm presentation.
 - f. Use of report generator and generation of reports.
 - g. Data entry.
 - h. Operator commands.
 - i. Alarm messages.
 - j. System permissions functions and requirements.
4. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, cleaning, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.11 WARRANTY

- A. Unless otherwise noted, provide warranty for one (1) year after date of Substantial Completion for all materials and labor.
- B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.
 - 1. Inspections: The Contractor shall perform two minor inspections at six-month intervals (or more often if required by the manufacturer), and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
 - 2. Minor Inspections: These inspections shall include:
 - a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
 - b. Mechanical adjustments if required on any mechanical or electromechanical devices.
 - 3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:
 - a. Clean all equipment, including exterior surfaces and accessible and serviceable interior surfaces.
 - b. Perform diagnostics on all equipment.
 - c. Check, test, and calibrate (if required) all sensors.
 - d. Run all system software diagnostics and correct all diagnosed problems.
- C. Operation: Upon the completion of any scheduled adjustments or repairs, Contractor shall verify operation of the SMS.
- D. Service: The Owner will initiate service calls when the SMS is not functioning properly. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Qualified service personnel shall be at the site within 24 hours after receiving a request for service.

- E. Records, Logs and Work Requests: Contractor shall keep records and logs of each task completed under and outside of warranty. These logs shall be maintained in Microsoft Word or Excel. The log shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, description of work performed, the amount and nature of the material used, and the time and date of commencement and completion of the work. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the SMS. The Contractor shall deliver a record of the work performed within three (3) business days after work is completed. Defective items that have been replaced shall be given to the Owner. Should the replacement item be a temporary replacement until the removed item is repaired, Contractor shall retain possession of the defective item for repair and subsequent re-installation.
- F. System Modifications: Modifications by the Contractor are allowed after system acceptance. Contractor shall make recommendations for system modification in writing to the Owner. No system modifications shall be made without prior, written approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Manuals, and other documentation affected. The Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.
- G. Software: At no charge, the Contractor shall provide to Owner all updates released by the manufacturer during the period of the warranty and verify operation of the system upon installation. These updates include system software updates, patches, bug fixes and revisions, as well as firmware updates. These updates shall be accomplished in a timely manner, fully coordinated with SMS administrators and operators, shall include training for the new changes/features, and shall be incorporated into the Operations and Maintenance Manuals and software documentation.
- H. Refer to the individual product sections for further warranty requirements of individual system components.

1.12 ANNUAL SERVICE CONTRACT

- A. Provide annual cost for extended service and maintenance agreement after the first year for the access control system according to the following terms:
 - 1. The term of the warranty shall begin on the system acceptance date and shall continue for one (1) year. The extended service and maintenance warranty shall begin following this first year if accepted by the Owner. The term shall be automatically renewed for successive one-year periods unless canceled in writing by the Owner with Contractor confirmed receipt, up to the date of expiration. The service and maintenance agreement shall include the following basic services to the Owner, including all necessary parts, labor and service equipment:
 - a. Repair or replace any security equipment item that fails to perform as initially installed, as specified, or as determined per the manufacturer's performance criteria.
 - b. Perform preventive maintenance on the security equipment during the 6th month and 12th month of the service contract. This preventive maintenance shall include cleaning, realignment, inspection, and testing of security

devices. The Owner shall receive a written report of these inspections that identifies the security system's status and, if required, a list of all necessary repairs or replacements.

- c. Provide maintenance on the SMS system software. At no charge, the Contractor shall provide to Owner all updates released by the manufacturer during the period of the service contract and verify operation of the system upon installation. These updates include system software updates, patches, bug fixes and revisions, as well as firmware updates. These updates shall be accomplished in a timely manner, fully coordinated with SMS administrators and operators, shall include training for the new changes/features, and shall be incorporated into the Operations and Maintenance Manuals and software documentation. Contractor shall not be responsible for maintenance of Owner data.
2. The Contractor shall be compensated for any repairs or maintenance provided as a result of Owner abuse, misuse, intentional damage, accidental damage, or power fluctuations exceeding specified equipment tolerances.
 3. Service: The Owner will initiate service calls when the SMS is not functioning properly. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Qualified service personnel shall be at the site within 24 hours after receiving a request for service.
- B. Provide complete terms and conditions of warranty and service.
 - C. The Owner will enter into a contract directly with the vendor. This specification section is not a contract between the Owner and the vendor to perform these services.

PART 2 - PRODUCTS

2.1 ELECTRONIC ACCESS CONTROL SYSTEM MANUFACTURERS

- A. Genetec Synergis
- B. Lenel OnGuard
- C. AXIS
- D. S2 Extreme/Enterprise
- E. Should the access control manufacturer offer, as an option, the use of hardware by Mercury Security, the Contractor proposed solution shall utilize this hardware. Contractor shall state whether or not the software is compatible with the SCP, AP and EP families of Mercury Security hardware. For future additions or defective hardware replacements, the system shall not be "locked" to require Mercury Security hardware be purchased only from the access control software manufacturer or from the original Installing Contractor.

F. Approval of Alternate Manufacturers:

1. Contractors seeking approval for alternate manufacturers for any devices or software in this section shall submit requests for approved equals as defined by Division 1 in addition to submitting:
 - a. Bill of materials for each piece of hardware and software proposed.
 - b. Manufacturer's data sheet for each piece of equipment proposed.
 - c. Line-by-line typewritten statement of compliance or non-compliance comparing Part 2 of this section with the published specifications of the proposed alternate products. This compliance statement shall be signed by an officer of the local contractor branch office that proposes to install the alternate product and either an officer of the manufacturer or an officer of the manufacturer's representative.
2. Refer to the project drawings for manufacturer and model numbers for the Basis of Design products.

2.2 SERVER

- A. The system shall not be required to have a traditional or virtual server and, instead, may be provided with embedded server functionality integral to the controller if the following three (3) conditions are met. The server specified below shall apply if the system does not meet these three (3) conditions:
 1. The network controller is a distributed architecture, native IP network appliance.
 2. The network appliance contains an onboard, embedded operating system (e.g., Linux-based), web server, ODBC-compliant database engine, data storage device and application logic controller.
 3. The network appliance contains onboard SSL communications.
- B. If the system architecture utilizes traditional servers, the system shall be a true multi-tasking, multi-threading application system architecture designed specifically for the Windows environment. All modules, including access control, alarm monitoring, credential management, etc., shall be built from a single unified 32-bit source code set.
- C. The system shall communicate on a TCP/IP based Ethernet LAN capable of utilizing 10/100/1000 BaseT.
- D. The system shall be functional in a virtual server environment.
- E. Provisioning:
 1. The server shall be furnished by the Owner and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality and performance specifications of the system and integrations defined in this and related sections. Contractor shall furnish specifications to the Owner in writing as part of the submittals. Owner furnished server may be traditional or may be virtual.

2. Backup Power:
 - a. Owner-furnished uninterruptible power supply (UPS) with surge suppression.

2.3 CLIENT WORKSTATIONS

A. Provisioning:

1. The workstation(s) shall be furnished by the Owner and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality and performance specifications of the system and integrations defined in this and related sections. Contractor shall furnish specifications to the Owner in writing as part of the submittals.

2.4 FIELD CONTROL HARDWARE

A. Interior Control Panels:

1. Control boards, power distribution and terminals shall be enclosed in a NEMA 1 rated enclosure that is key lockable. Contractor shall not furnish padlock. All enclosures that are part of this project shall be keyed alike. Contractor shall furnish and install a mechanically fastened tamper switch on the interior of the enclosure.
2. Control boards are allowed to be in an enclosure separate from the power supplies/power distribution. Should they be in separate enclosures, the interface wiring shall be in rigid metallic conduit, RMC, with Myers hubs at both ends of the conduit.
3. Intra-enclosure wiring shall be dressed using tie wraps and/or covered plastic wire way. Hook-up wires for identical purposes shall have the same color insulation. For example, if one input pair utilizes green and white insulated conductors, all similar inputs shall use green and white insulated conductors. The same color scheme shall be followed for all access control panels that are part of this project.
4. Cabling from field devices such as readers, door position switches, request-to-exit devices and locking devices shall not be directly terminated to the control boards and power supplies. The field devices shall be terminated to terminals located on the left side, right side or both sides of the enclosure back panel. Intra-enclosure wiring shall be routed from the terminals to the control boards and power distribution. Quantity and functional sequence of the terminals shall be identical portal to portal.
5. All devices inside the enclosure, less cabling and batteries, shall be mechanically fastened to a removable solid or perforated metal back panel with either:
 - a. Metal or plastic standoffs
 - b. DIN rail
6. Hook and loop fasteners, double sided tape or adhesives are not allowed to attach devices to the back panel. Mounting devices to the interior of the door shall only be allowed when the following two (2) conditions are met:

- a. The access control hardware manufacturer offers prefabricated enclosures with devices mounted to the interior of the door.
 - b. Only the same devices that the access control manufacturer mounts to the interior of the door are allowed to be mounted in a different enclosure, and those devices shall be mounted in an identical manner.
7. 120V 20A input power shall be hard wired to a circuit breaker disconnect and to one duplex receptacle on the interior of the enclosure. Should devices in the enclosures require plug-in transformers/power supplies, the receptacle shall be utilized. One (1) power strip with integrated circuit breaker shall be located in the bottom of the enclosure as needed.
8. Power to the locking devices shall be provided by a power distribution board with no fewer than four (4) outputs. Each lock shall be individually protected. The power distribution board shall:
 - a. Provide protection with fuses or positive temperature coefficient (PTC) devices.
 - b. Provide control so that each output is individually selectable as latching or non-latching with fire alarm activation.
 - c. Provide control so that each output shall have Fail Safe and Fail Secure terminals.
 - d. Provide a fire alarm input with associated trigger LED.
 - e. Provide an individual LED per output to indicate when an input has been triggered and the associated output has been activated.
 - f. Accept a dry, closed contact input to activate the individual lock outputs.
 - g. Provide a dry, Form C relay that energizes on activation of the fire alarm input. This output may then be used as a fire alarm input to other power distribution boards in the same or a different enclosure, or may provide input to another device such as a multi-pole relay.
9. Power to control boards, readers and auxiliary devices such as request-to-exit motion detectors shall be provided by a power distribution board with no fewer than four (4) outputs. All devices powered by the same voltage at an individual portal shall be protected by the same fuse or PTC unless current requirements dictate otherwise. Individual fuses or PTCs may protect more than one control board.
10. All access control panels, when populated with control boards and power supplies, shall have the following capacities:
 - a. Control of a minimum of two (2) portals.
 - b. Spare capacity of a minimum of one (1) access control portal, two (2) auxiliary inputs and two (2) auxiliary outputs greater than the requirements of the project at the time of system specification.

- c. Five (5) spare fuses of each type used, to be in their original packaging, to be located in each power supply enclosure.
 - d. 50% spare current capacity on all power supplies located in unconditioned spaces and 40% spare capacity for those in conditioned spaces. Lower spare capacities are allowable based on prior approval of Contractor-provided power calculations.
- 11. Locations where enclosures may be mounted are shown on the plans. Final location, with approval of Owner's representative, shall be selected by Contractor based on distribution of controlled portals and devices.
 - 12. At time of Substantial Completion, Contractor shall furnish a schematic diagram of intra-enclosure wiring and a complete bill of materials for the enclosures and the devices located within. This documentation shall include a schedule of fuses and the device(s) that each fuse protects. This documentation shall be placed by Contractor in a Contractor-furnished print pocket located on the inside of the enclosure door.
- B. Intelligent System Controllers (ISC):
- 1. The controller shall communicate with the host via an on board 10/100 Base T Ethernet port.
 - 2. The controllers shall be a distributed architecture with full peer-to-peer networking capability. Master/Slave controller configurations are not acceptable. All controllers in the system shall be capable of operating in a standalone mode if communication is lost with the server or main controller. In no case shall a controller depend on communication with an upstream controller for proper standalone operation.
 - 3. The communications bus shall be supervised for wiring integrity. If a communication failure is detected, the system shall report the loss. All controllers unable to receive communication shall operate as standalone devices including grant/deny decisions, complete with event buffers. All events shall be uploaded to the server upon restoration of communications.
 - 4. The controllers shall utilize flash memory or similar technology, allowing program updates to be downloaded from the server. Program storage shall be in ROM.
 - 5. The controllers shall have the capacity for 5,000 cardholders and 45,000 transactions. All access decisions involving these cardholders shall be made at the lowest controller level without communication to the server.
 - 6. 32-bit microprocessor controlled.
 - 7. Handle all non-host related access control monitoring and decision making.
 - 8. LED indicators for power, fault and communications.

9. Provide for local and global input/output linking:
 - a. The SMS shall support a global linkage feature whereby any input/output/event shall be linked to any other input/output/event in the SMS. Input/output linkages shall be able to span across intelligent system controllers.
 - b. System administrators shall be able to create global input/output function lists, each consisting of a sequence of actions to be performed, such as changing card reader modes, activating outputs, and opening or closing anti-pass back areas. Each function list may include up to six actions.
10. Reporting of transactions and status information to the server.
11. Interface with standard reader technologies without special interface hardware, additional logic panels or other integrators. Supported technologies shall include:
 - a. 13.56 MHz Contactless Smart with or without biometrics or keypad
 - b. 13.56 MHz Multi-technology Smart
 - c. Wiegand

C. Reader Interface Module (RIM):

1. Reader interface modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of reader interface modules required based on the inherent characteristics of each product line and the requirements and restrictions described in this document.
2. RIM shall interface with and accept data from TTL, Wiegand and RS-485 type readers and door hardware.
3. RIM shall provide a minimum of three (3) inputs per portal for portal position, request to exit and auxiliary input.
4. RIM shall provide a minimum of two (2) outputs per portal for locking device and auxiliary output. Each output shall be Form C and shall be rated at 3A at 28VDC.
5. RIM shall communicate to controller by RS-485.

D. Input Control Module (ICM):

1. The input control module shall provide supervised and non-supervised alarm input zones and monitor/report line fault conditions, alarm conditions, power faults and tampers.
2. Input control modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of input control modules required, based on the inherent characteristics of each product line and the requirements and restrictions described in this document.
3. UL 294 and 1076 listed.
4. Each input configurable for normally open or normally closed.

5. Each input configurable for timing.
6. Each input configurable for end of line resistance.
7. Status LEDs for communication to the host, heartbeat and input status.
8. Communications line supervision.
9. AES 128 bit encryption.
10. 2-wire RS485 communications.
11. No fewer than eight (8) inputs per board/control module.
12. Assignment of unit addresses and communications speed.
13. Alarm Masking: The ability to mask the alarm input on a time zone basis.
14. Activate Output: The ability for any input to activate any output.
15. Configuration of Debounce Time: The ability to control the amount of time that an input state change must remain consistent in order for it to be considered a real change of state.
16. Elevator control support for number of floors shown on the drawings.
17. Noise rejection filtering to prevent false alarms.
18. Global Linkage: The ability to link outputs with inputs that are attached to any ICM/output control module (OCM).
19. Checkpoint: The ability to configure an input as a designated stop on one or more guard tours.
20. Entry/Exit Delay: The ability to set up entry/exit delays for inputs that are attached to any ICM. This shall include:
 - a. Non-Latched Entry: When an input activates, the alarm will not be reported until the entry delay expires. If the input is still active when the entry delay expires, the alarm will be reported. If the input is not active when the entry delay expires, then the alarm will not report.
 - b. Latched Entry: When an input activates, the alarm will not be reported until the entry delay expires. If the input is still active when the entry delay expires and the alarm has not been masked, the alarm will be reported. If the input has been masked when the entry delay expires, then the alarm will not report.
 - c. Exit Delay: When an input activates, the alarm will not be reported (operates as if masked) until the exit delay expires. If the input is still active when the exit delay expires, the alarm will be reported. If the input is not active when the exit delay expires, the alarm will not be reported.

- E. Output Control Module (OCM) and Functionality:
1. Output control modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of output control modules required, based on the inherent characteristics of each product line and the requirements and restrictions described in this document.
 2. The output control module(s) shall provide Form C relay contacts for load switching, rated at 3A at 28VDC.
 3. Each relay shall support “On” “Off” and “Pulse.”
 4. Outputs can be pulsed from 0.1 seconds to 24 hours.
 5. Status LEDs for communication to the host, heartbeat and relay status.
 6. 2-wire RS485 communications.
 7. No fewer than eight (8) outputs per board/control module.
 8. Communications line supervision.

2.5 APPLICATION SOFTWARE

- A. General Performance:
1. The application software, in conjunction with the associated hardware, shall have the following features, functionality and capabilities. The functions that are to be implemented shall be determined in the planning conference between Contractor and Owner referenced in Part 3 of this section.
 2. All Users:
 - a. All users shall be capable of being authenticated against Active Directory using LDAP before being granted system access. Should the Owner not use Active Directory, the system shall provide a built-in login and credential management tool to permit rules-based access rights on a per-user basis.
 - b. The access rights shall be selectable on a per-user basis. In addition, user groups shall be capable of being assigned whereby each user group has a common set of access rights. Users shall be capable of being assigned to these user groups by the system administrator.
 3. Operators:
 - a. The SMS operator interface shall be standard Windows style graphical interface allowing point and click access to features such as drop-down menus, radio buttons, check boxes, list boxes and other standard Windows components.

- b. On-line Context Sensitive Help: The SMS shall provide on-line context sensitive help files to guide system administrators and system operators in the configuration and operation of the SMS. The help menu shall be available from any window in the SMS by pressing one function key or clicking on the "HELP" icon/selection in the toolbar. Help windows shall be context sensitive so operators and system administrators can move from form to form without leaving the help window. The SMS shall come with complete on-line documentation on CD or the ability to offload the documentation to removable media.
 - c. Operator Groups: A minimum of 32 operator groups, allowing specific system module privileges to be accessed with each module being granted specific views, edit and execute privileges.
 - d. Operator Levels: System access shall require a valid operator name and password, governing a specific operator's level of access to each menu item.
 - e. The SMS shall allow a system operator to login over another system operator who is already logged into the same client workstation without the need to reboot the system. This process shall log the first system operator off alarm monitoring and log the new system operator on, changing any permission necessary for that system operator.
4. Logs, Status, Maintenance, Diagnostics:
- a. Historical Log: The system shall allow event history to be written to the hard disk in an archive format. At a minimum, the system shall support 500,000 transactions. Warning messages shall be generated at a user defined level of capacity. The system shall have the ability to offload the archive files to removable media automatically or manually.
 - b. System Status: The system shall query the status of any or all of the system's access control points, inputs and outputs.
 - c. System Maintenance/Diagnostics: The system shall provide for remote diagnostic capabilities. In addition, online diagnostics and communications maintenance shall be able to be activated from the operator interface.
5. Administrator:
- a. The SMS shall provide system administrators with the ability to segment their access control SMS field hardware devices into various zones or areas where alarm monitoring client workstations will monitor. These zones shall be assigned an alphanumeric name using up to a minimum of 64 characters.
 - b. The SMS shall allow other devices such as card readers, input and output modules and intelligent system controllers to be automatically part of the monitoring zone when an intelligent system controller is selected, and it shall allow the system administrator to define which devices such as card readers, etc. belong to that monitor zone.

- c. Updating of monitor zones shall take place in real time and without requiring operators to re-login.

6. General:

- a. Elevator control support for the number of floors and cabs shown on the drawings.
- b. The SMS software shall be written to Microsoft's published standards for user interface design, secure coding practices and database implementation guidelines such as Microsoft Open Database Connectivity (ODBC) interface.
- c. All tasks shall be accessible from any compatible client workstation on the network using one or all of the following:
 - 1) Traditional client/server architecture.
 - 2) N-Tier architecture where the SMS shall support the expansion of the system architecture and allow for end-user deployment. The SMS shall allow, but not require, the separation of the database, application server, web server and client interface. The system shall require that all connections to the database be performed through a trusted link from the client or internet browser interface.
 - 3) Centralized publishing of applications using Windows Terminal Server and Citrix through any compatible internet browser application and/or by mobile computer including tablet PC.
- d. The SMS shall use an open architecture where all data must reside on a single database and must be accessible in real time to every SMS workstation or web-based client connected to the network. The system database shall be used to create and maintain the cardholder database. A screen designer module shall allow the creation and editing of custom database tables and data entry screens.
- e. The SMS shall be able to connect to and interface bi-directionally with external data sources using all of the following methods:
 - 1) ASCII with support for XML-formatted text exchange of data activated both manually and automatically.
 - 2) ASCII with support for XML-formatted text exchange of data using a direct table interface activated both manually and automatically.
 - 3) Real time exchange of data via Active Directory/LDAP utilizing an API supported by the SMS manufacturer. The live exchange of data shall permit exposure of SMS events and transactions to other data sources in real time and allow for receipt of data into the SMS, permitting this data to be acted upon and trigger linked events in the SMS in real time.

- f. Security: Access privileges within the application software shall be permitted by use of a password protection system. The cardholder database shall have the following password security levels.
 - 1) A minimum of six (6) unique operator access levels
 - 2) Ability to view only the database fields
 - 3) Ability to restrict operator viewing to any of the individual database screens within a record
 - 4) Ability to restrict operator viewing to any of the database partitions
 - g. Cardholder Configurations: The system shall have the capacity to support a minimum of 5,000 cardholder files. Each cardholder shall be capable of having up to five (5) access levels actively assigned to their account.
 - h. The cardholder database screen shall have the following data associated with each cardholder:
 - 1) Last edit by operator with edited date and time
 - 2) Last date/time card was used
 - 3) Last reader giving valid access
 - 4) Last reader denying access
 - 5) Anti-pass back status
 - i. The system shall provide advanced query capability with the following search criteria: equal to, not equal to, greater than, greater than or equal to, less than, less than or equal to, like, is empty, is not empty, is between, and, or, not.
 - j. Access Control Configuration: The configuration application shall be password protected, restricting what each individual may edit or display inside the configuration application.
 - k. Text descriptions of access points such as doors.
7. Time Zones:
- a. The SMS shall be capable of creating and storing up to 255 time zones. Each time zone shall have a minimum of six (6) intervals. Each interval shall be assignable to any day of the week.
 - b. Each time zone shall be assignable to an alphanumeric name. Time zones shall be applied to access levels, card reader modes, alarm inputs, alarm outputs, and alarm masking and logging functions. Time zones shall be allowed to belong to any or all access levels so that the time zone only has to be defined once.
8. Access Levels:
- a. The SMS shall be capable of defining a minimum of 32,000 access levels with a minimum of 32 access levels per cardholder per database segment. Access levels shall consist of a combination of card readers and time zones.

- b. Each access level shall be assignable to an alphanumeric name.
 - c. Card readers shall have the ability to be assigned to any or all access levels defined in the SMS. Individual card readers shall be capable of having a distinct time zone assigned to it.
 - d. The SMS shall allow an 'Allow User Commands' option to be assigned on a per access level basis where keypad readers are in use.
 - e. The SMS shall allow a 'First Card Unlock' option to be assigned on a per access level basis. First Card Unlock feature, when configured, retards a pre-determined time zone activated unlock command until a valid credential has been presented and granted access to the portal.
9. Temporary Access Levels:
- a. The SMS shall be capable of assigning temporary access levels inclusive of the 32,000 assignable access levels.
 - b. Each temporary access level shall be assignable to an alphanumeric name.
 - c. Each temporary access level shall be definable with a start and end date.
 - d. Temporary access levels shall be stored in the ISC, and functionality shall be maintained in the event of disconnection with the ISC.
10. Access Groups:
- a. The SMS shall be capable of assigning access groups, with a maximum of 32 access levels per access group.
 - b. Each access group shall be assignable to an alphanumeric name.
11. Precision Access Levels:
- a. The SMS shall be capable of assigning precision access levels in addition to the 32,000 access levels, with the ability to assign unlimited card reader and time zone combinations. Precision access levels provide capability of assigning a unique access level on a per card basis.
 - b. Each precision access level shall be assignable to an alphanumeric name.
12. Holidays:
- a. The SMS shall provide a minimum of 255 holiday assignments using an embedded calendar. Holidays shall be assigned an alphanumeric name and shall be grouped into eight (8) types of holidays, and shall be assignable to individual time zones. Access rights, card reader modes, and alarm masking schedules must be able to be altered when the current date is designated as a holiday.
 - b. Dates for Daylight Saving Time changes shall be definable and shall take effect automatically.

- c. The SMS shall support holiday ranges that allow a single holiday to span across multiple calendar days.

13. Database Segmentation:

- a. The SMS shall be required to support data segmentation whereby each segment shall have its own set of cardholders, field hardware, and system parameters (time zones, access levels, etc.). This segmentation shall expand the limitations of the SMS parameters (e.g., access levels and time zones) to the maximum capacity of each parameter multiplied by the number of segments. The following list shall be made available for segmentation:

- 1) Access group
- 2) Access levels
- 3) Actions
- 4) Action groups
- 5) Alarm inputs
- 6) Alarm mask groups
- 7) Alarm outputs
- 8) Areas
- 9) Credential types
- 10) Card formats
- 11) Cardholders
- 12) Card readers
- 13) Central station receivers
- 14) Device groups
- 15) Digital video archive servers
- 16) Fire alarm panels
- 17) Guard tours
- 18) Global I/O function lists
- 19) Global I/O links
- 20) Holidays
- 21) Intercom panels
- 22) Intercom stations
- 23) Intrusion detection panels
- 24) ISCs
- 25) Maps
- 26) Monitor zones
- 27) Precision access groups
- 28) Receiver accounts
- 29) System operators
- 30) Time zones
- 31) Tour groups
- 32) Visitors
- 33) User permission groups

14. Field Hardware Communications:

- a. The SMS shall support communications with the intelligent system controllers (ISCs) by the following protocols:

- 1) TCP/IP

- b. Download communication between the SMS and the ISC shall be fully multi-tasking and shall not interfere with operational functions.
- c. Upon loss of communications between the SMS server and the ISC, an alarm shall be created with a time stamp. Upon re-established communication, the SMS and the ISC shall automatically re-synchronize from the point of communication loss without operator intervention.

15. Intelligent System Controller Remote Support:

- a. The SMS shall support remote operations to and from the intelligent system controller (ISC). The remote connection shall be either a constant connection or a scheduled connection. If the connection is constant, then every panel shall have its own connection at the host. If the connection is scheduled, then all panels using remote connections shall have the ability to share the same host connection(s).
- b. System administrators shall have the ability to define the remote connections available in the pool. For each connection, system administrators shall be able to define the connection type and the client workstation to which it is installed.
- c. Remote sessions shall occur under any of the user defined scenarios:
 - 1) On Demand Connection: A system operator shall have the ability to automatically initiate a remote session to an ISC via the alarm monitoring module.
 - 2) Scheduled Connection: System administrators shall have the ability to configure the SMS so that the ISC remotes into the SMS at pre-determined times through use of time zones.
 - 3) Critical Alarm Activated: System administrators shall have the ability to configure the SMS so that the ISC initiates a remote session with the SMS when a critical alarm is activated in the field.
 - 4) Buffer Threshold: System administrators shall have the ability to configure the SMS so that the ISC initiates a remote session with the SMS when a pre-determined number of events are stored in the ISC memory buffer.
- d. Extended Individual Door Held Open Times:
 - 1) The SMS shall support Extended Individual Door Held Open Times that allow a card reader's door to be held open for an extended period of time beyond the pre-determined standard held open time on a per cardholder basis. The extended held open time shall be user definable up to eight (8) hours. Extended held open times shall be set on a card reader by card reader basis.

- e. Extended, On Demand, Door Held Open Times:
 - 1) The SMS shall support Extended, On Demand, Door Held Times via a command keypad located in the field. The Extended Held Open command configuration shall consist of a command key sequence that shall be from three to six keys used to enter the number of minutes to extend the door held open time (up to 999 minutes) and a pre-alarm time (from 0 to 30 minutes).
 - 2) Only those cardholders having command authority at a given card reader configured for 'Allow User Commands' shall have the ability to execute the Extended Held Open command at that card reader. The Extended Held Open command shall be available after a valid cardholder has received an access grant at the card reader. The cardholder shall have a period of 15 seconds after the access grant to enter the extended held open command sequence.

- f. Graphical System Overview Tree:
 - 1) A Graphical System Overview Tree shall display a graphical representation of all field hardware including hardware from other systems which are interfaced, System administrators shall be able to modify a device that is depicted on the Graphical System Overview Tree or see its properties by double clicking on the icon, and the SMS shall bring them to the appropriate form.

- g. Pre-Alarm:
 - 1) The SMS shall support a Pre-Alarm feature at the card reader. The pre-alarm will sound a tone at the card reader prior to the door held open alarm. The pre-alarm setting shall be configurable for up to the maximum allowable door hold open time.

- h. Alarm/Event Logging:
 - 1) All alarms and events in the SMS shall, by default, always be recorded in the database. The SMS shall give system administrators the ability to select, on a time-zone basis, the times that they require the SMS to log specific events to the database.
 - 2) System administrators shall have the option for particular alarm/events to be set to log or not to log on any individual reader and/or input.

- i. Scheduling Utility:
 - 1) The SMS shall provide an integral Scheduling Utility. The Scheduling Utility shall allow system administrators to schedule actions to occur on a one-time or a recurring basis. Recurring schedules shall be configured to begin immediately, last indefinitely, or have optional start and end dates.
 - 2) The Scheduling Utility shall be available from both the system administration and alarm monitoring modules.

- 3) The types of actions that shall be schedulable include, but are not limited to:
 - a) Action Group
 - b) Event Archiving/Purging
 - c) Arm/Disarm Area
 - d) Start of Guard Tour
 - e) Execution of Scripts
 - f) Activate, Deactivate, Pulse Device Output and Device Output Groups
 - g) Global Anti-Pass back Reset
 - h) Download Firmware to equipment.
 - i) Download Database to ISCs
 - j) Execute Function List
 - k) Mask/Unmask Inputs, Input Groups, Alarm Mask Groups, Door Forced Open or Held Open
 - l) Open Door, Open Door Group
 - m) Change Reader Mode
 - n) Automatic Reports
 - o) Reset Use Limit
 - p) Move Bulk Credentials from an Area
 - q) Deactivate Credentials
 - r) Logout Visitors
 - s) Schedule PTZ Presets
- 4) The Scheduling Utility shall maintain a history log in the database for actions that it executes.

16. Multiple Card Formats:

- a. Each ISC shall support a minimum of eight (8) access control card formats and, if applicable, eight (8) asset formats.

17. Denied Access Attempts Counter:

- a. The SMS shall support a Denied Access Attempts Count on a per card reader basis. The “Denied Attempts Count” value shall be configurable from 0 to 255. The following access denial types shall cause the current denied count to be incremented:
 - 1) Unknown PIN entry at a card reader configured as ‘PIN or Card’ mode.
 - 2) Invalid cipher entry at a card reader in Cipher Mode.
 - 3) Invalid PIN entered for a given card at a card reader configured as ‘Card and PIN’ mode.
 - 4) Non-matching biometric presented for a given card at a card reader in Biometric Verify mode.

18. Card Reader Time Zone Overrides:

- a. The SMS shall allow for the pre-defined default card reader settings to be overridden or temporarily changed on a time-zone basis. At the beginning of the selected time zone, the selected card reader's operational mode shall be modified from its default mode to any one of the following modes: Locked, Unlocked, Facility Code, Card Only, Card or PIN, Card and PIN, Card and Biometric, Card or PIN and Biometric, and/or Card and PIN and Biometric. The aforementioned options shall be available depending on the type of card reader used.
- b. Each card reader shall have the ability to have multiple time zone setting overrides assigned to them as required by the system administrator.

19. Alarm/Event Routing:

- a. The SMS shall be capable of allowing system administrators to route alarms and events to various alarm monitoring client workstations on the network. The SMS shall allow any alarm or event to be routed to one or multiple client workstations on the network regardless of where the alarm is generated in the field. Alarms shall be routed to client workstations on a device-by-device level.
- b. The SMS shall be capable of automatic re-routing of an alarm from workstation X to workstation Y if the alarm is not responded to within a user definable time period.
- c. The SMS shall implement network synchronization such that in the event that an alarm is routed to multiple client workstations, once the first client workstation acknowledges the alarm, the alarm shall be cleared from all other client workstations. As such, alarms that are routed to an Alarm Monitoring client workstation that does not have a System Operator logged in shall be queued so that all unacknowledged alarms will report to that client workstation once a System Operator has logged into the SMS. Alarms/Events shall be routed based on default settings or time zone control.

20. Alarm Attributes:

- a. The system administrator shall have the ability to configure how the SMS handles the annunciation of alarms on an individual basis. Each alarm and/or event shall have the option(s) to:
 - 1) Display at one or more alarm monitoring client workstation.
 - 2) Allow higher priority alarms to be displayed on the alarm monitoring client workstation ahead of lower priority alarms.
 - 3) Require the field device that generated the alarm to be restored to its normal state before the alarm is cleared.
 - 4) Print the alarm to the local event printer.

- 5) Have a customized voice message annunciate at the client workstation.
- 6) Have the alarm breakthrough to the alarm monitoring window should the system operator be working in another application
- 7) Allow system operators to change the journal entry once the alarm has been acknowledged.
- 8) Ensure that the alarm will not be able to be deleted from the alarm monitoring window upon acknowledgment.
- 9) Display text and audio instructions outlining the procedures to follow when responding to the alarm.
- 10) Automatically call-up associated maps.
- 11) Automatically call up the associated cardholder record.
- 12) Automatically call up the associated cardholder photo using the video verification function.
- 13) Require a password to view the alarm.
- 14) Require a password to acknowledge the alarm.
- 15) Require acknowledgment to clear.
- 16) Allow mandatory journal entry upon acknowledgment.
- 17) Use pre-defined journal entries for alarms.
- 18) Select the option for journal entry based upon the specific alarm.
- 19) Send surveillance interface commands to the surveillance system.
- 20) Automatically send an e-mail message.
- 21) Automatically send an alphanumeric page.
- 22) Have the alarm appear on the alarm monitoring window with a flashing colored coded bar across the alarm for high priority alarms.
- 23) Have the alarm, when acknowledged, display an alternative flashing color coded bar across the alarm than for the original alarm color.
- 24) Trigger a function list(s) when the alarm is acknowledged.
- 25) Require user logon for acknowledgment.

- 26) Have the ability to mark an alarm as “In Progress” where the system shall silence any repeating audio notifications on the workstation where the alarm was routed, and remove the alarm sprite notification on the graphical map. Additional operators’ monitoring alarms shall be notified that the alarm has been marked “In Progress”.

21. Alarm-Event Mappings:

- a. The SMS attributes in Alarm Attributes shall be assignable on a ‘global’ basis to all devices that share an alarm description. Thus, the ‘Door Forced Open’ alarm attributes shall apply to any door with a card reader that is forced open in the SMS. The SMS shall have the capability to assign a unique group of alarm attributes to specific device/alarm combinations to override the global settings for specific case settings. Each device/alarm combination shall have the ability to have its own unique attribute set if the system administrator desires.

22. System Downloads:

- a. The SMS shall provide for the downloading of data to the ISCs. Downloads shall load SMS information such as time zones, access levels, alarm configurations, cardholder information and card reader configurations.
- b. All ISCs on the SMS shall be capable of either full or selective downloads to individual intelligent system controllers, and bi-directionally so that alarms will still report to their respective alarm monitoring client workstations as cardholder information is being downloaded.
- c. Information on cardholder status, credential status, time zones or access levels shall download in real time as they are added, modified, or deleted from the SMS.

23. Portal Configuration Options:

- a. The SMS shall include the following options for each portal on the system:
 - 1) Allow user commands such as manual door unlock
 - 2) Rename auxiliary inputs
 - 3) Rename auxiliary outputs
 - 4) Independently supervise REX and DPS
 - 5) Configure REX and DPS as Normally Open or Normally Closed
 - 6) Deny if duress
 - 7) Assume door used
 - 8) Alarm masking
 - 9) Activate outputs
 - 10) Two card control
 - 11) Checkpoint
 - 12) Do not activate strike on REX
 - 13) The ability to allow system administrators to determine on a time-zone basis to log or not to log on a card reader by card reader basis
 - 14) Access grants

- 15) Access denied
 - 16) Card reader status alarms
 - 17) The SMS shall allow for user definable door strike functionality for each card reader in the SMS
 - 18) The SMS shall allow for each card reader to be selected as either an 'In' reader, 'Out' reader, or 'None' to allow for ease of reporting time and attendance basic 'Time In' and 'Time Out' data.
 - 19) Enforce Use Limit: This option shall enable card use limits at the card reader. limiting the number of times that cardholders may use their credential to gain access at the card reader
 - 20) Supervise Door: Sets the SMS so that the card reader door contact is wired as a supervised input
24. The SMS shall allow for one or more access points in a specified area to be armed and disarmed directly from a control keypad.
25. Real-Time, Live Video User Verification:
- a. The SMS shall have the capability of interfacing to a surveillance system and displaying a live video image next to a stored cardholder image record. This feature shall be system configurable.
26. Traces:
- a. The SMS shall allow for a live or historical trace on any ISC, ICM, alarm input, credential (cardholder), intrusion detection device, monitor zone, or card reader. If applicable, the SMS shall allow for a trace on any asset, intercom, or camera. Multiple traces may be run simultaneously. The SMS shall allow system operators to filter alarm types from the history trace window. Alarms that shall be filtered from the trace window are access granted alarms, access denied alarms, system alarms, duress alarms, and area control alarms.
 - b. Destination Assurance: The system shall provide the ability to alert the system operator when a cardholder does not reach a required location and present their credential after entering at a designated checkpoint in a designated period of time.

2.6 ACCESS CONTROL GRAPHICAL USER INTERFACE (GUI)

- A. A workstation based custom GUI shall be provided for complete display of real time system activity.
- B. The GUI shall provide the following features:
 - 1. Display in real-time, the status of devices by dynamically changing shape or color to indicate status.
 - 2. Acknowledge alarm conditions.
 - 3. Perform manual operations on all monitor and control points.
 - 4. Perform graphic editing functions.

5. Customization of icons color or shape based on status.
- C. Graphical representations shall be made of the following activity:
1. Cardholder Activity: Access granted (including duress), access denied, lost card used, stolen card used, inactive card used, unescorted visitor.
 2. Input Point Activity: Input condition (normal, abnormal, cut, short, shunt, unshunt).
 3. Output Point Activity: On status (automatic, by operator, by link), off status (automatic, by operator, by link), access level on, access level off.
 4. Door Activity: Auto unlock, auto lock, closed, opened, forced open, left open, door switch cut, door switch shorted, REX status (cut, shorted, normal, abnormal), input unlock, operator lock, operator unlock.
 5. Controller Activity: Controller on-line, controller off-line, controller communications normal, communications cut.
 6. System Activity: System error, workstation start, workstation stop, printer off-line, printer unavailable, printer overflow, unknown card.
 7. Regional Group Activity: Occupancy restriction (high limit, low limit), anti-pass back (entry, exit), policy violation, escort left, number of escorts, numbers of users, number of visitors.
- D. The GUI shall have the ability to display a minimum of 100 custom graphical screens, developed by the SMS vendor with electronic maps provided by Owner.
- E. The system shall have the ability to automatically call up specific maps. Each input point shall be linked to a primary map.
- F. Graphical editing software shall be included, allowing the Owner to create and edit the graphical screens.
- G. Graphics screens shall be developed using a minimum of eight (8) colors from a palette of 64 available.
- H. The system shall operate on a Windows workstation as provided and recommended by the SMS vendor.

2.7 CREDENTIALS AND BADGING

- A. Badging Station:
1. Provisioning:
 - a. The workstation(s) shall be furnished by the Contractor and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality and performance specifications of the system and integrations defined in this and related sections. Contractor shall coordinate with Owner for possible requirements to utilize a specific manufacturer. Contractor-furnished workstation(s) shall have a three (3) year limited warranty.

2. Software:
 - a. General:
 - 1) The SMS shall support a credential design module that is integral to the SMS source code with the ability to create and maintain credential designs. Features shall include the ability to support:
 - a) Complete credential design and layout tools
 - b) Chroma key
 - c) Image import
 - d) Ghosting
 - e) Signature capture
 - f) Barcodes
 - g) Smart chip support
 - b. Licensing
 - 1) Required badging/credential management licensing shall be furnished.
3. Hardware:
 - a. Workstation by owner
 - b. Printer:
 - 1) Printer Manufacturer shall be:
 - a) Fargo
 - b) Magicard
 - 2) The SMS shall support a printer with industry standard and Microsoft certified drivers. The printer shall support:
 - a) Double sided printing at a resolution of no less than 300 dpi, full color on the front, monochrome on the back
 - b) Edge to edge printing
 - c) High speed printing per card of a minimum of 7 seconds for monochrome and 35 seconds for YMCKO
 - d) Holographic overlay
 - e) Inline magnetic stripe encoding
 - f) Inline Contactless Smart card encoding
 - g) An input feeder/hopper with a minimum capacity of 100 cards and an output stacker/hopper with a minimum capacity of 30 cards
 - c. Images:
 - 1) Camera:
 - a) The badging station shall be compatible with flash lighting and USB connected cameras, allowing the capture of a cardholder image at a minimum resolution of 3 mega pixels.

- b) SMS image capture, storage, and hardware compression techniques must be in compliance with the ANSI standard or JPEG (Joint Photographic Experts Group).
- c) The SMS shall provide the ability to capture a cardholder's image through the use of any industry standard scanner or digital camera that utilizes a TWAIN interface. Images shall be able to be scanned at up to 16.7 million colors for a true color scanned image. When using a digital camera that supports multiple resolutions, the system shall allow the operator to select the desired resolution.

2) Image Import:

- a) The SMS shall allow system operators to have the ability to import a cardholder's image at the time of enrollment. The SMS shall support importing image formats of Bitmap (.bmp, .dib), JPEG (.jpg), JFIF (.jif), Adobe Photoshop (.psd), Macintosh PICT (.pct), Portable Network Graphics (.png), TIFF (.tif), Windows Metafile (.wmf, .emf).

4. Badge Design:

- a. Provide training and work in conjunction with Owner for development of four (4) badge designs.
- b. Cleaning Kits:
 - 1) One cleaning kit shall be provided for every ribbon provided.
- c. Lanyards and Sleeves:
 - 1) Lanyards and badge sleeves shall be furnished by Owner.
- d. Badge Quantities:
 - 1) Badge quantities and types shall be as defined below.

B. Credentials:

- 1. Multi-Technology Contactless Smart Cards: 13.56 MHz and 125 kHz proximity radio frequency identification electronics, passive design. Card shall meet ISO 15693 and ISO 14443B2 standards.
 - a. Maximum Dimensions: CR 79: 3.313" x 2.063" x 0.04", CR 80: 3.375" x 2.125" x 0.04".
 - b. Construction to be of PVC or polyester laminate.
 - c. Each card shall contain a unique serial number.

- d. Cards shall contain options for various memory capacities of 2k, 16k or 32k with a fixed number of application areas or areas which are sized by dynamic allocation.
- e. Each application area shall contain a unique authentication key. The card and reader shall require matching keys in order to function together. All RF communication between card and reader shall be encrypted using a secure algorithm.
- f. Cards shall be encoded with bit lengths that are compatible with all other components of the SMS.
- g. Cards shall support programming and updating of custom applications after issue.
- h. Cards shall be capable of having a photo and/or other graphical images printed directly on the surface of the card.
- i. Provide optional slot punch-outs on the short and long edge of the card.
- j. Provide min. 10 multi-technology cards. Cards shall be individually numbered with sequential matching of internal and external numbers.
- k. Cards shall be provided with a lifetime warranty;

C. Credential Management:

- 1. The SMS shall support a Credential Management and Enrollment module that is integral to the SMS source code with the ability to create and maintain the cardholder database. Features shall include the ability to:
 - a. Add, modify and delete records based upon permissions
 - b. Capture photo images, biometric information and signatures
 - c. Print credentials
 - d. Boolean search on any single or multiple fields
 - e. Customization of screen layout and field names
 - f. Advanced customization of fields, field names and screen tabs (pages) with optional Forms Designing and Editing module
 - g. Determine single or multiple active credentials
 - h. Assign access levels and access groups
 - i. Bulk assignment/modification/deletion of access levels
 - j. Bulk deletion of cardholder records.
 - k. Native support for U.S. Government CHUID Standard
 - l. Limit the number of times the credential can be printed
 - m. Limit the access for searching the database based upon user defined criteria
 - n. Mobile badging operations.
- 2. The SMS shall support the following bar codes:
 - a. Code 3 of 9 (3:1)
 - b. Code 93
 - c. UPCA
 - d. EAN 13

- e. EAN 8
- f. Code 128 A
- g. Code 128 B
- h. Code 128 C
- i. Codabar
- j. PostNET (Zip + 4 Postal)
- k. Code 3 of 9 (2:1)
- l. Interleaved 2 of 5 (2:1)
- m. PDF-417 (2D)
- n. Code 128 Auto
- o. UCC-128
- p. MSI Plessey
- q. Extended Code 3 of 9
- r. Extended Code 93
- s. 2D Aztec

2.8 PORTAL DEVICES

A. Credential Readers:

1. Manufacturers:
 - a. HID Multiclass SE
2. Multi-Technology:
 - a. Compatible with 125 kHz proximity, 13.56 MHz Contactless Smart card, MIFARE, DESFire EV1.
 - b. Backwards compatibility with legacy 13.56 MHz Contactless Smart cards and 125 kHz proximity access control formats, including 26, 32, 35, 37 bit as well as HID Corporate 1000 format.
3. Card readers manufactured specifically for non-access control applications shall not be acceptable.
4. Provide compatibility with most access control systems by providing card data outputs in Wiegand and Clock/Data.
5. Allow the firmware to be updated in the field without the need to remove the reader from the wall.
6. Secure mounting methods using tamper resistant screws.
7. An audio beeper that provides various tones to signify access granted, access denied, power up and diagnostics.
8. Tri-color LED or three (3) LEDs for visual notification of various conditions.
9. ISO1443A, 1443B and 15693 compliant.
10. The ability to transmit an alarm from an integrated tamper switch.

11. Support dual authentication of identity through the combined use of access badge and personal identification number (PIN) on an integrated 12 key keypad.
12. PBT polymer or UL94 polycarbonate.
13. Read Range:
 - a. Using 125 kHz cards or 13.56 MHz Contactless Smart cards, minimum operational read range shall not be less than one (1) inch after the readers have been installed in their permanent locations.
14. Operational voltage of 5-16 VDC, with operating temperature range of -31° F to 150° F, and rated for outdoor use with a minimum rating of IP55.
15. Readers and credentials shall be compatible with each other and shall be from the same manufacturer.
16. Available in sizes to be mounted to a standard single gang box or to a mullion. Maximum sizes:
 - a. Single gang box mount, with or without keypad: 5.1” x 3.1” x 1.1”
 - b. Mullion mount: 6.0” x 1.9” x 0.9”
17. Lifetime warranty against defects in material and workmanship.

B. Gate Position Switch

1. Manufacturers:
 - a. GE
 - b. GRI
 - c. Honeywell
 - d. Pre-approved equal
2. Gate:
 - a. Maximum 1.5 (1-1/2) inch gap
 - b. DPDT contacts
 - c. Three feet (3’) stainless steel armored cable
 - d. Aluminum construction
 - e. Basis of Design: UTC/GE/Sentrol 2507AD

C. Cable:

1. Composite cable is allowed, although sufficient conductors may not be available in composite cables for all portal configurations. Contractor shall be responsible for additional required cables beyond one composite cable to each portal to meet functional requirements of the system.
 - a. Reader: 16 AWG, 3 pair, stranded, overall shield. Shield shall be grounded at control panel end only. Request to Exit Motion Detector: 22 AWG, 4 conductor, stranded.
 - b. Door Position Switch: 16 AWG, 2 conductor, stranded.

- c. Lock: Minimum 16 AWG, 4 conductor, stranded.
 - 1) Lock may require heavier gauge cable depending on door hardware solution power requirements. Contractor shall coordinate with door hardware provider for higher current devices and shall adjust the gauge of the lock cable accordingly.
 - d. Auxiliary Devices: Refer to plans for requirements.
- D. Locks and Door Hardware:
- 1. Electric/electronic locks shall be furnished and installed by the door hardware provider.
 - 2. Access Control Contractor shall interface with and terminate cables to locks.
 - 3. Access Control Contractor shall coordinate with door hardware provider for specified sequences of operation at the various portals.
 - 4. Refer to architectural specifications and/or the architectural door schedule.

2.9 ASSET MANAGEMENT

- A. The Asset Management System (AMS) shall be provided as an integrated solution that is seamlessly integrated with the SMS and all integrated SMS systems. All asset data shall be stored in the SMS database, and all related functions and features of the SMS shall be incorporated into the AMS.
- B. The AMS shall employ a distributed architecture so that all access / asset decisions are only made locally at the ISC. All assets shall be stored locally at the ISC, and all decisions to grant asset access shall be made by the local ISC. Decisions made at the Host or Database Server PC shall not be allowed.
- C. The AMS shall employ asset technology independence. The AMS shall support multiple asset technologies including radio frequency identification (RFID) and barcode.
- D. The AMS shall support multiple card reader technologies. The AMS shall support any card reader that outputs a standard Wiegand communications protocol, including proximity and barcode readers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with the manufacturer's instructions and recommendations for installation of all products.
- B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.
- C. Network controllers shall be installed centralized in the nearest telecommunications room(s). Mount controllers to the structural walls in a location coordinated with other utilities.

- D. Provide wiring and connection to all electrified locking hardware devices. Complete programming and testing of all electrified locking hardware devices.
- E. Install all credential readers in accordance with manufacturer's instructions where shown on floor plans, in accordance with the Americans with Disabilities Act (ADA) requirements. Provide wiring and connection to all credential readers. Complete programming, adjustment, and testing of all credential readers.
- F. Provide wiring and connection to all hardware request-to-exit devices that are integral to electrified door hardware. Provide wiring and connection to all request-to-exit motion detectors. Complete programming and testing of all integrated request-to-exit devices. Where possible, avoid false activation by persons passing by but not exiting.
- G. Install all request-to-exit motion detectors in accordance with manufacturer's instructions directly above the door frame, centered on the door opening. Adjust sensitivity to permit operation on motion of persons within 2'-0" of door. Avoid false activation by persons passing by where possible.
- H. Install all request-to-exit pushbuttons in accordance with manufacturer's instructions where shown on floor plans, in accordance with the Americans with Disabilities Act (ADA) requirements. Provide wiring and connection to all request-to-exit pushbuttons. Complete programming, adjustment and testing of all request-to-exit pushbuttons.
- I. Install all door alarm contacts in accordance with manufacturer's instructions either recessed in the door header or surface mounted as required. Provide wiring and connection to door alarm contact devices. Complete programming, adjustment and testing of all door alarm contacts.
- J. Install all duress switches in accordance with manufacturer's instructions, surface mounted under counter in locations shown on plans. Verify exact mounting location with Owner prior to cable rough-in or installation. For hard wired devices, provide wiring and connection to duress switch devices. For wireless duress switch devices, mount receivers in accessible locations. Complete programming, adjustment and testing of all duress switch devices. Wireless testing shall include signal reception when transmitter is in all sections of the area in which it will be used in normal operations.
- K. Install, wire, configure, adjust, program and test all access control system servers, workstations, badging workstations and other user interfaces.
- L. Install, wire, configure, adjust, program, and test all specified interfaces and integrations between access control and other systems. Contractor shall provide all cabling, wiring, terminations, components, devices, accessories, hardware, software and other material and accessories necessary to complete all specified interfaces and integrations and make them fully operational.
- M. All low voltage access control cabling shall be installed in conduit from end to end. Electronic access control system cabling shall not be spliced.
- N. Flexible conduit is not allowed except with prior approval. Refer to Section 26 05 33 for conduit requirements. Refer to Section 27 05 28 for cable hanger and support requirements.
- O. Each cable shall be appropriately identified, as defined on the record documents, at each end's termination point using pressure sensitive label strips.

- P. The conductor color code used in terminating system cabling at system devices shall remain consistent from device to device for each unique device type throughout the project.
- Q. Install and tighten all connectors in accordance with manufacturer's instructions using the appropriately designed tools recommended by the manufacturer for that purpose. Do not strip or damage connectors, terminals, or equipment by over tightening termination fasteners.
- R. Grounding and Bonding Requirements:
 - 1. Provide a minimum of 6AWG bonding conductor from each electronic access control system control panel, power supply and surge suppression device to the nearest telecommunications grounding busbar. Actual bonding conductor size is determined by its length; refer to Section 27 05 26 for grounding and bonding conductor sizing criteria.
 - 2. Cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground the shield only at the control panel end.
- S. Coordinate installation of all devices with other trades and utilities in the vicinity.
- T. Cabling shall be plenum rated when installed outside conduit in plenum ceilings.

3.2 FIELD QUALITY CONTROL

- A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.
- B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.
- C. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL) as suitable for purpose specified and indicated.

3.3 MANUFACTURER AND INTEGRATOR COMBINED FIELD SERVICES

- A. Installation shall be performed by a factory-trained and certified Contractor.
- B. The Contractor shall provide a comprehensive, site-specific customer planning guide for the system. The Contractor shall conduct conference(s) with the Owner prior to any installation to discuss the programming and configuration options of the system and the planning guide.
- C. The Contractor shall include labor for all planning and all programming activities required to implement the Owner's access policies for each system point and each operator and administrator. Any software programmable access policy, within the bounds of the hardware specified, shall be included.

- D. It shall be the responsibility of the Contractor to provide a complete, functional system as described by the design documents. These responsibilities include:
1. Complete hardware setup, installation, wiring and software configuration of the system server, all workstations and all peripheral hardware.
 2. Complete programming of all operator software in accordance with the Owner's access policies determined by the planning guide conference(s).
 3. Manual data entry of 10 cardholders based on a printed roster provided by the Owner.
 4. Configuration of the network software for operation of the system. Templates shall be established representative of all user access right levels.
 5. Programming of all cardholder database screens including cardholder information screens, report templates, queries, etc. Encoding of 10 proximity cards shall be included.
 6. Programming of all custom graphic GUI screens including devices.
 7. Complete system diagnostic verification.
- E. The SMS Installation Contractor shall be present at meetings to coordinate all door hardware requirements with the door hardware vendor.

3.4 SYSTEM DOCUMENTATION

- A. Complete documentation shall be provided for the system. The documentation shall describe:
1. All operational parameters of the system
 2. Complete documentation of programming and access policies
 3. Complete operating instructions for all hardware and software
- B. The following sections shall be provided in the system documentation:
1. System Administrator Manual: Provides an overview and a step-by-step guide and instructions detailing all system administrator responsibilities and functions.
 2. User Manual: A step-by-step guide and instructions detailing all system user functions.
 3. Alarm Monitoring Manual: A step-by-step guide and instructions detailing all alarm monitoring system functions and responsibilities.
 4. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams and schematic diagrams.
 5. Refer to Part 1 for details.

- B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.
- C. The system shall not be accepted until all requirements of system documentation and training have been completed.

END OF SECTION

SECTION 28 23 00

VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Network Video Management System (NVMS).
- B. Video Storage Solution
- C. Cameras and Accessories.
- D. Video Printer.
- E. Equipment Racks.
- F. Cabling.

1.2 RELATED WORK

- A. Section 26 05 33 - Conduit and Boxes
- B. Section 26 05 13 - Wire and Cable
- C. Section 27 15 00 – Horizontal Cabling Requirements
- D. Section 28 05 00 - Basic Electronic Safety and Security System Requirements
- E. Section 28 31 00 - Fire Detection and Alarm Systems
- F. Section 28 13 00 - Electronic Access Control

1.3 QUALITY ASSURANCE

- A. NVMS Software Developer (Manufacturer): The NVMS system shall be a single-source manufacturer such that the single manufacturer develops, supports, and warranties the NVMS software solution. The manufacturer shall have three (3) years documented experience.
 - 1. The software developer shall be, at a minimum, a Microsoft Gold Certified Integrator and Partner for systems that reside in a Microsoft environment.
- B. Integrator/Installer (Contractor): The Contractor must be a NVMS-certified installation, service, and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming. The installer shall retain a Microsoft MCSE or equivalent technician for the purposes of server deployment, software configuration, and system integration.
 - 1. The integrator must have local service representatives within 30 miles of the project site.

1.4 REFERENCES

- A. NFPA 70 - National Electrical Code
- B. Electronic Industries Association (EIA) Video Surveillance Equipment Standards
- C. UL 2044 - Standard for Commercial Closed Circuit Television Equipment
- D. UL 3044 - Standard for Safety for Surveillance Closed Circuit Television Equipment

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 28 05 00.

- B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
1. Compliance with each requirement of these documents.
 2. All component options and accessories specific to this project.
 3. Electrical power consumption rating and voltage.
 4. Heat generation for all power consuming devices.
 5. All required wiring shall be identified.
 6. Number of IP addresses that will be required from the Owner's Information Systems Department.
 7. Statement of Acceptability of Designed Server:
 - a. If the Contractor agrees that the server(s) designed and described herein is acceptable for the chosen manufacturer's solution and meets the demand of the application, this shall be stated in writing and submitted as part of the shop drawing submittal.
 - b. If the Contractor does not agree that the server(s) designed and described herein is acceptable for the chosen manufacturer's solution, Contractor shall itemize the quantity, technical specifications, and capacities of the servers required to support the functionality and device quantities required by the project drawings. Indicate the capacity utilization factor for each server.
 - c. Contractor's bid shall include any required changes in server(s) capacity.
 8. Calculation for storage required using the criteria contained in the project drawings.
 9. Calculation for required network bandwidth, including any latency restrictions.
 10. Provide annual cost and all terms and conditions for the NVMS Software Maintenance Agreement. Include all additional costs and terms and conditions for any Annual Service Contracts provided by the Contractor for all services that are not included in the Software Maintenance Agreement.
- C. System Drawings: Project-specific system CAD drawings shall be provided as follows:
1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical cameras), the diagram may show one device and refer to the others as "typical" of the device shown.
- D. Sample format of site specific programming guides to be used for system planning/programming conference with Owner.

3.5 SYSTEM TRAINING

- A. All labor and materials required for on-site system training by a certified representative of the system manufacturer shall be provided. Training shall be conducted at the project site using the project equipment.
- B. Coordinate training days and times with Owner.
- C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- D. At a minimum, the following training shall be conducted:
 - 1. System Administrators: A course detailing the system functions, configurations and operations. Provide training on all aspects of the system including data import/export, report, cardholder management, system workstation and server configuration and maintenance, software and hardware configuration and peripheral hardware operation.
 - 2. Operators: A course detailing the operational features of all aspects of the user interface. Topics shall include alarm monitoring functions, reports, error handling, alarm handling, output relay control, operation of integrated systems interface, and general overview of the report hardware.
 - 3. GUI Editing: Conduct detailed training on using the GUI editing software. Topics shall include the editing of existing graphical maps and the creation of new graphical maps.
- E. Minimum on-site training times shall be:
 - 1. System Administrators: Four (4) hours
 - 2. Operators: Eight (8) hours.
 - 3. GUI Editing: Eight (8) hours.
 - 4. Integrations : Eight (8) hours
 - 5. Badging System: Four (4) hours.
 - 6. Four (4) additional hours of training each quarter for the 12-month period of the project warranty shall be provided. A minimum of half of this additional training shall be on site; the remainder may be support by telephone or email. Contractor shall document this training, including dates performed, trainer and Owner representative(s) present. Each phone call or email shall be documented as a minimum of 15 minutes duration.

3.6 SYSTEM ACCEPTANCE

- A. The SMS vendor shall submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components, software and functionality. The Contractor shall perform the tests and document all results under the supervision of the manufacturer's systems engineer.

- E. Meeting agenda for planning/programming conference required in Part 3 of this specification.
- F. Submit detailed description of Owner training to be conducted at project end, including specific training time.
- G. Quality Assurance:
 - 1. Provide materials documenting experience requirements of the manufacturer and installing contractor.
 - 2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.
- H. Coordination Drawings:
 - 1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 28 05 00 for coordination drawing requirements.

1.6 SYSTEM DESCRIPTION

- A. This specification section describes the furnishing, installation, commissioning and programming of a complete, turnkey, closed circuit television system.
- B. Performance Statement: This specification section and the accompanying project drawings are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
- C. Refer to the project drawings for model numbers for the Basis of Design for all equipment.

1.7 OWNER-SUPPLIED MATERIALS

- A. Workstation, Servers, IT Switches

1.8 LICENSING REQUIREMENTS

- A. All licenses required for system operation shall be included in the Contractor's bid. Licenses shall include, but not be limited to, server and workstation software, cameras, encoders/decoders, and any other licensing that is required by the manufacturer for operation of any system component.
 - 1. Camera licensing that is restricted to a particular device MAC address or in any way is only valid for a particular manufacturer or model number is not acceptable. Camera licenses shall be issued such that the Owner can replace a camera with another camera brand and/or model number and transfer the license from the old camera to the new camera at no additional cost at any future time. This license transfer procedure shall be capable of being performed by the Owner and shall not require the services of an integrator.

- a. Exception: When a camera license is issued as a no-cost license in the limited condition that the NVMS manufacturer and the camera manufacturer are the same company, it is permissible to charge a future license fee to the Owner if the Owner elects to replace the NVMS manufacturer-branded camera with a third-party manufacturer's camera.
2. The Contractor shall fill out the NVMS Bid Inventory Form located herein and provide at the time of bid.

1.9 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 28 05 00.
- B. Provide final system block diagram showing any deviations from shop drawing submittal.
- C. Provide statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.
- D. Provide final camera type and camera requirements schedules documenting all changes made during construction.
- E. Warranty: Submit written warranty and complete all Owner registration forms.
- F. Complete all operation and maintenance manuals as described below.

1.10 OPERATION AND MAINTENANCE DATA

- A. Submit documents under the provisions of Section 28 05 00.
- B. Manuals: Final copies of the manuals shall be delivered within 30 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the manufacturer for each piece of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:
 1. Hardware Manual: The manual shall describe all equipment furnished including:
 - a. General description and specifications.
 - b. Installation and check out procedures.
 - c. System layout drawings and schematics.
 - d. Alignment and calibration procedures.
 2. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper installation, testing, and operation. The manual shall include:
 - a. Definition of terms and functions.
 - b. System use and application software.
 - c. Graphical user interface use.
 - d. Reports generation.

3. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:
 - a. Computers and peripherals.
 - b. System startup and shutdown procedures.
 - c. Use of system.
 - d. Recovery and restart procedures.
 - e. Use of report generator and generation of reports.
 - f. Data entry.
 - g. Operator commands.
 - h. Alarm messages.
 - i. System permissions functions and requirements.
4. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.11 WARRANTY

- A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.
- B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.
 1. Inspections: Perform one minor inspection six-months after Substantial Completion and one major inspection prior to the expiration of the warranty.
 2. Minor Inspections: Inspections shall include:
 - a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
 - b. Mechanical adjustments if required on any mechanical or electromechanical devices.
 - c. Install all available software updates, patches, or bug fixes available from the NVMS manufacturer.
 3. Major Inspections: Inspections shall include all work described under paragraph Minor Inspections and the following work:
 - a. Clean all equipment, including interior and exterior surfaces.
 - b. Perform diagnostics on all equipment, including all system software diagnostics, and correct all diagnosed problems.
 - c. Adjust all camera alignments that have become out of alignment from their documented position at Substantial Completion.
 - d. Install all available software updates, patches, or bug fixes available from the NVMS manufacturer.

- e. All warrantable system deficiencies during the Major Inspection shall be remedied under warranty at no cost to the Owner.
- C. Operation: Upon the performance of any scheduled adjustments or repairs, verify operation of the NVMS system.
- D. Emergency Service: The Owner will initiate service calls when the NVMS system is not functioning properly. Qualified personnel shall be available to provide service within the distance defined above. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365.
- E. Records and Logs: Keep records and logs of each task completed under warranty. The log shall contain all initial settings upon Substantial Completion. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the NVMS system.
- F. Work Requests: Record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what must be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. Deliver a record of the work performed within five (5) days after work is accomplished.
- G. System Modifications: Make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. To the fullest extent possible, the Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.
- H. Software: Provide all software updates during the period of the warranty and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with NVMS system operators, shall include training for the new changes/features enabled, and shall be incorporated into the operations and maintenance manuals, and software documentation.
- I. Refer to the individual product sections for further warranty requirements of individual system components.

1.12 SOFTWARE MAINTENANCE AGREEMENT/ANNUAL SERVICE CONTRACT

- A. The Owner will enter into a contract directly with the vendor. This specification is not a contract between the Owner and the vendor to perform these services. The cost and terms of the SMA *may* be used by the Owner for NVMS solution selection.

PART 2 - PRODUCTS

2.1 NETWORK VIDEO MANAGEMENT SYSTEM – GENERAL REQUIREMENTS

- A. The network video management system (NVMS) shall be an enterprise-class client/server based video security solution that provides management of digital video, audio and data across a TCP/IP network a commercial class PC-based software solution that provides management of digital video and data across a TCP/IP network.

- B. Provide a turnkey solution that includes furnishing, installation, and configuration of a separate IP network, complete with all required network electronics, switches, and other hardware. The VMS shall utilize network switch ports provided by the Owner for all required IP connections. Provide the Owner with a complete list of all IP ports required.
- C. ONVIF Compliance
1. The NVMS system shall be ONVIF certified as an ONVIF Network Video Client.
 2. Cameras shall be ONVIF certified as an ONVIF Network Transmitter unless specifically noted as an exception to this requirement in the project drawings.
- D. The NVMS system shall be an “open system.”
1. To meet this requirement, the NVMS must directly support cameras from a minimum of three (3) readily available camera manufacturers.
 2. The three (3) camera manufacturers must have no corporate relationship to the NVMS manufacturer.
 3. “Directly support” shall be defined as plug-n-play using drivers that are commercially available at the time of bid.
 4. In addition to the requirement to support three (3) independent manufacturer’s cameras, the NVMS may support an unlimited additional quantity of in-house or other proprietary cameras.
 5. The open system shall not require proprietary storage solutions. It shall support third party storage solutions, including:
 - a. Commercially available Direct Attached Storage (DAS) devices.
 - b. Network Attached Storage (NAS) devices.
 - c. Storage Area Networks (SAN) for primary or archival storage purposes. Primary support for SAN shall be defined as:
 - 1) The ability to directly record to SAN device without first recording to an NAS or DAS.
 - 2) The NVMS is provided with a user experience that makes the video recorded to the SAN transparent to the user. This shall be defined as:
 - a) Full search, bookmarking, and other software features for finding, marking, locating, and identifying video are supported by the NVMS for video recorded to a SAN in an identical way to video that is recorded to an NAS or DAS.
 - b) No loading of the video from the SAN into the NVMS shall be required.

- c) Full playback, windowing of camera video, archiving, and exporting is supported by the NVMS for video recorded to the SAN in an identical way as video recorded to an NAS or DAS.
- 6. The system must have a published API/SDK permitting third party integrations to the product without restrictions.
- 7. The NVMS shall support active directory using LDAP protocol.
- E. The NVMS system shall consist of the following hardware/software components:
 - 1. Software:
 - a. Server and client
 - b. Recording services, archival services, and storage management
 - c. Configuration tools
 - 2. System storage as specified on the project drawings.
 - 3. Cameras and related hardware as specified on the project drawings.
 - 4. Hardware: Servers, workstations, and miscellaneous hardware (keyboard, mouse, KVM) as specified on the projects drawings.
 - 5. Network electronics and related hardware and software as specified on the project drawings.
- F. Video from any camera on the system (on the LAN, WAN or Internet) shall be capable of being viewed from single or multiple workstations simultaneously at any time, limited only by network bandwidth.
- G. The NVMS shall support simultaneous displaying of live (30 fps) video of a minimum of 16 cameras while the video monitoring screen is configured in a 16-camera split configuration. In no case shall the frame rate of the camera be required to be restricted to less than 30 fps to display a 16-camera split view.
- H. Simultaneous display and recording of every camera shall be supported with independent user-adjustable frame rates that can be set differently for the display stream and the recording stream. These independent settings shall be unique per camera.
- I. The NVMS monitoring software shall support any combination of recorded and live video in any multiple camera split view, including viewing recorded video and live video from the same camera.
- J. The NVMS shall support continuous recording and event-based recording simultaneously. This shall be capable of being set on a per camera basis.
- K. Viewing of video (live and recorded) shall be possible from client software from any client hardware that is connected to the security LAN/WAN or Internet (through appropriate firewalls). In addition, system administration shall be permitted from remote client hardware.

2.2 NVMS MANUFACTURERS

- A. Basis of Design: Genetec
- B. ONSSI
- C. Milestone

2.3 NVMS SERVER REQUIREMENTS

- A. The NVMS shall operate on the Windows 2008 Server Operating System. The server software shall be a multi-tasking, multi-threading application system architecture designed specifically for the Windows environment.
- B. The server shall communicate on a TCP/IP based Ethernet LAN capable of utilizing 100/1000BaseT.
- C. The server shall be provided by the Owner.
- D. The server(s) requirements have been calculated based on the NVMS Basis of Design manufacturer noted above. By submitting a bid, the Contractor acknowledges that the calculated server requirements listed here may not be sufficient for a listed alternate, acceptable manufacturer selected by the Contractor. The Contractor shall modify the calculated server requirements listed herein based on the calculated requirement of the chosen manufacturer. The server requirements for the basis of design are as follows:
 - 1. Server Quantity and Location: Refer to project drawings for quantity of servers required and their location.

2.4 NVMS CLIENT REQUIREMENTS

- A. The NVMS PC workstation(s) shall be provided by the Owner.

2.5 NVMS SYSTEM DETAILED REQUIREMENTS

- A. Network Requirements: The NVMS shall support Ethernet 10/100 BaseT and Gigabit Ethernet.
 - 1. Network protocols shall be supported including TCP/IP, IPX, and UDP.
 - 2. The network interface shall allow remote access of the NVMS from anywhere on the end-user's LAN/WAN or Internet (behind firewall).
 - 3. The system shall permit limiting of frame rate transmission to individual clients.
 - 4. Both Multicast and Unicast shall be supported.
 - 5. All transmission of system data shall be secured using Secure Socket Layer (SSL) security on the TCP/IP network.
 - 6. Simple Network Management Protocol (SNMP) shall be supported.
- B. Video Formats:
 - 1. The NVMS shall support MPEG-4, and H.264 compression formats.

2. The system shall support any single stream of bandwidth up to 90Mbit/sec at 30 fps at 4872 x 3248 resolution with no system performance degradation, assuming appropriate network bandwidth.
3. Video shall be recorded using a 256-bit encryption algorithm with authentication (watermarking) software suitable for evidentiary proceedings. The watermarking feature shall provide evidence of altered video.
 - a. The video shall be watermarked with the authentication key/signature during recording of live video to the drive.
 - b. A video player shall be provided with the NVMS system.
 - 1) The player shall have the ability to validate the authentication upon playback.
 - 2) This authentication shall provide the storage media name, camera name, video time, and user information.
 - 3) The authentication shall have the ability to be password protected.
4. Resolution:
 - a. The camera resolution shall be user selectable on a per-camera basis. Selecting or changing resolution shall not require a restart of the application, server, or workstation.
 - b. The system shall support the following resolutions:
 - 1) NTSC Resolutions: 0CIF (176 x 120), CIF (352 x 240), 2CIF (704 x 240), 4CIF (704 x 480).
 - 2) VGA Resolutions: QVGA (320 x 240), VGA (640 x 480), SVGA (800 x 600), XVGA (1024 x 768), 4xVGA (1280 x 960).
 - 3) Megapixel Resolutions: SXGA (1280 x 1024: 1.3MP), SXGA + EXGA (1400 x 1050: 1.4 MP), UXGA (1600 x 1200: 1.9MP), WUXGA (1920 x 1200: 2.3MP), QXGA (2048 x 1536: 3.1MP), WQXGA (2560 x 1600: 4.1MP), QSXGA (2560 x 2048: 5.2MP), 3296 x 2472: 8MP, 4000 x 2672: 11MP, 4864 x 3248: 16MP, 6576 x 4384: 29MP.
 - a) 16:9 and 4:3 formats shall be supported.
 - 4) HDTV Resolutions: 720p, 1080(i/p) in 16:9 format.

C. Remote Clients:

1. The NVMS system shall include the ability to view live video or playback recorded video over the LAN/WAN or the Internet from any PC. This function shall NOT require any installed client software. An industry standard Web Browser (e.g., Internet Explorer, Firefox, Chrome) shall be the only software required to view non-authenticated video from a remote PC.

- a. Any plug-ins (e.g., ActiveX, Java, Flash) required to view remote video shall be capable of being pushed to the user's PC at the time of initiating the remote video viewing session.
- b. Remote viewing shall be supported whether the remote client is:
 - 1) Inside the firewall containing the NVMS.
 - 2) Outside the firewall containing the NVMS.
 - 3) Accessing the NVMS through a VPN.

2. Remote Client Features:

- a. Display live video.
- b. Digital zooming and panning of fixed cameras.
- c. PTZ camera control in real time, including adjusting PTZ lock and dwell times.
- d. Ability to access video from all accessible recording devices.
- e. Priority-based camera control takeover.
- f. Customizable camera viewing screen split configurations that are retained under the user login between remote client sessions.

D. Mobile Clients (Apps):

- 1. The NVMS shall include a mobile video viewing application for the operating system.
 - a. The iOS application shall be a single universal application supporting both the iPhone 4s and iPad 2 resolutions. An iPhone application that scales up for use on the iPad using the iPad 1x/2x feature is not acceptable.
 - b. The Android application shall be a universal application that supports Android smartphones and Android tablets. The Android application shall support Android codeset name Ice Cream Sandwich and may require a minimum installed codeset of Gingerbread.
- 2. Features:
 - a. The mobile client shall permit viewing of live video or playback of recorded video.
 - b. Split screen video display shall be supported. The split screen shall permit live and recorded video simultaneously in the screen split. The screen split layout shall be retained between mobile client sessions.
 - c. Provide time synchronization of the video of different cameras to account for mobile network latency to ensure that live video from multiple cameras is time synchronized.

- d. The mobile client shall be optimized with video compression to support video viewing on mobile networks. The mobile client shall maintain a minimum of 7 fps per camera on a mobile network performing at 200 Kbit/s with a latency of 200ms.
 - e. All transmission of system data shall be secured using Secure Socket Layer (SSL) security at a minimum.
3. Licensing:
- a. Provide licensing for 1 iOS mobile clients.
 - b. Provide licensing for 1 Android mobile clients.
- E. Workstation Client Software Requirements:
- 1. The client software for the NVMS shall run as an application on Windows 7 64-bit. The client software shall not require a PC more robust than that defined above in the section entitled “NVMS CLIENT REQUIREMENTS.” Should the workstation client software require a PC configuration more robust than that defined herein, the cost of upgrading the workstation hardware to the more robust requirement shall be paid by the Contractor.
 - 2. Licensing:
 - a. Provide licensing for 2 concurrent clients on the system.
 - 3. The client software shall provide video signal detection and provide alerts whenever video is lost on any input channel.
 - 4. Updates to the client software shall be capable of being pushed to all clients from the NVMS server.
 - 5. The client software shall provide a graphical mapping feature. The graphical map shall accommodate the importation of CAD files, or custom development of floor plans or site plans to create a to-scale or not-to-scale graphical representation of the system layout including all cameras.
 - a. Cameras located on the graphical map shall be “live,” which is defined as the ability to click the camera in the graphical user interface (GUI) to see camera information and live video. The camera name shall be available to the user via a “mouse hovering” maneuver over the camera icon.
 - b. For site cameras, the graphical map shall consist of an overall site plan showing all exterior cameras. Buildings and other physical entities on the site shall be graphically represented.
 - 1) The buildings shown on the site plan shall visually indicate to the user that cameras are located inside that building’s interior, if applicable.
 - c. The user shall be able to click a building that contains cameras to obtain a new graphical layout of that building. Once the building interior layout graphical map is on screen, interior cameras shall be represented by icons.

- d. The user shall have the ability to navigate back to the main (previous) graphical map via a single-click graphical icon.

6. Camera Configuration:

- a. Each camera shall be configurable for a 32-alphanumeric character name.
- b. The system shall allow for the setup and adjustment of brightness, contrast, archiving, motion detection, and Pan/Tilt/Zoom on a per camera basis.
- c. The NVMS shall support a separate frame rate for recording and a separate frame rate for viewing for every camera input (assuming the camera provides two streams). These frame rates shall be capable of being independently set for each camera input.
- d. The NVMS shall support the PTZ control of analog NVMS cameras through the encoders.
- e. The compression algorithm formats MJPEG and MPEG4 shall be supported in the same system and shall be individually selectable on a per-camera basis.
- f. Each individual camera shall be capable of having individual camera settings that shall include (at a minimum):
 - 1) Continuous recording.
 - 2) Motion-based recording capability shall be provided including:
 - a) Motion as determined by the NVMS software using:
 - (1) Entire screen motion detection
 - (2) User defined area triggers
 - b) Motion as determined at the camera.
 - c) Motion trigger by digital inputs from external trigger systems such as contact closures, alarm inputs, POS integration, etc.
 - (1) Motion triggers received by external trigger inputs shall be recorded by the event recording capabilities of the NVMS and identifiable on a timeline during playback and in reports.
 - 3) Alarm-initiated recording.
 - a) When a camera enters alarm recording mode, the NVMS shall have the capability of changing to different camera settings for the recorded video during the duration of the alarm mode. The settings capable of being changed shall include the frame rate and the resolution. These setting changes shall be configurable in advance per camera by the User through the software GUI.

- 4) Time-based recording on a preset schedule.
- 5) Manual (user) activation of the start and stop of the recording process through the GUI.
 - a) The NVMS software shall prevent any user from manually starting and stopping the recording of video based on that user's login credential.
- 6) Defined pre-event and post-event recording buffers shall be provided for all non-continuous recording events.
- 7) Each camera shall be capable of having unique storage retention settings.

F. Software Security Requirements:

1. All users shall be capable of being authenticated against Active Directory using LDAP, before being granted system access. Should the Owner not use Active Directory, the NVMS shall provide a built-in login and credential management tool to permit rules-based access rights on a per-user basis.
2. The access rights shall be selectable on a per-user basis. In addition, user groups shall be capable of being assigned whereby each user group has a common set of access rights. Users shall be capable of being assigned to these user groups by the system administrator.
3. Access rights available for customization shall include:
 - a. Live Video Viewing:
 - 1) Use of PTZ controls.
 - 2) Start and stop of manual recording.
 - 3) Access to and exclusive from individual cameras and monitors.
 - 4) Access to system settings.
 - 5) Ability to define video blocking positions of PTZ cameras for certain users.
 - b. Viewing Recorded Video:
 - 1) Ability to export recorded video, including email.
 - 2) Access to system archiving and backup.
 - 3) Ability to watch recorded video from individual cameras.
 - 4) Ability to delete recorded video.
 - c. Camera Setup:
 - 1) Add or remove cameras from the system.
 - 2) Change camera settings including resolution and frame rate.
 - 3) Change motion detection and other defined triggers.

d. General Settings:

- 1) Change client software settings.
- 2) Ability for user to configure or change custom viewing screen configurations.
- 3) Modify server settings.
- 4) Change recording or bandwidth settings.
- 5) Configure users.
- 6) Access and configure external messaging capabilities.
- 7) View, print, save and clear the system log.

G. Pan/Tilt/Zoom (PTZ) Control:

1. The NVMS shall support PTZ control from any client, including remote and mobile clients.
2. The following PTZ features shall be supported:
 - a. Priority Levels
 - b. Device Group Control
 - c. PTZ Override (Lockout)
 - d. Proportional PTZ Control
 - e. Preset Lock via video screen
 - f. Preset Tour

H. Video Archiving:

1. The archiving feature shall be hardware independent, providing the ability to utilize commercial off-the-shelf mass storage devices as archived video destinations, including optical DVD, DAS, NAS, SAN, and other external storage drives.
2. The archiving software shall provide the ability to manage and store video information from multiple recorded video locations to a central location.
3. Each NVMS server shall have the ability to set its own unique archiving settings. Video shall automatically be archived based on user-defined "percentage full" settings. When the NVMS reaches the designated capacity threshold, video shall be automatically copied to the archive storage destination, and space on the source of the recorded video shall be released for overwrite by new video information using a first-in, first-out algorithm.
 - a. Exception: Video marked or tagged by the user or by automated alarm inputs shall be retained by the archiving process despite its location in the first-in, first-out timeline.
4. Regardless of the video's storage location (local or in the archive), the NVMS software shall automatically retrieve video associated with an event on demand by the user in response to a search, browse, or other retrieval action. The actual storage location of the video shall be transparent to the user.
 - a. Exception: Video archived to removable media (e.g., removable hard drives or optical DVD) shall require prompting to the user to insert the appropriate media.

5. Archiving shall be capable of being scheduled such that archiving will only run during certain hours defined by the Owner.
 6. The NVMS solution shall be permitted to utilize advanced algorithms for managing onboard storage such as reducing the frame rate of recorded video for the oldest video as an alternative to completely removing the video using a first-in, first-out algorithm. If this option exists in the NVMS software, it must have the following features:
 - a. Ability of the Owner to completely disable the feature.
 - b. Ability to set a minimum frame rate that the system will not exceed.
 - c. Ability to set the feature on a per-camera basis.
- I. Video Viewing Layouts:
1. The NVMS shall support the ability to save the list of camera views currently being displayed, along with the currently selected template, with a user-defined name to be loaded as needed by the system operator.
 2. System operators shall have the ability to define multiple viewing templates that can be recalled and configured on an as-needed basis.
 3. This feature shall be subject to the access rights provided by the system administrator through their login credential.
- J. Still Image Capture/Save:
1. During playback or monitoring of video, the system shall have the ability to create and save a still picture. This operation shall not affect any other operation and shall not alter the recorded video. The file format shall be an industry standard format (JPEG, TIFF) allowing for file transfer via e-mail, printing, or file transfer to other media.
 2. This feature shall be subject to the access rights provided by the system administrator through their login credential.
- K. Export Video Clip to File:
1. The NVMS shall have to ability to save and export recorded video to a file (MPEG, AVI) for sharing and reviewing video clips. The start and end times for each video segment shall be user defined. The exported video clip shall be viewable via a standard Windows media player.
 2. This feature shall be subject to the access rights provided by the system administrator through their login credential.
- L. Automated Motion Video Searching:
1. The system shall support advanced automated motion video searching against pre-recorded video. The automated motion video search shall analyze frames in a video segment to detect motion activity from image to image. It shall display thumbnail images of the frames with activity, complete with a histogram depicting the relative amount of activity within each frame.

2. The search shall be defined by selecting a specific camera and a specific time period in which the suspected activity took place. All motion events associated with that camera and time period shall be displayed in either a trace or thumbnail format for review.
3. Motion shall be capable of being restricted to any user-defined area of the screen as drawn by the user using a windowing tool in the software.

M. Video System Analytics (VSA):

1. The NVMS shall provide an embedded Video System Analytics solution.
2. The result of a trigger of an VSA shall be user definable and shall include:
 - a. Marking video.
 - b. Adjusting recording characteristics including frame rate and resolution.
 - c. Activating changes in the monitoring of cameras, including showing full screen video of the triggered camera.
 - d. Providing screen prompting to the system operator.
3. The set of Intelligent Video Analysis algorithms shall provide the following functionality:
 - a. Alert Types:
 - 1) Smart Video Motion Detection. This VSA shall have algorithms to filter out minor vibrations. The sensitivity of this filter shall be user adjustable. This VSA shall also provide motion masking where the user can define an area of the frame where motion will be ignored.
 - 2) Camera Tampering. When the VSA detects a camera is moved from its original position, when the camera view is obstructed, or when the focus is changed, this VSA shall activate.
 - 3) Sudden Change in Light Intensity. This VSA shall trigger when there is an extreme change in ambient light – light to dark or dark to light. The sensitivity of this VSA shall be user definable.
 - 4) New Object in Scene. This VSA shall detect an object that was not present when the VSA originally learned the scene or that has been inserted into the scene in a user defined area in the field of view.
 - 5) Object Removed from Scene. When an object that was present when the VSA originally learned the scene view has been removed from the scene, this VSA shall activate. This VSA shall be capable of being applied to a window of the total field of view as defined by the user.

- 6) Specific Object Detected in Scene. This VSA shall trigger when an object is detected that is defined by specific properties including people, automobiles, or an object of a specific color.
 - 7) Congestion in Defined Area. This VSA shall occur when the VSA detects congestion in a specific area of the scene as defined by the user.
 - 8) Directional Motion VSA shall occur when the VSA detects an object moving in a direction specified in the setup of this feature.
 - 9) Object Crosses a Defined Region. This VSA shall detect an object moving across a virtual boundary or into a defined area from a specified direction.
 - 10) Moving Object Stops. This VSA shall detect when a moving object in the scene ceases to move.
 - 11) Static Object Starts to Move. VSA shall occur when the VSA detects when a static object in the scene starts to move.
 - 12) Object Moves Too Fast. This VSA shall trigger when an object is moving faster than a pre-defined speed.
 - 13) Loitering. This VSA shall detect when a person or group of people in the scene slows down or ceases to move for a specified period of time.
 - 14) Detection of a Human Face. This VSA shall trigger when the VSA detects a frontal view of a human face.
 - 15) People Counting. This VSA shall be used when a camera is positioned in a top-down view of an entry/exit portal. This feature shall provide an alarm with a positive count for entry and a negative count for exit.
- b. The VSA shall support the ability to store the graphical output for a specific event for use with VSA alarms. This feature shall allow the graphical output of a specific event to be stored as a file and later used as an overlay to be used and associated with an alarm for historical searching.
 - c. The VSA shall support CIF, 4CIF, and D1 video resolutions during video processing.
 - d. The VSA shall support video infrared imaging.
- N. The NVMS shall provide up to 10 different and independent programmable recording schedules.
1. The schedules may be programmed to provide different record frame rates for day, night, and weekend periods, as well as holidays and exception days.

2. Advanced task schedules may also be programmed that could specify allowed log-on times for user groups, when events may trigger alarms, and when data backups and archiving should occur.
- O. The VMS shall support Dual Authorization logon. It shall function as follows:
1. Dual Authorization user groups may be created.
 2. Logon pairs, consisting of any two normal user groups, may be assigned to each Dual Authorization user group.
 3. A separate set of privileges and priorities can be assigned for each Dual Authorization user group.
 4. For each user group assigned as part of a logon pair, it shall be configurable whether the group can:
 - a. Log on either individually or as part of the logon pair.
 - b. Log on only as part of the logon pair.
 5. If a user that is part of logon pair logs on individually, then the user shall receive the privileges and priorities of the user's assigned user group. If the same user logs in as part of a logon pair, then the user shall receive the privileges and priorities assigned to the Dual Authorization group to which the pair is assigned.
- P. The NVMS shall auto-discover cameras and encoders. Device detection shall support devices in different subnets.
- Q. The NVMS shall be designed in such a way that server downtime or loss of communication to the server does not affect the functionality of the recording services. Normal recording and motion recording shall continue during server downtime.,

2.6 NVMS RECORDING REQUIREMENTS

- A. The NVMS shall provide management of the recording and playback of video, audio, and data (bookmarking, alarm data, etc.).
- B. Refer to the Camera Schedules on the project drawings for specific variables to be used on a per-camera basis for the purpose of calculating storage capacity and retention.
1. Total distributed storage requirements shall be determined based on a minimum of 30 days storage retention.
 2. Cameras, unless otherwise noted on the Camera Schedule(s), shall be assumed to be recording 24 hours per day, 7 days per week, 365 days per year. Specific per-camera assumptions stated on the Camera Schedule for percent motion shall be used in the storage calculation.
 3. Compression shall be permitted to be used in the storage calculation. The compression algorithm (MPEG-4, H.264, etc.) shall be used on a per-camera basis. If the NVMS permits variable levels of compression intensity, the use of the "average" or "medium" level setting shall be used in the storage calculation unless otherwise noted.

4. The Contractor shall provide the complete storage analysis and calculation as a shop drawing.

C. Network Video Recorder (NVR) Hardware Platform:

1. The NVR shall be defined as a storage device for recording IP video streams from IP cameras or from analog cameras that have been encoded to IP. In both cases, the NVR shall record IP streams from cameras or encoders located anywhere on the IP network without being direct-cable connected to the NVR.
2. Refer to the project drawings for specific requirements, model numbers, and basis of design for the NVR.
3. NVR Configuration:
 - a. The NVR shall contain one hard drive for the operating system and software, and all hard drive storage required to achieve the required storage retention.
4. The NVMS shall provide a failover function where an NVR can be assigned as a backup to other NVRs. When an assigned NVR goes out of service, the failover NVR takes over the responsibilities of the failed NVR. When the primary NVR returns to service, the control shall be automatically transferred back to the primary NVR.
5. It shall be possible to assign a redundant NVR to every NVR for use in normal operation of all NVR(s) in the system. The redundant NVR shall record the same streams as the primary NVR. The redundant NVR shall have its own disk drives where it shall store the recorded data.
 - a. It shall be possible to view the data recorded by the redundant NVR in the client software. The redundant NVR shall have camera symbols that can be placed in the camera selection tree. These cameras shall have the same name as the cameras of the primary NVR. An indication shall be provided to indicate that the camera names are located on the redundant NVR.

D. Additional Integration Requirements:

1. Relays from devices connected to the system shall be controllable from command scripts, the NVMS SDK, and icons on the user interface.
2. Input and relay state changes from devices connected to the system shall be recognizable as events in the NVMS.
3. The video management system shall be capable of monitoring third party equipment using SNMP and Rmon protocols.
4. The video management system shall provide a command script interface that allows system operations to be programmatically controlled.
 - a. The system shall provide a built-in editor for the creation of the command scripts.

- b. The system shall be configurable such that operators can execute the created scripts by double-clicking on representative icons in a logical tree or site map.
 - c. The system shall be configurable such that the created scripts can be executed automatically in response to a system event. The automatic event-driven execution shall optionally be schedule-dependent.
 - d. The system shall be configurable to execute a user-group dependent command script on user logon.
 - e. The system shall be configurable to execute an alarm-dependent command script on user acceptance of the alarm.
- 5. The video management system shall provide a software interface that allows third-party software to generate events in the video management system. The software shall support any COM programming languages (e.g., Visual Basic and C++), any .Net programming language (e.g., C#) or JavaScript.
 - 6. The NVMS shall allow third-party software to include up to 10 data fields and an alarm ID, along with the virtual input event.
 - a. These fields shall be searchable in the system logbook.
 - b. The virtual input data shall be capable of being displayed in playback mode synchronously with the associated video.

E. SDK Integration:

- 1. The video management system shall provide a documented Software Development Kit (SDK) to allow integration with third-party software.
- 2. The SDK shall expose all functionality of the command scripts, including, for example:
 - a. Control of operator workstation image window layout
 - b. Sending messages to specific workstations
 - c. Assignment of cameras, documents, URLs, and maps to operator client workstation image panes
 - d. Assignment of cameras to analog monitors connected to encoders
 - e. Dome control
 - f. Alarm generation
 - g. Recording mode control
 - h. Exporting of recorded data
 - i. Relay control
- 3. SDK functionality shall be password protected.
- 4. The SDK shall be accessible from all .Net programming languages.

F. OPC Server:

- 1. The VMS shall provide an OPC server for integration into third-party software systems, such as building management systems.

2. The OPC interface shall follow the OPC Alarms and Events standard.

2.7 NVMS CABLING

- A. Refer to Division 27 for all cabling requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with the manufacturer's instructions and recommendations for installation of all products.
- B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.
- C. Mount all cameras in the approximate locations shown on the drawings. Coordinate installation with other trades and utilities in the vicinity. Cameras containing fixed lenses, moved by more than 1'-0" from their location shown on the drawings, shall have a new lens calculation performed by the Contractor. Provide Architect/Engineer with results of lens calculation before proceeding with installation.
- D. Coordinate with Owner's IT Department to acquire network connections as well as any network configuration information, such as IP numbers, that will be required to connect NVMS to Owner network (if applicable).
- E. Provide all low voltage and +120 VAC power to all devices as required for proper system operation. Refer to Sections 26 05 33 and 26 05 13 for further requirements.
- F. All low voltage security wiring shall be routed and supported separately from all other telecommunications cabling.
- G. Cabling shall be plenum rated when installed outside of conduit in plenum ceilings.

3.2 FIELD QUALITY CONTROL

- A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.
- B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the project drawings.
- C. It shall be the Contractor's responsibility to correct all inadequate picture quality issues prior to acceptance of the system.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Installation shall be performed by a factory-trained and certified Contractor.
 1. Provide a comprehensive, site-specific customer planning guide for the system. Conduct a conference with the Owner prior to any installation to discuss the

programming options of the system and the planning guide. The result of this planning guide shall be the determination of the system options for each device and for the software.

- B. Include labor for all planning and all programming activities required to implement the Owner's operational preferences for each device and software. Any software programmable option, within the bounds of the capabilities of the hardware specified, shall be included.
- C. Provide a complete, functional system as described by the project drawings. These responsibilities include:
 - 1. Complete hardware setup, installation, wiring, and software configuration of the system, including all remote operator locations and all peripheral hardware.
 - 2. Complete programming of all hardware and software options in accordance with the Owner's preferences as determined by the planning guide conference.
 - 3. Programming of all custom graphic GUI screens including devices.
 - 4. Complete system diagnostic verification.
- D. Provide an authorized manufacturer representative to commission the system and ensure that facility-wide standards and project setup procedures are adhered to.

3.4 SYSTEM ACCEPTANCE

- A. Submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components and software. Perform the tests and document all results under the supervision of the manufacturer's system engineer.
- B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.

3.5 SYSTEM DOCUMENTATION

- A. Complete documentation shall be provided for the system. The documentation shall describe:
 - 1. All operational parameters of the system.
 - 2. Complete documentation of all programming and options.
 - 3. Complete operating instructions for all hardware and software.
- B. The following sections shall be provided in the system documentation:
 - 1. System Administrator Manual: Provides an overview and a step-by-step guide and instructions detailing all system administrator responsibilities and functions.
 - 2. User Manual: A step-by-step guide and instructions detailing all system user functions.

3. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams, and schematic diagrams.

3.6 SYSTEM TRAINING

- A. All labor and materials required for on-site system training by a certified representative of the system manufacturer shall be provided. Training shall be conducted at the project site using the project equipment.
- B. Provide two weeks advanced notice of training to the Owner.
- C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- D. At a minimum, the following training shall be conducted:
 1. System Administrators: A course detailing the system functions and operations. Provide configuration training on all aspects of the system.
 2. Users: Provide a detailed course outlining the operational features of all aspects of the user interface. Topics shall include alarm monitoring functions, reports, error handling, alarm handling, output relay control, and general overview of the report hardware.
 3. GUI Editing: Conduct detailed training on using the GUI editing software. Topics shall include the editing of existing graphical maps and the creation of new graphical maps.
- E. Minimum on-site training times shall be:
 1. System Administrators: One (1) days.
 2. Users: One (1) day.
 3. GUI Editing: One (1) day.

END OF SECTION

NVMS Bid Inventory Form

Item	Cost/Other
Total fixed (lump sum cost) for the entire project:	
Itemize the total fixed lump sum cost as follows: <ul style="list-style-type: none"> • Software cost for NVMS including all implementation services. • Cost for all camera hardware and associated accessories. 	
Itemize software cost for the following (show the math): <ul style="list-style-type: none"> • Fixed, non-reoccurring flat base cost (if any) • Fixed, non-reoccurring per-camera licensing fee (if any) • Recurring flat base cost (if any – do NOT include optional software maintenance agreement costs) • Recurring flat per-camera licensing fee (if any) • Client workstation licensing fees (if any) • Remote Client licensing fees (if any) • Mobile Client licensing fees (if any) • Itemize all other license fees not included above. 	
Add all required and optional software maintenance agreement costs (do NOT include in bid cost).	
Acknowledge receipt of addenda by writing addendum number to the right.	_____ through _____ inclusive

Include below Server Acknowledgement Statement per Section 28 23 00, Article 2.3, Paragraph D.

List below all separate software options, licensing or other monetary features that the Integrator interprets as *not* being requested by this RFP, but that are available from the NVMS manufacturer for purchase. Attach separate document if needed.

SECTION 28 31 00

FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire alarm and detection systems

1.2 RELATED WORK

- A. Section 26 05 53 – Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years' experience.
- B. Installer: A factory-authorized licensed electrical or security contractor with five years' experience in the design, installation and maintenance of fire alarm systems by that manufacturer.
- C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 2. This person's name and certification number shall appear on the start-up and testing reports.

1.4 REFERENCES

- A. NFPA 70 - National Electrical Code
- B. NFPA 72 - National Fire Alarm and Signaling Code
- C. NFPA 101 - Life Safety Code
- D. UL 2017 – General Purpose Signaling Devices and Systems

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 26 05 00 and as noted below.
 - 1. Failure to comply with all the following and all the provisions in 26 05 00 will result in the shop drawing submittal being rejected without review.
 - 2. Failure to submit the fire alarm without all requirements fulfilled in a single comprehensive submittal will be grounds to require a complete resubmittal.
- B. Provide product catalog data sheets as shop drawings.
 - 1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings, but required for the operation of the system.

2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.
 3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.
- C. Submit CAD floor plans as shop drawings:
1. The complete layout of the entire system, device addresses, auxiliary equipment, and manufacturer's wiring requirements shall be shown.
 2. A legend or key shall be provided to show which symbols shown on the submittal floor plans correspond with symbols shown on the Contract Documents.
- D. About all fire alarm circuits, provide the following: manufacturer's wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.
- E. Provide installation and maintenance manuals under provisions of Section 26 05 00.
- F. Submit manufacturer's certificate that system meets or exceeds specified requirements.
- G. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.
- H. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.
- I. When required to comply with local or state regulatory reviews, the fire alarm submittal shall have a Professional Engineer's stamp and signature of the state in which the project is completed. NOTE: The Architect/Engineer cannot stamp and seal submittal drawings not prepared under their supervision.

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Provide quantity equal to 2 percent (2%) of amount of each type installed, but no less than two (2) units of each type.
 - a. Smoke and heat detectors, manual pull stations, duct smoke detectors, monitor modules, control modules and relays.
 - b. Notification appliances: Speakers, speaker strobes, and strobes.
 2. Keys: The installing contractor shall collect all equipment spare keys provided with each lockable or resettable device/cabinet [minimum of one (1) set each] and shall turn over to the Owner upon completion.
 3. All spare parts shall be housed in metal cabinet labeled "Fire Alarm Spare Parts."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 26 05 00.
- B. Store and protect products under provisions of Section 26 05 00.

1.8 REGULATORY REQUIREMENTS

- A. System: UL or FM Global listed.
- B. Conform to requirements of NFPA 101.
- C. Conform to requirements of Americans with Disabilities Act (ADA).
- D. Conform to UL 864 Fire Alarm, UL 1076 Security, UL2017 General Signaling, and UL 2572 Mass Notification Communications.

1.9 SYSTEM DESCRIPTION

- A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
- B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.
- C. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.
- D. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.
- E. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.
- F. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.
- G. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.

1.10 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 26 05 00.
- B. Include location of end-of-line devices.
- C. Provide a CAD drawing of each area of the building (minimum scale of 1/16" = 1'-0") showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.
- D. Submit test results of sound pressure level (dBA) with the rooms tested designated on the floor plan. Notification devices shall have the tap wattage designated.

1.11 OPERATION AND MAINTENANCE DATA

- A. Submit data under provisions of Section 26 05 00.
- B. Include operating instructions, and maintenance and repair procedures.
- C. Include results of testing of all devices and functions.
- D. Include manufacturer's representative's letter stating that system is operational.
- E. Include the CAD floor plan drawings.
- F. Include shop drawings as reviewed by the Architect/Engineer and the local Authority Having Jurisdiction.

1.12 DOCUMENT STORAGE CABINET

- A. The cabinet shall have all fire alarm system documents, including record drawings, wiring diagrams, operation manuals, etc. A legend sheet permanently attached to the door shall contain system passwords and inspection logs. The enclosure shall also provide two (2) key ring holders for system keys and a location for a standard size business card with service contact information. The cabinet will have, permanently and securely mounted inside, a digital flash memory device with a minimum of 4 GB of storage capacity and a standard USB B connector for uploading and downloading electronic versions of record documents and system programming information.
- B. The cabinet shall be red in color with an identification label reading "FIRE ALARM DOCUMENTS". Refer to Identification Section 26 05 53. The cabinet shall be lockable.
- C. The final version of the system database program shall be stored within the cabinet.

1.13 WARRANTY

- A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.
- B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Johnson Controls - Simplex
- B. Notifier by Honeywell
- C. Edwards - EST
- D. Siemens Fire Safety
- E. Gamewell - FCI

2.2 [FAP-#]: FIRE ALARM CONTROL PANEL (FAP)

A. Control Panel: Modular, power-limited electronic design. Provide surface wall-mounted enclosure as shown on plans. Enclosure shall be minimum 0.060 steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.

B. Each Signaling Line Circuit (SLC loop) shall not be loaded over 80% of the maximum device capacity. For example, in the minimum system capacity column listed below, if the fire alarm manufacturer's system capacity of analog sensors per loop is 99 devices, then no more than 79 devices shall be wired on that loop. The minimum system capacity shall be as follows:

Minimum Total Addressable Points: 250

Minimum Total SLC loops (including board, ready for field connections): 2

C. Signal Line Circuit Board (SLC):

1. Each board shall communicate directly with each addressable analog sensor and binary input to determine normal, alarm, or trouble conditions. Analog signals would be used for automatic test and determination of maintenance requirements.
2. Each board shall contain its own microprocessor and shall be provided to monitor addressable inputs and to control addressable outputs (addressable relays). The board shall communicate and provide power to all devices on its loop over a single pair of wires, except where 4-wire devices require a separate power circuit.
3. Class A, Style 6: Circuits capable of transmitting an alarm signal during an open or a non-simultaneous single ground fault on a circuit conductor wiring system. Wiring of outgoing and return conductors shall be physically separated by a minimum of 50 feet or by a two-hour rated enclosure.
4. Class B, Style 4: Circuits NOT capable of transmitting an alarm beyond the location of the fault condition. Wiring of outgoing and return conductors is permitted to be run in the same conduit or cable.
5. SLC for addressable devices with less than 50 devices can be Class A or B, and more than 50 devices shall be Class A.

D. Notification Appliance Circuit (NAC) Board:

1. Each board shall contain its own microprocessor and shall be provided to control each notification appliance circuit. The board shall communicate and provide power to all devices on its loop.
2. Class B, Style Y: Circuits NOT capable of transmitting an alarm beyond the location of the fault condition. Wiring of outgoing and return conductors is permitted to be run in the same conduit or cable.
3. Class A, Style Z: Circuits capable of transmitting an alarm signal during an open or a non-simultaneous single ground fault on a circuit conductor. Wiring of outgoing and return conductors shall be physically separated by a minimum of 50 feet or by a two-hour rated enclosure.

E. Central Processing Unit:

1. The central processing unit (CPU) shall communicate with the monitor and control all other modules in the panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the CPU.
2. The CPU shall execute all control-by-event programs for specific action to be taken if a designated situation is detected in the system. A real-time system clock for time annotations on the display and printer shall be included.
3. All power for the unit shall be supervised and supplied by the FAP.

F. Display:

1. The board shall provide all controls and indicators used by the system operator and may also be used to program all control panel parameters.
2. The board shall provide an alphanumeric array for display of custom alphanumeric labels for all addressable points. It shall also provide indicators for AC Power, System Alarm, System Trouble, Display Trouble and Signal Silence.
3. Displayed descriptions of addressable points shall include actual room names/numbers selected by the Owner. This information shall be obtained prior to programming. Room names/numbers shown on floor plans shall not be used.
4. The board shall provide a touch key-pad with control capability to command all system functions and entry of any alphanumeric information. Twenty different passwords with four levels of security shall be supported to prevent unauthorized manual control or programming.

G. Memory: The CPU and display interface board shall be augmented by non-volatile field programmable memory. EPROM memory will also be allowed provided the memory is burned in with minimum expansion capability equal to the total system capacity of the panel. Memory shall not be lost upon primary and secondary power failure.

H. Serial Interface Board: The board shall provide interfaces to a printer, LCD display and other monitoring devices through RS-232 connections. The minimum operational distance between the board and the peripheral devices shall be 500 feet. Up to three (3) RS-232 outputs shall be supported.

I. Power Supply:

1. Input power shall be 120 VAC, 60 Hertz. Output power shall be as noted on the device specifications and drawings. Each component of the fire alarm system requiring 120 VAC input power shall be served from a dedicated branch circuit. Provide two #12 conductors and one #12 ground in 3/4" conduit to a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Identify/label breaker and branch circuit in accordance with NFPA requirements and Specification Section 26 05 53.
2. Adequate to supply 125% of all control panel and peripheral power needs as well as 125% of power required for all external audio-visual devices. The power supply may be increased as needed by adding additional modular expansion power supplies. Over-current protections shall be provided on all power outputs.
3. All power supplies shall be designed and installed to meet UL and NFPA requirements for power-limited operation on all external initiating and indicating circuits.
4. The power supply shall provide integral charger for use with internal batteries. Battery capacity shall be sufficient for operation of the entire system for 24 hours in a non-alarm state followed by alarm mode for 15 minutes, plus 25% spare capacity for future devices.

J. Surge Protection:

1. All fire alarm control panels, NAC panels, etc. shall be provided with a surge protection device (SPD). The SPD shall be UL listed to Standard 1449 Rev 3. The unit should be clearly labeled in accordance with Identification Section 26 05 53. The SPD shall have thermal fuses to protect against fire in short circuit conditions. The unit shall provide visual indication that the unit is protecting and functioning.
2. Any communications or signaling circuits associated with the fire alarm system, which leave or enter a facility, shall be provided with a surge protection device. The devices shall be as recommended by the fire alarm system manufacturer.

K. Digital Communicator:

1. Provide dual phone line interface capable of fire alarm notification to the local fire department, fire protection agency, or monitoring service. Communicator shall report in SIA and most major communication formats, with the capability of transmitting each device address point in a format compatible with the central station receiver.
2. Communicator shall be fully supervised and shall operate on loop start phase lines ahead of the building PBX system.
3. Communicator shall be FCC registered. Contractor shall provide two RJ31X jacks. Contractor to provide connection of communicators to Owner's telephone system.
4. Approvals: UL listed - UL 864/NFPA 72, FM approved.

5. The communicator shall be provided integral to the fire alarm panel as furnished by the fire alarm panel manufacturer. If the panel construction requires a separate unit, the unit shall be as manufactured by Silent Knight, Ademco, or fire alarm panel manufacturer approved equal.

L. IP-GSM Digital Cellular Fire Communicator:

1. Provide digital internet / cellular phone interface capable of fire alarm notification to the local fire department, fire protection agency, or monitoring service. Monitoring fees and initial connection charges are not part of this project.
2. Contractor to provide connection of communicator to Owner's Ethernet 10/100 Base network connection. Wiring shall be in 1" conduit.
3. Communicator shall convert fire alarm control panel phone outputs into Ethernet packets and transmit to GSM networks in area including 2G, 3G and 4G.
4. Communication shall include system status including individual addressable device status, power loss, low battery and earth fault, and 24-hour test signal.

2.3 SIGNALING LINE CIRCUIT DEVICES

A. [FA-120]: Smoke Detectors:

1. Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
2. Each smoke detector shall connect directly to an SLC loop.
3. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.
4. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
5. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.
6. A test means shall be provided to simulate an alarm condition.
7. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.
8. Audible sounder detector base for sleeping room applications:
 - a. The audible base shall sound an alarm in the local room in UL2017 operation and UL484 for general evacuation. The unit shall be programmable by the main control panel for the duration of operation.

b. The audible sounder base shall sound Temporal 3 (fire) or Temporal 4 (CO alarm) and be at 75 dB at 10 feet.

9. A subscript is used to identify the device with a specific sequence of operation as follows: E=Elevator Recall, S=Sleeping/Patient Room, D=HVAC Control, A=Atrium, SW=Stairwell, CR=Computer Room, SD=Smoke Dampers, DH=Door Hold Release, FD= Fire Door Release, MP=Medical Procedure Room.

B. [FA-121]: Projected Beam Type Detectors:

1. This device shall utilize photoelectric analog smoke sensor technology. Provide with transmitter and associated receiver. Microprocessor-based detector shall provide a minimum of eight sensitivity levels, temperature and dirt compensation, and automatic gain control. Sensor to contain beam alignment adjustments and receiver calibration.
2. Detector shall connect directly to an SLC loop or shall be provided with multiple monitor modules, as required, to connect to the SLC loop and for monitoring alarm and trouble output contacts. The detector shall be provided complete with all mounting hardware provided and installed where indicated on the drawings.
3. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided.
4. Provide with remote indicator panel providing LED indications of alarm and trouble.

C. [FA-122]: Duct Smoke Detectors:

1. Duct-type smoke detectors shall use the same analog photoelectric sensor technology, with the same features specified for standard smoke detectors, except with additional features as specified below.
2. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Where the detector housing is larger than the duct height, the Contractor shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer's recommendations.
3. Provide a remote alarm LED indicator device (FA-240/241) if detector is not visible from a floor-standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate labeled: Duct Smoke Detector.

D. [FA-123]: In-Duct Smoke Detectors:

1. Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
2. Low Flow Type: Listed for use in duct with 0-2000 feet per minute velocity.
3. Each smoke detector shall connect directly to an SLC loop.

4. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided to match the duct application. Provide a two-piece head/base design.
5. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
6. Provide a remote LED indicator device (FA-240/241), mounted in ceiling directly below detector with a single-gang faceplate labeled: Duct Smoke Detector.

E. Manual Pull Stations:

1. Manual stations shall match the description on the drawings (refer to the General Electrical Equipment Schedule). The stations shall be mounted where shown on the drawings and be provided with all necessary mounting hardware.
2. **[FA-130]:** Addressable, double action, reset key lock, semi-flush mount, red high abuse plastic or cast metal construction with white lettering.
3. **[FA-131]:** Hazardous location, addressable, double action, red cast metal construction with white lettering. Class I, Div 2 rated. Edwards XAL-53 or equal.
4. Manual stations shall connect directly to an SLC loop. Stations shall provide address setting means using rotary decimal or DIP switches.
5. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location, with maintained temperatures between 32°F and 120°F.

F. Heat Detectors:

1. **[FA-140]:** Combination rate of rise and 135°F fixed temperature analog thermal type sensor. Factory programmed to alarm at 135°F and at 15°F per minute rate-of-rise. Sensor shall measure heat level and send data to the control panel representing the analog level of thermal measurement and rate-of-rise.
 - a. A subscript is used to identify the device with a specific sequence of operation as follows: E=Elevator Shutdown.
2. **[FA-141]:** 200°F fixed temperature. Provide a remote addressable monitor module to interface with addressable system as shown on the plans.
3. **[FA-142]:** Explosion-proof. Combination rate of rise and 135°F fixed temperature. Non-current carrying metal enclosure. Hazardous classification: Class I, Group D. Provide a remote addressable monitor module to interface with addressable system.
4. Provide a two-piece head/base design, with a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.

5. Heat detectors shall connect directly to SLC loops. Where fixed temperature or explosion proof detectors are used, one monitor module may be used to monitor all detectors in one room/area as shown on the drawings.
6. Detectors shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided.
7. Provide a remote LED indicator device if detector is not visible from a floor-standing position.
8. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. A connection for attachment of a remote indicator shall be provided.
9. A test means shall be provided to simulate an alarm condition.
10. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

G. **[FA-151]:** Flame Detector:

1. Microprocessor based design. Ultraviolet and infrared type detector. Swivel mount. Provide with anti-contaminant air shields and a remote test switch located at the fire alarm control panel. Provide two addressable monitor modules for monitoring alarm and fault output contacts.

H. **[FA-160]:** Monitor Modules:

1. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.
2. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.
3. The module shall supply the required power to operate the monitored device(s).
4. The module shall provide address setting means using rotary decimal or DIP switches.

I. **[FA-161]:** Addressable Relays:

1. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional slave relay(s), as required, rated for the electrical load being controlled (contractor to match voltage, amps, etc.).
2. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.

3. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.
4. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

J. **[FA-XX]:** Isolation Module:

1. Provide fault isolation modules or isolator detector base capable of isolating and removing the fault from Class A or Class X addressable loop data circuits while allowing the remaining data loop to continue operation. Provide a minimum of two isolation modules or bases and between every 15 devices.

2.4 NOTIFICATION APPLIANCE DEVICES

A. Device Color:

1. Wall Mounted: Red housing with white lettering or pictogram.
2. Ceiling Mounted: Red housing with white lettering or pictogram.
3. WG subscript indicates wire guard is required.

B. Visual Alarm Devices:

1. **[FA-200]:** Wall mounted.
2. **[FA-201]:** Ceiling mounted.
3. High intensity (candela rating as scheduled on the drawings) xenon strobe or equivalent under a lens. Candela rating shall be visible from exterior of the device.
 - a. Candela Ratings: V1=15, V3=30, V7=75, VH=110, VS=177.
4. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.
5. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.

C. Audio (Horn) Alarm Devices:

1. **[FA-210]:** Wall mounted.
2. **[FA-230]:** Ceiling mounted.
3. Sound Rating: 85 dB at 10 feet. Sound levels for alarm signals shall not exceed 120 dBA in the occupied area.
4. Device shall be capable of a high and low dB level setting. Unless noted otherwise, the device shall be set to the high setting at building completion.

5. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.
- D. **Combination Audio (Horn) and Visual Notification Device:**
1. **[FA-211]:** Wall mounted.
 2. **[FA-231]:** Ceiling mounted.
 3. Combine horn and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.
- E. **[FA-203]:** Weatherproof Visual Notification Device:
1. High intensity strobe, square housing, 75 candela rating, suitable for wet locations. Provide with weatherproof back box.
 2. Mounting: Semi-flush wall.
 3. Conduit shall not be exposed.
- F. **[FA-212]:** Weatherproof Audio/Visual Notification Device:
1. Electronic horn with high intensity strobe, square housing, 75 candela, suitable for wet locations. Provide with weatherproof back box.
 2. Mounting: Semi-flush wall.
 3. Conduit shall not be exposed.
- G. **[FA-232]:** Industrial Methane LEL detector, explosion proof housing, IP66 rated. Provide all necessary Modules and devices to integrate detector with fire alarm panel.
1. Acceptable manufacturer: Honeywell Sensepoint XCD
- H. **[FA-233]:** Mini-Horn Audio Notification Device:
1. Electronic horn.
 2. Mounting: single-gang flush wall.
- I. **[FA-234]:** Explosion Proof Audio Notification Device:
1. Heavy-duty, high decibel, vibrating horn
 2. Red, corrosion resistant heat flowed epoxy finish
 3. Hazardous location, Class I, Div 2, and outdoor rated
 4. 24VDC, 90dB @ 10'
 5. Edwards 888D-N5 or equal
 6. Provide addressable relay for control of notification device in accessible location.

J. **[FA-235]:** Explosion Proof Visual Notification Device:

1. Hazardous location, Class I, Div 2, and outdoor rated
2. 24VDC, 220 mA LED visual signal light.
3. Red lens covered with impact-resistant glass globe
4. Bracket mounting.
5. Light shall flash at 65 fpm.
6. Edwards 107XBRBMR120A or equal.
7. Provide addressable relay for control of notification device in accessible location.

2.5 [NEP-#]: NAC EXTENDER PANELS (NEP)

- A. As shown on the plans or as a Contractor's option if not shown, furnish and install NAC extender panels as necessary to provide remote power supply for notification appliance circuits (NAC). Contractor shall indicate quantity and locations of each NEP on the shop drawing submittals.
- B. Each NEP shall be self-contained remote power supply with batteries, and battery charger mounted in a surface lockable cabinet. Battery capacity shall be sufficient for operation for 24 hours in a non-alarm state followed by alarm for 15 minutes, plus 25% spare capacity for future devices. Each NEP provides a minimum of up to 4 outputs, 2A continuous, or 6A full load total capacity.
- C. Power for each NEP shall be from a local 120 VAC circuit. Provide two #12 conductors and one #12 ground in 1/2" conduit to each NEP from a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Coordinate panel and circuit number with Architect/Engineer prior to installation.
- D. NAC extender panels may be installed only in locations coordinated with the Owner/Engineer.
- E. Mounting: Surface.

2.6 ANNUNCIATION

A. **[FAA-#]:** Remote LCD Annunciators:

1. Auxiliary annunciators shall indicate alarm and trouble conditions visually and audibly as shown on the drawings. Provide local TROUBLE ACKNOWLEDGE, TEST, and ALARM SILENCE capability. Minimum 80-character display.
2. Communications and power to the annunciators shall be supervised. The annunciator shall receive power from the fire alarm control panel.
3. A single key switch shall enable all switches on the annunciator.

- B. Facility Management Control System (FMCS) Interface:
 - 1. Provide BACnet IP interface for fire alarm panel to communicate status with the FMCS. Provide list of points and descriptions to FMCS supplier.
 - a. UL listed to Standard 864. Provide RJ45 connection and cable.
- C. **[FA-241]**: Fire Alarm Remote Indicator:
 - 1. Red LED type.
 - 2. Mounts flush to a single gang box.
- D. **[FA-242]**: Fire Alarm Remote Indicator and Test Switch:
 - 1. Red LED type.
 - 2. Key switch test selector.
 - 3. Mounts flush to a single gang box.

2.7 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS

- A. **[FA-260]**: Flow Switch:
 - 1. Connection to flow switch to monitor fire protection flow switch or discharge output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed and MC; wired by EC.
- B. **[FA-261]**: Monitor Switch:
 - 1. Connection to monitor switch to monitor fire protection system supervisory switches or output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.
- C. **[FA-262]**: Post Indicator Valve:
 - 1. Connection to post indicator valve for sprinkler system supervisory notification. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC. Provide surge protection device as recommended by the fire alarm system manufacturer on line entering/leaving the facility.
- D. **[FA-263]**: Electronic Bell:
 - 1. Electronic bell for sprinkler alarm, electro-mechanical type, 120 VAC. Furnished and installed by MC. Fire alarm control and power connections by EC.

2.8 WIRING

- A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with NFPA 70, Article 760 for power-limited fire alarm signal service.
- B. Approved manufacturers of fire alarm cable:
 - 1. Comtran Corp.
 - 2. Helix/HiTemp Cables, Inc.

3. Rockbestos-Suprenant Cable Corp.
4. West Penn Wire/CDT.
5. Radix.

PART 3 - EXECUTION

3.1 SEQUENCES OF FIRE ALARM OPERATION

A. General:

1. Refer to the Fire Alarm Operation Matrix on the drawings for basic requirements and system operation.
2. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

B. Panel/Annunciator Alarm, Trouble, Supervisory Indication:

1. Appropriate system Alarm, Trouble, or Supervisory LED shall flash at the control panel, transponder, and annunciator locations.
2. A local signal in the control panel shall sound.
3. The LCD display shall indicate all information associated with the condition, including the name of the item, type of device and its location within the protected premises.
4. History storage equipment shall log the information associated with the fire alarm control panel (FAP) condition, along with the time and date.
5. Transmit the appropriate signal (supervisory, trouble, alarm) to the central station via the digital communicator.
6. Transmit the appropriate signal (supervisory, trouble, alarm) to the building automation system.

C. Audible Alarms Sequence:

1. Audible alarms throughout the facility shall sound.

D. Visual Alarms Sequence:

1. Visual alarms throughout the facility shall flash.

E. Fire Protection Electric Sprinkler Bell Sequence:

1. The fire alarm shall utilize an addressable relay to energize the electric sprinkler bell upon activation of the flow switch.

- F. Double Interlocked Preaction Sprinkler Activation Sequence:
 - 1. The fire alarm system shall utilize an addressable relay to signal the double-interlock preaction sprinkler system to allow filling with water upon initiation of alarm in zone of sprinkler coverage.
 - 2. Where there are multiple zones to the preaction system, a separate addressable relay shall be provided for each zone and the system shall be programmed to signal only the zone that is in the area of the fire. Coordinate with the fire protection system installer.
 - 3. The fire alarm system shall utilize addressable monitor modules to monitor the control panel supervisory and trouble conditions.
- G. Smoke Damper Control Sequence:
 - 1. All smoke and fire/smoke dampers shall be closed throughout the facility.
- H. AHU Shutdown Sequence:
 - 1. All AHUs shall be shutdown simultaneously throughout the facility.

3.2 INSTALLATION

- A. Install system in accordance with manufacturer's instructions and referenced codes.
- B. Fire Alarm Control Panel:
 - 1. Install the control panel where shown on the drawings.
 - 2. All expansion compartments, if required, shall be located at the control panel.
- C. Devices:
 - 1. General:
 - a. All ceiling-mounted devices shall be located where shown on the reflected ceiling and floor plans. If not shown on the reflected ceiling or reflected floor drawings, the devices shall be installed in the relative locations shown on the floor drawings in a neat and uniform pattern.
 - b. All devices shall be coordinated with luminaires, diffusers, sprinkler heads, piping and other obstructions to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.
 - c. Where the devices are to be installed in a grid type ceiling system, the detectors shall be centered in the ceiling tile.

- d. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall adjust location of device so that new location meets all requirements in NFPA 72 and all applicable building codes.
2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.
3. Protection of Fire Alarm System:
 - a. A smoke detector shall be installed within the vicinity of the main fire alarm panel and every NAC extender panel per NFPA 72. A heat detector may be substituted when a smoke detector is not appropriate for the environment of installation.
4. Duct-type Analog Smoke Detectors:
 - a. Duct-type analog smoke detectors shall be installed on the duct where shown on the drawings and details. The sampling tubes shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
 - b. All detectors shall be accessible.
 - c. Duct-type detectors shall be installed according to the manufacturer's instructions.
5. In-Duct Analog Smoke Detectors:
 - a. In-duct analog smoke detectors shall be installed in the duct where shown on the drawings and details. The devices shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
 - b. All detectors shall be accessible.
6. Manual Pull Stations:
 - a. Stations shall be located where shown and at the height noted on the drawings.
7. Addressable Relays and Monitor Modules:
 - a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.

- b. All modules shall be mounted in or on a junction box in an accessible location.
 - c. Where not visible from a floor standing position, a remote indicator shall be installed to allow inspection of the device status from a local floor standing location.
8. Notification Appliance Devices:
- a. Devices shall be located where shown on the drawings.
 - b. Wall-mounted audio, visual and audio/visual alarm devices shall be mounted as denoted on the drawings.
- D. Annunciators:
- 1. Remote Annunciators: The annunciators shall be located where shown on the drawings and approved by the fire marshal.
- E. Wiring:
- 1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes.
 - 2. Wiring shall be installed in conduit. Refer to Identification Section 26 05 13 for color and identification requirements.
 - 3. All junction boxes with SLC and NAC circuits shall be identified on cover.
 - 4. Fire Alarm Power Branch Circuits: Building wiring as specified in Section 26 05 13.
 - 5. Notification Appliance Circuits shall provide the features listed below. These requirements may require separate circuits for visual and audible devices.
 - a. Fire alarm temporal audible notification for all audio appliances.
 - b. Synchronization of all visual devices where two or more devices are visible from the same location.
 - c. Ability to silence audible alarm while maintaining visual device operation.
 - 6. Notification Appliance Circuits shall not span floors.
 - 7. Signal line circuits connecting devices shall not span floors.
 - 8. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device with "E-Z Markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its

terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.

- F. Fire Alarm Cabling Color Code: Provide circuit conductors with insulation color coding as follows, or using colored tape at each conductor termination and in each junction box.
 - 1. Power branch circuit conductors: In accordance with Section 26 05 53.
 - 2. Signaling line circuit: Overall red jacket with black and red conductors.
 - 3. DC power supply circuit: Overall red jacket with violet and brown conductors.
 - 4. Notification appliance circuit: Overall red jacket with blue and white conductors.
 - 5. Door release circuit: Gray conductors.
 - 6. Central station trip circuit: Orange conductors.
 - 7. Central station fire alarm loop: Black and white conductors.
- G. Devices surface mounted in finished areas shall be mounted on surface backboxes furnished by fire alarm equipment supplier. Backboxes shall be painted to match device, and shall not have visible knockouts.
- H. Make conduit and wiring connections to door release devices, sprinkler flow and pressure switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer's product data and shop drawings.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 26 05 00.
- B. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.
- C. Contractor shall test and adjust the fire alarm system as follows:
 - 1. Speaker taps shall be adjusted to the lowest tap setting which achieves a sound level higher than or equal to the greatest of the following:
 - a. 70dBA.
 - b. 15 dBA above ambient levels as indicated in NFPA 72 Table A.18.4.3.
 - c. 15 dBA above measured ambient. 5 dBA above the maximum measured sound level with duration of more than 60 seconds.
 - d. As specified on the drawings.
 - 2. Sound level measurement procedure shall meet the following requirements:
 - a. All measurements shall use the 'A' weighted, dBA, sound measurement scale.
 - b. All measurements shall be taken after furnishings, wall coverings and floor coverings are in place.

- c. All measurements shall be taken after fixed equipment (HVAC units, etc.) producing ambient noise is installed and is in operation.
- d. All sound level measurements shall be taken at a height of 5' above the finished floor level.
- e. Measurements shall be taken in every unique room. If there are multiple rooms, which have the identical dimensions and function, 10%, or a minimum of 2 rooms shall be tested. The results from the rooms tested shall be averaged and the remaining rooms may be adjusted per the average.
- f. Measurements shall be taken on a 20' x 20' grid and the results for all points taken shall be averaged. If the room is smaller than 20' x 20' a minimum of two measurements are required.
- g. Measurements shall be taken halfway between speakers or halfway between a speaker and the wall. No measurements shall be taken at the extreme edges of the room, nor directly under speakers.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Provide manufacturer's field services under provisions of Section 26 05 00.
- B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.
- C. Note that room numbers depicted on the drawings will not necessarily reflect the actual room (signage) numbers that the Owner selects. The Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Owner directs to identify each device. This list shall be a part of the floor plan record drawing to be turned in at the project closeout.

3.5 SYSTEM TRAINING

- A. System training shall be performed under provisions of Section 26 05 00.
- B. Minimum on-site training times shall be:
 - 1. System Operators: One (1) day.

END OF SECTION

SECTION 31 00 00

EARTHWORK

PART 1 - GENERAL

1.1 Section Includes

- A. Excavating, hauling, grading, sorting, stockpiling, placing, conditioning, and compacting soil and rock materials including finish-grading necessary and incidental to accommodate lines, grades, thicknesses, and typical sections shown on the Drawings or specified, including borrow areas.
- B. Construction & Maintenance of haul roads to and from construction borrow and stockpile areas.
- C. Finish grading of stockpiles and borrow areas.
- D. Restoration of disturbed surfaces to specified lines, grades, and contours.

1.2 References

- A. Refer to Geotechnical Exploration Report (CGC, Inc: Project Number C1789, December 7, 2017)
- B. Wisconsin Department of Transportation (WISDOT) standard specification for construction 2017, or latest edition.

1.3 Definitions

- A. Relative compaction – As defined in the Soils Report. Refers to the in-place dry density of soil expressed as a percentage of maximum dry density of the same soil, as determined by ASTM Test Method 1557.
- B. Special Fill, as defined in the Geotechnical Exploration Report for use in stabilizing subgrades, backfilling undercut excavations or filling behind retaining walls.
- C. General Fill: Consistent, on-site soil materials free from organic matter, or any other non-soil material which by decomposition might cause settlement. Fill containing rock, boulders or concrete pieces should include sufficient finer material to fill voids among the larger fragments. Materials shall be placed, spread and leveled in layers no more than 10 inches thick before compaction.

1.4 Submittals

- A. Submit documentation that materials meet the Specification and Drawing requirements.
- B. Submit grain size analysis for proposed pipe bedding material and Geotechnical Approved Subgrade.
- C. Submit samples for proposed pipe bedding material and Geotechnical Approved Subgrade.
- D. Submit documentation for proposed Rip-Rap materials.

PART 2 - PRODUCTS

2.1 Fill Materials

- A. Unclassified Fill (Fill not classified below): Use existing excavated soils from on-site or borrow area. To be supplied by OWNER.
- B. Geotechnical Engineering Approved Subgrade.
- C. General Fill: on site excavated or borrow material meeting the specifications in Section 31 23 26, free from organic matter.

2.2 Special Fill Materials

- A. Gradation of Special Fill Materials:

Table 1
Gradation of Special Fill Materials

Material	WisDOT Section 311	WisDOT Section 312	WisDOT Section 305			WisDOT Section 209		WisDOT Section 210
	Breaker Run	Select Crushed Material	3-in. Dense Graded Base	1 1/4-in. Dense Graded Base	3/4-in. Dense Graded Base	Grade 1 Granular Backfill	Grade 2 Granular Backfill	Structure Backfill
Sieve Size	Percent Passing by Weight							
6 in.	100							
5 in.		90-100						
3 in.			90-100					100
1 1/2 in.		20-50	60-85					
1 1/4 in.				95-100				
1 in.					100			
3/4 in.			40-65	70-93	95-100			
3/8 in.				42-80	50-90			
No. 4			15-40	25-63	35-70	100 (2)	100 (2)	25-100
No. 10		0-10	10-30	16-48	15-55			
No. 40			5-20	8-28	10-35	75 (2)		
No. 100						15 (2)	30 (2)	
No. 200			2-12	2-12	5-15	8 (2)	15 (2)	15 (2)

Notes:

1. Reference: Wisconsin Department of Transportation *Standard Specifications for Highway and Structure Construction*.
2. Percentage applies to the material passing the No. 4 sieve, not the entire sample.
3. Per WisDOT specifications, both breaker run and select crushed material can include concrete that is 'substantially free of steel, building materials and other deleterious material'.

2.3 Rip Rap

- A. Rip Rap comply with WisDOT standard specifications for riprap and meet the sizes shown on the plans.
- B. Rip Rap in channels shall consist of a clean, angular stone resistant to weathering with a D_{50} of 6-inches. 50% of the stone by weight, should be larger than the D_{50} . The diameter of the largest stone should not exceed 1.5 times the D_{50} size.
- C. Rock outlet Protection stone shall consist of the following:

Percent Passing by Weight	Diameter (inches)
100	2 x D_{50}

60-85	1.5 x D ₅₀
25-50	D ₅₀
5 -20	0.5 x D ₅₀
0-5	0.2 x D ₅₀

Refer to Plans for D₅₀ sizes.

2.4 Stone Tracking Pad

- A. Aggregate material used shall consist of a 3 -6-inch washed stone. All material to be retained on a 3-inch sieve.

2.5 Stone Check Dams

- A. Materials consist of a well graded angular stone with a D₅₀ of 3 inches or greater with no more than 5% passing the #4 sieve, free of fines and sands. The one foot layer shall consist of a 1-inch (#2) washed stone over the 3 to 6-inch clear stone. Angular stone meeting the gradation for WisDOT specification 312 select crushed or local equivalent.

2.6 Storm Basin Riser Pipe Stone

- A. The one foot layer shall consist of a 1-inch (#2) washed stone. Angular stone meeting the gradation for WisDOT specification section 312 select crushed or local equivalent.

2.7 Infiltration Trench

- A. Top layer to consist of clean sand meeting one of the following gradation requirements:
 - i. United States Department of Agriculture (USDA) Course Sand (0.02-0.04 inches),
 - ii. ASTM C33 (Aggregate Concrete Sand or
 - iii. WISDOT Section 501.2.5.3.4 (Final Aggregate Concrete Sand) 2005 edition, or equivalent.

The preferred sand component consists mostly SiO₂, but sand consisting of dolomite or calcium carbonate may also be used. Manufactured sand or stone dust is not allowed. The sand shall be washed and drained to remove clay and silt particles prior to mixing.

- B. Bottom layer gravel shall meet the coarse aggregate #2 and other specifications of Wisconsin Standards and Specifications for Highway and Structure Construction, Section 501.2.5, 2003 edition, or equivalent as approved by the administering authority. Gravel shall be double washed.

2.8 Granular Materials

- A. Granular Fill: Bedding Material is for pipes outside of the limits of waste.
 - i. Have primarily sand size particles or sand-sized particles mixed with gravel, crushed gravel, or crushed stone. Do not use materials classified under WISDOT section 301.2.4.3 as crushed concrete, reclaimed asphalt, reprocessed material, and blended material.
 - ii. Have a maximum particle diameter of 1-½ inches.

- iii. Have a moisture content suitable for satisfactory consolidation with the compaction tool used.
- iv. Have a liquid limit less than or equal to 25 and a plasticity index less than or equal to 6.

2.9 Topsoil

- A. Topsoil shall meet the specifications in Section 31 23 29. To be provided by OWNER.

PART 3 - EXECUTION

3.1 Excavation Preparation

- A. Remove ice and snow before excavation.
- B. Identify required construction survey control lines and datum.
- C. Mark all trees identified for removal.
- D. Notify area utility companies prior to commencing work in accordance with state and local regulations.

3.2 Excavation

- A. Remove trees, stumps, root systems, rocks and objects larger than 6 inches in size to depth of 1 foot below required subgrade elevations, and as required to allow for proper, efficient construction. Apply appropriate herbicide to remaining stump material to inhibit growth. Refer to Section 02 01 00 for disposal of materials that will not be reused.
- B. Strip topsoil from project areas, including stockpile areas prior to stockpiling, to whatever depths encountered; prevent intermingling with underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping topsoil. Stockpile / reuse as shown. Clear undergrowth and deadwood, without disturbing subsoil.
- C. Excavate soils as required to accommodate new site grades as shown on the Drawings and specified herein. Grade perimeter of excavation, to prevent surface water drainage into excavation and ponding of water.
- D. Identify materials within the indicated excavation areas which will meet the required specifications for Topsoil. Excavate and place Overburden soils encountered in stockpile area if not used for Topsoil fill. Separate from stockpile for the Topsoil material within the construction limits. Stockpile areas to be approved by OWNER. Excavation of Unclassified Fill soils shall be placed in stockpile area as directed by Owner.
- E. Stockpile excavated material in areas designated. Keep general/structural fill in the stockpiles separate from topsoil, and other unclassified fill. Do not inter-mingle topsoil, and General / Structural Fill. Grade stockpile areas to provide positive drainage.
- F. Excavate soils to the minimum depth required for execution of work and as required to accommodate new site grades as shown on the Drawings and specified herein. Provide sufficient room for aggregate base compacted to at least 95 percent relative compaction. Grade perimeter of excavation to prevent surface water drainage into excavation and ponding of water.
- G. Notify Soils Engineer of unexpected subsurface conditions, and discontinue affected work in area until notified by Engineer to resume work.

3.3 Preparation for filling, backfilling, and compacting

- A. Remove ice and snow before placing fill. Do not place fill on frozen subgrade.
- B. Strip areas of topsoil prior to placing fill. Stockpile topsoil in area designated on-site.
- C. Proof roll subgrade before placing fill using loaded scrapers, haul truck or compaction equipment. Cut out or rework soft areas of unsuitable subgrade. Undercuts will be performed in accordance with Section 31 23 16.
- D. Scarify all soils prior to installation of Engineered Fill. If surface soil has dried, scarify to at least 2 inch depth and moisture condition.

3.4 Placement and Compaction

- A. Begin engineered fill placement only when underlying subgrade has been accepted by the Owner.
- B. Prior to placement of engineered fill verify that no substantial thickness of loose or uncompacted soil is present in the fill area.
- C. Blend slopes with existing landscape features, at the intersection of cuts and fills; provide gradual slope between new and existing construction.
- D. Maintain positive drainage.
- E. Maintain and/or adjust moisture content to achieve specified compaction. Use compactors well suited for the soil type being compacted.
- F. Fill and foundation excavations shall be observed and approved by the Soils Engineer prior to placing concrete.
- G. All Engineered fill and subgrade material proposed for use shall be approved by the Soils Engineer prior to placement.
- H. Place and spread Engineered Fill in lift thicknesses as required to obtain the specified levels of compaction. Engineered fill should not be placed in lifts no more than 10 inches thick.
- I. Engineered Fill and Geotechnical Approved Subgrade shall be compacted in accordance with the soils report and ASTM D-1557. Flooding not permitted. Refer to table below.

Compaction Guidelines

Area	Percent Compaction (1)	
	Clay/Silt	Sand/Gravel
<u>Within 10 ft of building lines</u>		
Footing bearing soils	93 - 95	95
Under floors, steps and walks		
- Lightly loaded floor slab	90	90
- Heavily loaded floor slab and thicker fill zones	92	95
<u>Beyond 10 ft of building lines</u>		
Under walks and pavements		
- Less than 2 ft below subgrade	92	95
- Greater than 2 ft below subgrade	90	90
Landscaping	85	90

Notes:

1. Based on Modified Proctor Dry Density (ASTM D 1557)

- J. Compact materials immediately after placement.
- K. Slabs: place and compact Geotechnical Engineering Approved Subgrade over scarified subgrade soils below all slabs in no less than 3 inch compacted lifts. Refer to Section 31 23 00 for additional information.
- L. Paved areas: place and compact 4 –inch thick, 1-1/4 in. Dense Grade Base (DGB) over approved, bottom part 6-inch thick, 3-inch DGB, under a moisture-conditioned and scarified Engineered fill below parking lot areas in no less than 6 inch compacted lifts.

3.5 Fill Stockpiles / Borrow Areas

- A. Grade stockpiles to provide positive drainage. Maximum slopes shall be 3:1 unless approved by Owner. Seal by tracking with dozer or other means to minimize erosion and limit surface water infiltration.
- B. Areas around stockpiles shall be graded to drain. Haul roads constructed to and from stockpile / borrow areas shall not restrict surface water drainage patterns. Haul road locations to be submitted with Bid and deviations from that submitted must be approved by Owner in advance of constructing.
- C. Borrow areas shall be graded to drain upon completion, with intent to minimize surface water pumping required by Owner thereafter. Work with Owner to agree on grading plans.

3.6 Field Quality Control

- A. Representative samples of soils shall be submitted to the Field Engineer and tested for optimum moisture-maximum density determination (ASTM D1557) prior to the start of fill placement. Sample size should be approximately 50 pounds.
- B. Field density tests to determine the level of compaction being achieved in the placed soil. The test shall generally be conducted on each lift at the beginning of fill placement and at a frequency mutually agreed upon by the project team for the remainder of the project.

* * * END OF SECTION * * *

SECTION 31 23 00

FOUNDATION EXCAVATING AND BACKFILLING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General and Supplementary Conditions of the Construction Contract and Division 1 - General Requirements apply to the work specified in this section.
- B. This section shall include, but is not limited to the following foundation, excavating and backfilling within five feet of the building perimeter.
 - 1. Removal of all unacceptable soil.
 - 2. Furnish and install acceptable fill as specified herein and on the drawings.
 - 3. Prepare subgrade for footings and slab on grade.
- C. The following items are not a part of this specification:
 - 1. Utility trenching and related backfilling outside the building footprint.
 - 2. Subgrade for exterior walks and paving.
- D. Structural notes indicated on the drawings regarding foundation excavating and backfilling should be considered part of this specification.

1.2 QUALITY ASSURANCE

- A. Codes and Standards: Comply with the provisions of the following codes, specifications and standards, except where more stringent requirements are shown or specified.
 - 1. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 2. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbs/ft³)
 - 3. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using the Modified Effort. (56,000 ft-lbs/ft³)
 - 4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - 5. ASTM D2940 - Standard Specification for Graded Aggregate Material for Bases and Sub-bases for Highways or Airports.
 - 6. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - 7. ASTM D4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

8. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

B. Comply with all applicable local, state and federal codes.

1.3 SUBMITTALS

- A. Material Test Reports: Provide the Owner and Engineer with the on-site material test reports from the Inspection Agency indicating the interpreting test results for compliance with this specification.

1.4 TESTING AND INSPECTION

A. Inspection and Testing:

1. The Owner shall employ an Inspection Agency to perform the duties and responsibilities specified below.
2. Refer to civil, mechanical, and electrical specifications for testing and inspection requirements of non-structural components.
3. Duties of the Inspection Agency:
 - a. Perform all testing and inspection required per the Testing and Inspection Schedule indicated below.
 - b. Furnish inspection reports to the building official, the Owner, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work.
 - c. Submit a final signed report stating whether the work requiring Inspection was, to the best of the Inspection Agency’s knowledge in conformance with the approved plans and specifications.
4. Structural Component Testing and Inspection Schedule for Section 31 23 00 is as follows:

	Continuous	Periodic
Foundation Preparation		
Verify materials below shallow footings are adequate to achieve the design bearing capacity.		X
Verify excavations are extended to proper depth and have reached proper material.		X
Perform classification and testing of compacted fill materials.		X
Verify use of proper materials, densities, and lift thicknesses during placement and compaction of compacted fill.	X	
Prior to placement of compacted fill, observe subgrade and verify that the site has been properly prepared.		X

- B. Minimum testing frequency and locations:
1. Laboratory Testing:
 - a. Granular fill: One representative gradation test for each type of material.
 - b. Cohesive soils: One representative moisture density test for each type of material used.
 - c. Non-cohesive soils: One representative moisture density test for each type of material used.
 2. Field Testing:
 - a. The Inspector shall determine the location of testing.
 - b. Testing of final utility trench backfill shall begin at a depth of 2 feet above the top of the pipe.
 - c. In-place field density test and moisture content tests shall be performed as follows:
 - 1) Fills not within the influence of building foundations and slab on grade: Per civil specifications.
 - 2) Fills within the influence of building foundations and slab on grade, the following criteria shall apply: One test for each 10 inch vertical lift of compacted fill placed per 2,500 square feet of fill area (minimum of two tests per lift per structure for areas smaller than 5,000 square feet).
 - d. Additional testing may be required by the Inspector if noncompliance or a change in conditions occurs.
 - e. If a test fails, the Contractor shall rework the material, recompact and retest as necessary until specific compaction is achieved in all areas of the trench. All costs associated with this work, including retesting, shall be the responsibility of the Contractor.

1.5 PROTECTION

- A. Contractor shall provide for design, permits and installation of all cribbing, bracing, shoring and other methods required to safely retain earth banks and excavations.
- B. Notify the Engineer of unexpected subsurface conditions and discontinue work in affected areas until notification to resume.
- C. Protect benchmarks, existing structures, fences, sidewalks, paving, curbing, etc., from excavation equipment and vehicular traffic.
- D. Maintain and protect above and below grade utilities that are to remain.
- E. Provide temporary heating or protective insulating materials to protect subgrades and foundations soils against freezing temperatures or frost during cold weather conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide borrow soil materials when sufficient acceptable soil materials are not available from excavations.
- B. Acceptable soils shall comply with the following:
1. Meet ASTM D2487 soil classification groups GW, GP, GM, SW, SP, SM or a combination of these group symbols;
 2. Be free of rock or gravel larger than 3 inches in any dimension;
 3. Be free of debris, waste, frozen materials, vegetation and other deleterious materials;
 4. Have a liquid limit less than 45 and a plasticity index less than 20.
 5. Be approved by the Inspection Agency.
- C. Unacceptable soils shall be defined as following:
1. ASTM D2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, PT or a combination of these group symbols.
 2. Unacceptable soils also to include acceptable soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Free-Draining Granular Fill: Free-draining granular fill shall comply with the following:
1. Be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone.
 2. Be clean and free of fines.
 3. Comply with ASTM D2940.
 4. Be uniformly graded as follows:

COARSE AGGREGATE GRADATIONS						
SIEVE SIZE - PERCENT PASSING						
Grade No.	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4
CA7	100	95 ± 5	-	45 ± 15	-	5 max

5. Be approved by the Inspection Agency.
- E. Engineered Fill and Utility Base Course shall comply with the following:
1. Be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, natural or crushed sand;

2. Comply with ASTM D2940;
3. Be uniformly graded as follows:

COARSE AGGREGATE GRADATIONS						
SIEVE SIZE - PERCENT PASSING						
Grade No.	1-1/2"	1"	1/2"	No. 4	No. 16	No. 200
CA6	100 to 90	95 ± 5	75 ± 15	43 ± 13	25 ± 15	8 ± 4

4. Be approved by the Inspection Agency.

F. Dense Graded Base:

1. Be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, natural or crushed sand;
2. Comply with ASTM D2940;
3. Be uniformly graded as follows:

COARSE AGGREGATE GRADATIONS							
SIEVE SIZE - PERCENT PASSING							
Grade No.	1 1/4"	3/4"	3/8"	No. 4	No. 10	No. 40	No. 200
CA6	100 to 95	70-93	42-80	25-63	16-48	8-28	2-12

4. Be approved by the Inspection Agency.

G. Material Applications: Provide and install material meeting with the above requirements as follows:

1. General fill: Acceptable soils.
2. Backfill at over-excavated areas beneath footings: Engineered fill.
3. Sub-grade layer beneath slabs-on-grade: Refer to Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Identify and verify required lines, levels, contours and benchmark elevations for the work are as indicated.
- B. Protect plant life, lawns, other features and vegetation to remain as a portion of the final landscaping.
- C. Identify known underground utility locations with stakes and flags.

- D. Site preparation summary is based on Section 1 of Geotechnical report by CGC, Inc. dated December 7, 2017. Refer to report for full summary.
1. Strip top soil at least 10 feet beyond building foot prints. Top soil ranged from 4 to 30 inches in thickness. Remove organic items (trees and tree roots).
 2. Compact the exposed soils and proof-roll with a heavy piece of rubber-tire construction equipment to check for soft or yielding areas. If soft or yield areas are encountered, correct per soils report.
 3. Fill with granular soils within the building envelopes. On-site soils should not be used.
 4. With the widespread presence of slightly compressible cohesive and fine-grained soils under the site, a time delay of 4 to 8 weeks is required between fill placement and beginning footing construction. Use settlement platforms or monitoring plates as described in geotechnical report.
 5. The normal construction sequence can begin after the settlement data indicates that settlement as largely ceased.
 6. If fill placement occurs at least 3 months prior to building construction, settlement monitoring will not be required.

3.2 EXCAVATION

- A. All excavations shall be safely and properly backfilled.
- B. All abandoned footings, utilities and other structures that interfere with new construction shall be removed.
- C. All unacceptable material and organic material shall be removed from below all proposed slabs-on-grade and the exposed natural soil shall be proof rolled and the compaction verified by the soils testing firm prior to placing fill. Proof-roll with a loaded tandem dump truck, loaded ready-mix truck, roller, or equivalent weight vehicle. Materials exhibiting weakness, such as those exhibiting rutting or pumping, shall be removed and replaced with acceptable compacted fill material.
- D. Do not excavate within the 45-degree bearing splay of any adjacent foundations.
- E. Outside 45-degree bearing splay of foundations, correct areas over excavated with aggregate at no additional cost to the Owner.
- F. Within the 45-degree bearing splay of foundations, correct areas over excavated with 2000 psi concrete fill at no additional cost to the Owner. Notify the Engineer prior to performing such work.
- G. Hand trim final excavation to remove all loose material.
- H. Contractor shall form all dams and perform other work necessary for keeping the excavation clear of water during the progress of the work and, at his own expense, shall pump or otherwise remove all surface and perched water which accumulates in the excavations. Perched water that cannot be de-watered in 48 hours of continuous pumping at a minimum rate of 60 gpm in dry weather shall be considered ground water.

- I. Stockpile excavated material in the area designated and remove excess material not being used, from the site.

3.3 BACKFILLING

- A. Support pipe and conduit during placement and compaction of bedding fill.
- B. Systematically backfill to allow necessary time for natural settlement. Do not backfill over porous, wet, spongy or frozen subgrade surfaces.
- C. Backfill areas to contours and elevations with unfrozen materials.
- D. Unless noted otherwise on the Drawings, make grade changes gradual.
- E. Unless noted otherwise on the Drawings, slope grade away from the building a minimum of 2 inches in 10 feet.
- F. Contractor shall procure the approval of the subgrade from the Inspection Agency prior to the start of any filling or bedding operations.
- G. Do not begin any backfill operations against any concrete walls until the concrete has achieved its specified strength.
- H. Place and mechanically compact granular fill in continuous layers not to exceed 10 inches compacted depth when using large equipment mounted compactors and 5 inches when using hand compactors.
- I. Employ a placement method that does not disturb or damage adjacent utilities, vapor barriers, foundation perimeter drainage and foundation waterproofing.
- J. All surplus fill materials are to be removed from the site.
- K. Fill material stockpiles shall be free of unacceptable soil materials.
- L. After work is complete, remove all excess stockpile material and repair stockpile area to its original condition.

3.4 COMPACTION

- A. Compact all fill that will support building footings or floor slabs to 95 percent of the maximum dry density in accordance with ASTM D1557. For relative cohesionless fill materials, where the percent passing the #200 sieve is less than 10 and the moisture density curve indicates only slight sensitivity to changing moisture content, compaction requirements should be changed to 75 percent relative density in accordance with ASTM D4253 and ASTM D4254.
- B. Compact all fills that support paving and landscape per civil specifications.

3.5 FOUNDATIONS

- A. Each footing excavation should be cleared of all obstructions and other organic or deleterious materials.

- B. Localized areas of unstable or unacceptable material may be discovered during the stripping and excavation operation and may require over-excavation and backfilling. The Inspection Agency shall be present during the proof rolling to evaluate any localized areas and make recommendations regarding over-excavation, backfilling and recompaction of these areas. Fill placement and compaction shall be inspected and tested by the Inspection Agency.
- C. Footing elevations shown on the Drawings designate a minimum depth of footing where a safe soil bearing pressure is expected. Footings, piers and/or walls shall be lowered or extended as required to reach soil meeting the design bearing pressure. This work shall be performed under direct supervision of the Inspection Agency.
- D. All footing excavations shall be recompacted by hand-operated, vibratory compaction equipment.
- E. All excavation and recompacted surfaces shall be inspected and tested to a depth of 2.0 feet below the excavated elevation by the Inspection Agency. Additional field density tests should be performed for each one foot of fill material placed. Any areas not in compliance with the compaction requirements should be corrected and re-tested prior to placement of fill material.
- F. For foundation areas where over excavation is performed, place and mechanically compact Engineered fill material in continuous layers not to exceed 10 inches compacted depth.

3.6 SLAB-ON-GRADE

- A. All disturbed areas after the clearing and stripping operation should be proof-rolled and recompacted with a heavy vibratory drum roller (approved by the Inspection Agency) in the static mode. The compactor should make a minimum of 10 passes, with a minimum of one foot overlap of each pass. The compactor speed should be less than 0.2 MPH.
- B. The Inspection Agency shall monitor proof-rolling and compaction operations. This area should then be tested for compaction to a depth of 2.0 feet below the compacted surface prior to the placement of any structural fill material.
- C. Refer to Drawings for required sub-grade preparation beneath slabs-on-grade.

3.7 UTILITY TRENCH BACKFILL (AT SLAB ON GRADE LOCATIONS)

- A. Excavate and backfill utility trenches under wall footings as shown on the Drawings
- B. Place utility base course on subgrades free of mud, frost, snow, or ice.
- C. Place and compact utility base course on trench bottoms and where indicated.
- D. Lay underground utilities on 6" sand bedding, which meets the acceptable criteria of Section 2.1,B.
- E. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- F. After connection joints are made, any misalignment can be corrected by tamping the sand around the utilities.

- G. Place and compact initial backfill of acceptable sand to a height of 6 inches over the utility pipe or conduit in 6 inches layer meeting specified compaction requirements.
- H. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit.
- I. Place and compact final backfill using acceptable soil to final subgrade elevation meeting specified compaction requirements.
- J. Backfill voids with acceptable soil while installing and removing shoring and bracing.
- K. Inspection Agency shall monitor and test compacted backfill to verify final compaction meets the specified requirement.

3.8 TOLERANCES

- A. Top surface of backfilling under paved areas: Plus or minus ½ inch from required elevation.
- B. Top surface of general backfilling: Plus or minus 1 inch from required elevation.

END OF SECTION

SECTION 31 23 16

EXCAVATION UNDERCUT

PART 1 - GENERAL

1.1 Section Includes

- A. Removing and disposing of unsuitable subgrade soils.
- B. Backfilling and compacting undercut area.

PART 2 - PRODUCTS

2.1 Materials

- C. Backfill with General/Structural Fill in accordance with Section 31 00 00.

PART 3 - EXECUTION

3.1 Inspection

- A. Owner representative will monitor and measure the Excavation Undercut. Restoration of disturbed surfaces to specified lines, grades, and contours.
- B. No compensation will be made for Excavation Undercut not monitored by Owner representative.

3.2 Performance

- A. Excavate and backfill the Undercut in accordance with Section 31 00 00 and 31 23 26. Maximum depth of undercut is 2 feet unless otherwise approved by Owner.

3.3 Disposal

- A. Dispose of unsuitable or excess excavation in the appropriate area as approved by OWNER.

3.4 Dewatering

- A. If groundwater is required to be pumped, it shall be pumped to a designated area on-site as approved by OWNER.

3.5 Field Quality Control

- A. Representative samples of soils shall be submitted to the Field Engineer and tested for optimum moisture-maximum density determination (ASTM D1557) prior to the start of fill placement. Sample size should be approximately 50 pounds.
- B. Field density tests to determine the level of compaction being achieved in the placed soil. The test shall generally be conducted on each lift at the beginning of fill placement and at a frequency mutually agreed upon by the project team for the remainder of the project.

END OF SECTION

SECTION 31 23 26

GENERAL/STRUCTURAL FILL

PART 1 - GENERAL

1.1 Section Includes

- A. CONTRACTOR shall place and compact structural fill in the locations shown on the Construction Drawings.

1.2 Related Sections

- A. Section 31 00 00 – Earthwork
- B. Section 31 23 16 – Excavation Undercut

1.3 References

- A. Refer to Geotechnical Exploration Report (CGC, Inc: Project Number C1789, December 7, 2017)

1.4 Description

- A. Work in this section covers the following items:
 - 1. Placement of structural fill for construction of the RNG Facility pad.
 - 2. Any areas shown as unsuitable during proof-rolling.

PART 2 - PRODUCTS

2.1 General

- A. Provide all materials as shown on the Construction Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Fill containing no vegetation, roots, topsoil, peat, ash, wood, or any other non-soil material which by decomposition might cause settlement.

2.2 Structural Fill Materials

- A. OWNER will provide soil for structural fill. Structural fill will be from existing on-site stockpiles or will come from soil excavated as part of this Work.
- B. Fill includes soils that are native to the project area.

2.3 Other Materials

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the CONTRACTOR and approved by the OWNER and ENGINEER.

PART 3 - EXECUTION

3.1 General

- A. The CONTRACTOR shall take necessary precautions to protect underground utilities, and especially any utilities whose original cover may be temporarily removed as part of construction.
- B. The CONTRACTOR is responsible for securing, purchasing, hauling and placement of fill material meeting the requirements of the Specifications.

3.2 Surface Conditions

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.3 Finish Elevation and Lines

- A. Finish to grades shown on Drawings.

3.4 Procedures

- A. Protection of Existing Utilities:
 - 1. Unless shown to be abandoned or removed, protect utility lines and other pipes shown on the Construction Drawings or otherwise made known to the CONTRACTOR prior to excavating. CONTRACTOR is required to perform all utility clearances, including interviewing on-site personnel to inquire about existing utilities in areas of proposed excavations. If a utility is damaged by the CONTRACTOR, the utility shall be repaired or replaced at no additional cost to the OWNER.
 - 2. If utility lines are encountered that are not shown on the Construction Drawings or otherwise made known to the CONTRACTOR, promptly take necessary steps to assure that service is not interrupted.
 - 3. If service is interrupted as a result of work under this Section, ENGINEER shall be notified, and CONTRACTOR shall immediately restore service by repairing the damaged utility.
 - 4. If existing utilities are found to interfere with the facilities being constructed under this Contract, immediately notify the OWNER and ENGINEER and request their instructions. Maintain a minimum 12-inch horizontal and vertical separation from existing utilities and the facilities being constructed under this contract.
 - 5. Do not proceed with permanent relocation of the work until written instructions are received from the OWNER/ENGINEER.
 - 6. Exposed utilities shall be properly supported at all times if undermined.
- B. Protection of Persons and Property:
 - 1. Protect structures, utilities, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Section.
- C. Dewatering:

1. Remove all water, including rainwater, encountered during work to an approved location by pumps, drains, and other approved methods.
 - a. Handling and disposal of water shall comply with all storm water and erosion and sedimentation control permits.
- D. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors and to other work being performed on or near the site.
- E. Maintain access to adjacent areas at all times.

3.5 Structural Fill Placement

- A. Structural fill shall be placed as indicated on the Construction Drawings.
- B. Ground Surface Preparation:
 1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious matter from ground surface prior to placement of structural fill in accordance with the Specifications.
- C. Structural Fill Placement and Compaction:
 1. Place backfill and fill materials in lifts no more than 10 inches in loose thickness.
 2. Compact structural fill using suitable mechanical equipment to achieve a minimum compaction level defined below:

Compaction Guidelines

Area	Percent Compaction (1)	
	Clay/Silt	Sand/Gravel
<u>Within 10 ft of building lines</u>		
Footing bearing soils	93 - 95	95
Under floors, steps and walks		
- Lightly loaded floor slab	90	90
- Heavily loaded floor slab and thicker fill zones	92	95
<u>Beyond 10 ft of building lines</u>		
Under walks and pavements		
- Less than 2 ft below subgrade	92	95
- Greater than 2 ft below subgrade	90	90
Landscaping	85	90

Notes:

1. Based on Modified Proctor Dry Density (ASTM D 1557)

Reference: Geotechnical Exploration Report (CGC, Inc: Project Number C1789, December 7, 2017)

3. Do not place backfill or fill material on surfaces that are muddy, frozen, or containing frost or ice.
4. Rock, stone or broken concrete greater than 6 inches in the largest dimension shall not be placed within 10 feet of the building area.
5. Fill used greater than 10 feet beyond the building limits shall not contain rock, boulders or concrete pieces greater than a 2 square foot area and shall not be placed within the final 2 feet of finished subgrade or in designated utility construction areas.

6. Fill containing rock, boulders or concrete pieces should include sufficient finer material to fill voids among the larger fragments.
7. Place backfill and fill materials evenly adjacent to structures, to required elevations.
8. Hydraulic compaction utilizing water to consolidate soils shall not be allowed.

3.6 Testing of Compacted Soils

- A. The ENGINEER will be on-site at all times during the placement of structural fill soil to test the fill during installation.
- B. The clay soils shall be tested using a nuclear density moisture gauge in accordance with ASTM D6938.
- C. Testing of structural fill will be conducted on each lift at the beginning of fill placement and at the frequency mutually agreed upon by the project team for the remainder of the project. The ENGINEER reserves the right to test any portion of the structural fill areas to verify compaction.
- D. Refer to the Table above for compaction requirements of compacted soils.
- E. Soil that does not pass initial tests shall be reworked by the CONTRACTOR at no cost to the OWNER until passing results are attained.

3.7 Maintenance

- A. Protection of Structural Fill Areas:
 1. Protect structural fill areas from traffic and erosion, and keep free from trash and weeds.
 2. Repair and reestablish grades in settled, eroded, and rutted areas to the specified tolerances.
- B. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape, and compact to the required density prior to further construction.

PART 4 - MEASUREMENT AND PAYMENT

4.1 NOT USED

* * * END OF SECTION * * *

SECTION 31 23 29

TOPSOIL

PART 1 - GENERAL

1.1 Section Includes

- A. Placement of topsoil for upper portion (4 inches) of required Vegetative areas within the limits disturbed by Construction, except for areas designed for roads, pads, and borrow areas.
- B. Fertility testing of topsoil.

1.2 Submittals

- A. Submit results of nutrients analysis testing on representative samples of topsoil. Testing to include pH, nitrogen, phosphorus, and potassium assessment. Testing results shall be accompanied by a recommendation for fertilizer mixture and application rate to be approved by OWNER. Testing is CONTRACTORs responsibility. Frequency: 1 composite sample per 10 acres of restoration.

PART 2 - MATERIALS

2.1 Topsoil Materials

- A. Friable, fertile, loamy soil containing an amount of organic matter normal to the region, capable of sustaining healthy plant life. Free from refuse, subsoil, materials toxic to plant growth, and foreign objects. To be Provide by OWNER.

PART 3 - EXECUTION

3.1 Preparation

- A. Remove vegetation, foreign materials, unsatisfactory or contaminated soils, obstructions, and matter harmful to plant growth from ground surface before placement.
- B. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- C. Scarify subsoil where Topsoil is to be placed. Repeat cultivation in areas where equipment used for hauling and spreading Topsoil has compacted subsoil.

3.2 Placement

- A. Place Topsoil to a uniform depth of 4 inches. Finish grade should be within plus 0.1 foot of elevations shown on Drawings or thickness required for project areas or as determined by grading tubes.
- B. Break down clods and lumps.

3.3 Field Quality Control

- A. OWNER will perform under provisions of these Specifications.

*** END OF SECTION ***

SECTION 31 23 33

TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES AND STORMWATER PIPING

PART 1 - GENERAL

1.1 Summary

- A. Trenching, backfilling and compacting for installation of piped utilities.
- B. Dewatering, protection, and maintenance of trenches, support of existing structures, sheeting and shoring, hauling and disposal of excess excavated materials and fill.

PART 2 - PRODUCTS

2.1 Backfill Materials

- A. Soil Backfill (outside paved / concrete surfaces): General Fill, comply with Drawings.
- B. Granular Fill (paved / concrete surfaces): Granular Fill, comply with Drawings

2.2 Bedding Materials

- A. For all pipes: Comply with Drawings.

PART 3 - EXECUTION

3.1 Preparation And Restoration

- A. Remove sod, topsoil, and other surface treatment and restore to original condition or better upon completion of the Work.
- B. Remove snow and ice before excavating.
- C. Identify required construction survey control lines and datum.

3.2 Protection

- A. Protect excavations by shoring, bracing, sheet piling, or other methods required to prevent cave-in or loose soil from falling into excavation.
- B. Place excavated and other material 2 feet minimum back from edge of trench excavation.
- C. Minimum trench excavation slope to be 1.5:1 unless otherwise approved by OSHA.
- D. Underpin adjacent structures which may be damaged by excavation Work, including utilities and piping.
- E. Notify Owner immediately of unexpected subsurface conditions.
- F. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.

3.3 Trenching

- A. Excavate to required width, alignment and grade. Elevations of pipes maybe subject to revisions, as necessary, to fit field conditions.
- B. No adjustment in compensation will be made for grade adjustments less than 1 foot above or below the elevations in the Drawings.
- C. Maximum trench width at pipe level shall be outside pipe diameter plus 24 inches.
- D. Remove water which may accumulate in trench, and construct ditches, flumes, and dams to direct water away from excavation to areas approved by Owner.
- E. Owner may limit the amount of open trench where required by operating conditions.
- F. Owner's Representative may order additional excavation where unsuitable soil conditions are encountered. Undercuts performed per Section 31 23 16.
- G. Promptly dispose of excess excavation material off-site or in appropriate stockpile area designated by Owner.

3.4 Utility Test Holes

- A. Where potential utility or other piping conflicts are anticipated, uncover utility lines / piping well in advance of trench excavation.
- B. Determine grade of utility line / piping, if encountered. Owner will advise of the adjustment required.
- C. Backfill and restore disturbed area to original condition.

3.5 Bedding

- A. Install bedding material from 6 inches below pipe to 12 inches above pipe, unless otherwise indicated on Drawings.
- B. Minimum depth of pipe in bedding shall be one third of the outside pipe diameter, unless otherwise indicated on Drawings.

3.6 Backfilling / Compacting

- A. Backfill following completion of pipe installation and review by Owner's representative, unless deficiencies are observed. Refer to Piping Sections for piping installation.
- B. Take necessary precautions with backfill and construction operations to protect completed system from damage.
- C. Backfill with care around structures and cleanouts.
- D. Backfill to the original ground elevation unless shown otherwise on Drawings.
- E. Place and compact backfill in accordance with Section 31 00 00.

3.7 Field Quality Control

A. OWNER will perform under provisions of these Specifications.

PART 4 - MEASUREMENT AND PAYMENT

(Not Used)

* * * END OF SECTION * * *

SECTION 31 25 00
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 Work Included

- A. Installation of soil erosion control devices.
- B. Maintenance of soil erosion devices during construction.
- C. Removal of temporary soil erosion control devices after stabilization of disturbed areas.
- D. Temporary grassing for soil erosion control.

1.2 References

- A. State of Wisconsin Department of Transportation (WisDOT):
 - 1. Standard Specifications for Road and Bridge Construction, latest edition.
- B. Erosion Control Product Acceptability List (PAL), latest edition.
- C. Dane County Erosion Control and Stormwater Management Manual, latest edition
- D. State of Wisconsin Department of Natural Resources (WDNR)
- E. WDNR Technical Standards, latest edition.
- F. Dane County No. 2 (Rodefeld) Landfill RNG Facility - Erosion Control Plans

1.3 Quality Control

After installing the soil erosion control devices as called for on the Construction Plans, the CONTRACTOR shall assure himself that all reasonable measures possible have been taken to prevent the siltation of nearby water courses and repair any areas damaged by erosion for a period of 1 year following completion of construction.

PART 2 - PRODUCTS

2.1 SILT FENCE

Posts

- A. Silt fence posts shall be post, a minimum of 4.5' long and spaced according to the details in the plans.

Woven Wire Fence

- A. Wire fence reinforcement shall be a minimum of 14-gauge 4" x 4" hogwire.

Filter Fabric

- A. Use only a synthetic filter fabric that is approved by the Wisconsin Department of Transportation. Synthetic filter fabric should contain ultraviolet ray inhibitors and

stabilizers to provide a minimum of six (6) months of expected usable construction life at a temperature of 0 to 120°F.

2.2 INLET PROTECTION

- A. Type B and Type D-M complying with Dane County Standards and WDNR Technical Standard 1060 (Storm Drain Inlet Protection for Construction Sites).

2.3 TRACKING PAD

- A. Aggregate base course according to the details in the plans.

2.4 RIP-RAP AND INFILTRATION TRENCHES

- A. Stone for rip-rap and infiltration trenches shall be durable, dense, specifically selected and graded quarried stone. The stone shall be the size specified in the plans.

2.5 TEMPORARY SEED

- A. Consist of Spring Oats, Sudangrass, Cereal Rye, Winter Wheat or Annual Rye, in accordance with Dane County Technical Standard - Seeding (temporary).

2.6 TURF REINFORCEMENT MAT

- A. Turf Reinforcement Mat (TRM) Class III, Type D Turf reinforcement.
- B. Anchoring devices for TRM shall be an approved anchoring device recommended by the manufacturer of the product.

2.7 MULCH

- A. Comply with Dane County Erosion Control and Stormwater Management Manual, latest edition- Technical Standard Mulching.

PART 3 - EXECUTION

3.1 GENERAL

- A. Construct temporary and permanent erosion control measures as shown on the plans, as required by site conditions, regulatory agency or ENGINEER.
- B. All permanent erosion control work shall be incorporated into the project at the earliest practicable time.
- C. Temporary erosion control measures shall be coordinated with permanent erosion control measures and all other work on the project to assure economical, effective, and continuous erosion control throughout the construction and post construction period and to minimize siltation of rivers, streams, lakes, reservoirs, other water impoundments, ground surfaces, or other property.
- D. If active construction ceases for more than 14 days, all disturbed areas shall be seeded and mulched using the temporary seed type and planting rates specified herein. The

CONTRACTOR shall be liable for all damages to public or private property and fines as may be placed on the project by the local regulatory agencies due to soil erosion from the project site. Clear only those areas required to install the soil erosion control devices, request an inspection by the local agency having jurisdiction.

- E. All erosion control devices shall be inspected by the CONTRACTOR after each rainfall. Any required repairs shall be made immediately. Sediment deposits shall be removed when deposits reach approximately one-half of the capacity of the erosion control device.

3.2 SILT FENCE

- A. Silt fence shall be installed in accordance with the details in the plans.
- B. Should the filter fabric deteriorate or become ineffective prior to the end of the construction as determined by the ENGINEER, the fabric shall be replaced immediately at no additional cost to the OWNER.
- C. Remove sediment when sediment deposits reach no more than one half of silt fence height.
- D. Remove silt fence once contributing drainage area is stabilized with vegetation or impervious area.

3.3 RIP-RAP

- A. Prepare subgrade to the required lines and grades as shown or indicated on the contract drawings. Place any fill required in the subgrade to a density equal to that of the surrounding area. Place filter fabric on the finished subgrade.
- B. Place rip-rap by mechanical methods, augmented by hand placing where necessary to prevent damage to permanent works, provided that when the rip-rap is completed it forms a properly graded, dense, neat layer of stone. The completed rip-rap shall have a thickness as shown on the plans.

3.4 TEMPORARY GRASSING

- A. Temporary grassing procedures will be implemented when directed by the ENGINEER or as required by the soil erosion inspector and in portions of the site where construction activities have temporarily or permanently ceased but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased.
- B. Where construction activity will resume on a portion of the site within 21 days from when activities ceased, stabilization measures do not have to be initiated on that portion of the site by the 14th day after construction activity temporarily ceased.
- C. Seeding for temporary grassing shall be applied to all shoulders, side ditches, cut slopes, fill slopes, and any other area disturbed by the CONTRACTOR and not designated for pavement or structures. Temporary seeding shall occur immediately following final land disturbing activities. Any unseeded area which erodes shall be repaired to the satisfaction of the ENGINEER at no additional cost to the OWNER. Apply temporary seeding in accordance with the Temporary Seeding rates specified in the Dane County Erosion Control and Stormwater Management Manual, latest edition.

3.5 MULCHING

- A. Place mulch on seeded areas within 24 hours after seeding has been completed.
- B. Begin mulching at top of slope and proceed downward.
- C. Maintain mulched areas and repair any areas damaged by wind, erosion, traffic, or other causes prior to final acceptance of work under contract.
- D. Place mulch in accordance with Dane County Erosion Control and Stormwater Management Manual, latest edition- Technical Standard Mulching.
- E. Inspect weekly and within 24 hours after each rainfall.

3.6 INLET PROTECTION (AS DIRECTED)

- A. A sump shall be constructed around the drop inlet and silt fence installed in accordance with the details in the plans for Inlet Protection.

3.7 TURF REINFORCEMENT MAT (TRM) FOR DITCH

- A. The ditch or slope shall be constructed to the configuration shown on the plans.
- B. Prepare seedbed and apply lime fertilizer and seed in accordance with grassing specifications.
- C. Install TRM in accordance with detail on plans and manufacturer's recommendations.

3.8 REMOVAL OF TEMPORARY EROSION DEVICES

- A. The CONTRACTOR shall remove all sedimentation and erosion control devices upon the approval of permanent seeding and stabilization by the agency having jurisdiction of the area and the ENGINEER. All sediment deposits remaining in place after the erosion control devices are removed shall be dressed to conform to the existing grade, prepared, and seeded. The cost of removal and cleanup shall be included in the cost of the installation of the device or in the cost for maintenance.

3.9 CLEAN OUT PERMANENT EROSION CONTROL DEVICES

- A. The CONTRACTOR shall clean out permanent sediment and erosion control devices upon approval of permanent seeding and stabilization by the agency having jurisdiction of the area and the ENGINEER. The devices shall be cleaned out to the original condition. The cost of cleanup shall be included in the cost of installation or in the cost of maintenance of the device.

*** END OF SECTION ***

SECTION 31 38 00

SITE RESTORATION/SEEDING/VEGETATION

PART 1 - GENERAL

1.1 Summary

- A. Provide site restoration as shown and as specified.
- B. The work shall include but is not limited to furnishing all labor, equipment and material necessary to final grade, seed, mulch, fertilize, maintain and establish permanent vegetation for the areas as specified herein.
- C. Topsoil all areas disturbed by Construction activities within the construction limits, except for areas designed for roads.
- D. Fertilize; seed, and mulch top-soiled areas, stockpiles and borrow areas as required.

1.2 Submittals

- A. Provide nutrients analysis and nutrient recommendations for topsoil to be used. Testing to include pH, nitrogen, phosphorus, and potassium assessment. Testing is Contractor's responsibility. Frequency: 1 composite sample/10 acres.
- B. The Contractor shall submit a complete materials list of items proposed for the work and a description of how the work will be completed.
- C. The Contractor shall submit seed and fertilizer certifications for all bags used in the project.
- D. Submit letter upon project completion guaranteeing the seed will grow and Contractor will come back in spring of following year to reseed, fertilize, mulch, etc. areas where seed did not take.

1.3 Work Seasons

- A. Conduct site restoration during favorable weather conditions*. Do not proceed with any seeding when conditions are not acceptable per seed manufacturer's recommendations. Do not proceed when air temperature exceeds 90 degrees F. or soil temperature is less than 50 degrees F.?

*Consult with owner regarding scheduled dates if weather delays prohibit above dates. Modification to above may be made if recommended by seed supplier and approved by Owner.

1.4 Delivery, Storage, and Handling

- A. Deliver grass seed in original containers showing analysis of seed mixture, percentage of pure live seed, year of production, net weight, and date of packaging, and location of packaging. Damaged packages are not acceptable.
- B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.5 Maintenance

- A. Maintain vegetated surfaces and supply additional topsoil where necessary, including areas affected by erosion.
- B. Maintain the proper moisture levels in the seeded areas to stimulate and establish growth.
- C. Replant damaged grass areas showing root growth failure, deterioration, bare or thin spots, and eroded areas.

PART 2 - PRODUCTS

2.1 Topsoil

- A. Fertile, friable, natural loam surface soil, reasonably free of subsoil, clay lumps, brush, weeds and free of roots, stumps, stones larger than 1” and other extraneous matter harmful to plant growth, containing an amount of organic matter normal to the region, capable of sustaining healthy plant life.

2.2 Fertilizer

- A. As required based on nutrient analysis performed on topsoil per Section 31 23 29.

2.3 Seed

- A. Deliver in bags tagged and labeled to show percentage of purity and germination. Seed shall have been tested within one year prior to date of seeding and shall conform to latest State and Federal laws. The seed mixes specified below shall be used or other seed mixtures approved by Owner and Engineer. All seed mixtures proposed need to be submitted for approval 20 days prior to use.
- B. The following seed mixtures shall be used in the specified locations. Seeding rates shall be 175 lbs/acre unless otherwise specified.

- 4. Areas: Use WDOT Seed Mix No. 20.
 - a. 6 Percent Kentucky Bluegrass
 - b. 24 Percent Hard Fescue of Chewings Fescue
 - c. 40 Percent Tall Fescue
 - d. 30 Percent Perennial Ryegrass

2.4 Straw Mulch

- A. Clean Oat/Wheat Straw: Reasonably free of grain, weed seed, or mold. Mulch materials shall not contain excessive moisture which prevents uniform feeding through mulching machine and at least 50% or more of the mulch by weight should be 10” or more in length.

2.5 TURF REINFORCEMENT MAT

- A. Turf Reinforcement Mat (TRM) Class III, Type D Turf reinforcement.
- B. Anchoring devices for TRM shall be an approved anchoring device recommended by the manufacturer of the product.

2.6 Hydroseed

- A. Not allowed on project unless approved by Owner.

2.7 Hydromulch

- A. Not allowed on project unless approved by Owner.

PART 3 - EXECUTION

3.1 Examination

- A. The Contractor shall not begin work in this section until the final grading has been approved by the Owner.

3.2 Seedbed Preparation

- A. The Contractor shall test the topsoil per Section 31 23 29. The test results shall be submitted to the Owner.
- B. The seedbed shall be prepared by pulverizing and breaking up the soil to a minimum depth of two inches with a harley rack, or harrowing tool. All rocks over two inches in diameter, clods and undesirable material that would interfere with seeding operations shall be removed.
- C. Immediately after seedbed preparation, and if needed as a result of the soil test results and recommendations, the Contractor shall properly apply the recommended appropriate mixtures and quantity of soil amendment/fertilizer to the prepared topsoil layer.

3.3 Seed Application

- A. The seeding shall commence immediately after seedbed preparation is complete or as soon thereafter as conditions are favorable.
- B. The seed shall be drilled over the seedbed at a rate and depth described in the Dane County Erosion Control and Stormwater Management Manual, latest edition, or as recommended by the seed manufacturer, using methods and drilling equipment acceptable to the seed manufacturer and Owner. Application of grass seed and fertilizer at the same time, in the same machine is not permitted.

3.4 Mulching

- A. Upon completion of temporary seeding the approved mulch shall be applied over the seeded area at a rate to be determined by the Contractor to be adequate to protect the seed during germination. If using Straw typical application rate in flat areas is 1.5 tons/acre.
- B. If Straw mulch is used it must be crimped in place with a mechanical crimper made for such a purpose, or using a farm-type disc plow sett straight with adequate weight to crimp the material to a depth of approximately 4 inches. If other mulch type material is used in lieu of Straw an appropriate and approved tackifying agent such as asphalt emulsion or similar will be applied to the entire surface at the recommended rate to hold it in place until permanent grass is established.

3.5 TURF REINFORCEMENT MAT

- A. Cover seeded slopes where grade is 2:1 or greater with establishment blanket. Roll matting down over slopes without stretching or pulling.
- B. Lay matting smoothly on soil surface, burying top end of each section in narrow 69 inch trench. Leave 12 inch overlap from top roll over bottom roll. Leave 4 inch overlap over adjacent section.
- C. Staple outside edges and overlaps at 36 inch intervals.
- D. Lightly dress slopes with topsoil to ensure close contact between matting and soil.
- E. In ditches, unroll matting in direction of flow. Overlap ends of strips 6 inches with upstream section on top.
- F. Cover all permanently seeded areas with Excelsior Matting as indicated on the plans.

3.6 Watering

- A. Water seeded areas as necessary to assure that moist good growth conditions are maintained until Owner accepts restoration work.

3.7 Protection

- A. The Contractor shall secure the work area and protect the vegetated areas from any traffic, disturbances, wildlife, or public use until vegetation is accepted by Owner.

3.8 Establishment & Replacement

- A. Seeded areas which fail to show an adequate stand of grass within four weeks shall be raked, reseeded, fertilized, and mulched at Contractor's expense. Areas seeded in fall, which fail to show an adequate stand shall be reseeded, fertilized, and mulched the following spring before June 1. Adequate stand shall be considered a minimum of 500 seeding per sq. ft. bare spots shall be no larger than 6" square. Total bare spots shall not exceed 2% of total seeded area.

* * * END OF SECTION * * *

SECTION 32 05 16

AGGREGATE ROAD BASE

PART 1 - GENERAL

1.1 Section Includes

- A. Gravel Area Sections, and
- B. RNG Facility Slabs.

1.2 Submittals

- A. Submit test results under provisions of Section 01 00 00, indicating that proposed materials meet the required specifications.
- B. Submit source of supply and test results from an accredited testing laboratory under provisions of Section 01 00 00. Submit request for substitution under provisions of Section 01 00 00.

PART 2 - PRODUCTS

2.1 Gravel Area Sections and Pad Construction Materials

- A. Aggregate Base: Crushed stone or gravel meeting requirements of WISDOT Std. Spec., Section 305, for 1-1/4 in. base.

2.2 Pavement Area Materials

- A. Dense Graded Base Course (DGB): Crushed stone or gravel meeting requirements of WISDOT Standard. Specification, Sections 305 and 301, for 1-1/4 inch base and 3 inch base.

PART 3 - EXECUTION

3.1 Inspection

- A. Owner's representative to observe proof-rolling and approve subgrade prior to Aggregate Surface Course placement.
- B. Rework subgrade or re-compact as necessary.

3.2 Installation

- A. Aggregate Surface Course: Deposit Aggregate Base Course material in a manner to minimize segregation and facilitate spreading to a uniform uncompacted layer. Construct the Aggregate Base Course in one or more layers. All Gravel Area Sections and facility pad of 12" aggregate base course placed in 2 compacted 6-inch lifts.
- B. Aggregate beneath pavement sections consist of 10-inches DBE shall consist of a minimum of 4-inches of 1-1/4 inch DGB and 6 inches of 3-inch DGB.

- C. Add water as necessary to assist compaction. If excess water is apparent, aerate Aggregate Base Course material to reduce the moisture content.
- D. Compact each layer of material to the degree that no further appreciable consolidation or movement of the base is evidenced under action of the compaction equipment. Compact each layer of Aggregate Base Course to a minimum of 95% of the materials modified Proctor value.
- E. Rework or remove and replace soft or yielding areas as required until proper compaction is obtained. The cost of such reworking or removal and replacement shall be at the CONTRACTOR's expense.

3.3 Field Quality Control

- A. OWNER will perform under provisions of these Specifications.

* * * END OF SECTION * * *

SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.1 Section Includes

- A. Mixing, spreading, compacting, and finishing of bituminous pavements for base, leveling, and surface courses on roads, parking lots, and other areas.

1.2 Quality Assurance

- A. Perform work in accordance with the State of Wisconsin Department of Transportation — Standard Specifications for Highway and Structure Construction, 2018 Edition, hereinafter referred to as “WISDOT Specifications.” Measurements and payments portions of those WISDOT Specifications do not apply to work performed under this contract.
- B. Mixing Plant: Comply with requirements of WISDOT Specifications.
- C. Qualifications of Asphaltic Concrete Producer: Use only materials which are finished by a bulk asphaltic concrete producer regularly engaged in production of hot-mix, hot-laid asphaltic concrete.

1.3 Paving Quality Requirements

- A. General: In addition to other specified conditions, comply with the following minimum requirements.
 - 1. Test in-place asphaltic concrete courses for compliance with requirements for density, thickness, and surface smoothness.
 - 2. Provide final surfaces or uniform texture, complying with required grades and cross-sections.
 - 3. Take not less than 4-inch diameter pavement specimens for each completed course, from locations as directed by the testing agency.
 - 4. Repair holes from test specimens as specified for patching defective work.
- B. Density
 - 1. Compare density of in-place material against laboratory specimens of same asphaltic concrete mixture, when subjected to 50 blows of standard Marshall Hammer on each side of specimen.
 - 2. Minimum acceptable density of in-place course material is 96% of the recorded laboratory specimen density.

1.4 Regulatory Requirements

- A. Comply with all applicable local standards, codes, and ordinances for paving work on public property.

1.5 Submittals

- A. Samples: Provide samples of materials for laboratory testing and job-mix design as required by OWNERS Representative.
- B. In lieu of laboratory test reports, CONTRACTOR may provide certificates signed by the asphaltic concrete producer and CONTRACTOR certifying that materials comply with all specification requirements.

1.6 Environmental Requirements

- A. Do not place asphalt when the base surface temperature is less than 40°F.
- B. Do not apply materials when substrate is wet or contains sufficient moisture to prevent uniform distribution and proper penetration.

PART 2 - PRODUCTS

2.1 Materials

- A. Tack Coat: Emulsified asphalt SS-1, diluted with equal parts of water.
- B. Asphalt Cement: AASHTO M320-10, 82-34 performance graded asphalt binder.
- C. Stone Base: Dense graded base course in accordance with WISDOT Specification Sections 301 and 305.
 - 1. Coarse aggregate: 3 inch
 - 2. Fine aggregate: 1 1/4 inch
- D. Mineral Filler: Shall meet the requirements of AASHTO M17 finely ground particles of limestone, hydrated lime, Portland cement, or other approved mineral dust, free from foreign matter.

2.2 Asphalt Paving Mix

- A. Use dry materials to avoid foaming. Mix uniformly.
- B. Mix designation: WISDOT Specification Sections as follows:
 - 1. Asphaltic Concrete Surface Course: Section 460, LT bituminous with grading No. 5
 - 2. Binder Course: Section 460, LT bituminous with grading No. 4
- C. The pavement shall be constructed in accordance with the Wisconsin State DOT Standard Specifications for Highway and Structure Construction, latest edition, including supplemental specifications and Wisconsin Asphalt Pavement Association 2016 Asphalt Pavement Design Guide.

PART 3 - EXECUTION

3.1 Inspection

- A. Verify compacted sub-grade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. Beginning of installation means acceptance of substrate.

3.2 Preparation

- A. Prepare mix materials and place of deposit in accordance with referenced WISDOT specifications.
- B. Tack Coat:
 - 1. Apply tack coat only when the air temperature is 32°F or more unless the otherwise approved by ENGINEER. Before applying tack coat ensure that the surface is reasonably free of loose dirt, dust, or other foreign matter. Do not apply to surfaces with standing water. Do not apply if weather or surface conditions are unfavorable or before impending rains.
 - 2. Apply tack coat to contact surfaces of concrete items, which abut pavement.
 - 3. Apply to contact surfaces of existing asphalt or concrete pavement at the rate of 0.050 – 0.070 gallons per square yard of surface. ENGINEER may adjust application rate based on surface conditions. Limit application each day to the area the contractor expects to pave during that day.
- C. Frames and subsurface structures:
 - 1. Coat Surfaces of new and existing frames with oil to prevent bond with asphalt paving.
 - 2. Set to be flush with finish surface and surround with a ring of compacted asphaltic concrete to one inch below top of frame. Adjust as required to meet paving.
 - 3. Provide temporary covers over openings until completion of rolling operations.

3.3 Placing Asphalt Pavement

- A. Place materials in accordance with referenced WISDOT Specifications.
- B. Place, spread, and strike-off to compacted thickness indicated with paving machine, except that inaccessible and small areas may be placed by hand.
- C. Place topping course within 2 hours of placing and compacting binder course.
- D. Compact pavement by rolling. Do not displace or extrude pavement from position. Hand compact area inaccessible to rolling equipment.
 - 1. Average relative density: Minimum of 96%
 - 2. Individual relative density: Minimum of 92%
- E. Develop rolling with consecutive passes to achieve even and smooth finish of uniform texture, without roller marks.
- F. Make joints between successive days work, or between old and new pavements in accordance with referenced State Highway Specification. Ensure a continuous bond is attained.

3.4 Tolerances

- A. Flatness: ± 0.25 inch measured with a 10-foot straight edge.
- B. Compacted scheduled thickness: ± 0.15 inch of design thickness.
- C. Variation from true elevation: 0.05 feet.

3.5 Patching

- A. Remove defective or deficient areas for full depth of course.
 - 1. Cut sides parallel and perpendicular to direction of traffic with edges vertical.
 - 2. Apply tack coat to exposed surfaces and place asphalt on prepared surfaces as specified above.

3.6 Field Quality Control

- A. Field inspection and testing will be performed by OWNER as described under provisions of these Specifications and the CQA Plan.

3.7 Protection

- A. Immediately after placement, protect pavement from mechanical injury for 7 days.
- B. Cover openings of substrate structures in paved area until permanent coverings are placed.

3.8 Schedule of Pavement Sections

- A. Place and compact materials to the thickness called for on the Construction Drawings.

* * * END OF SECTION * * *

SECTION 32 13 05

CONCRETE PAVEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Provide concrete pavement, including prepared base, as shown and as specified. Comply with applicable provisions of Divisions 00 and 01.

1.02 DEFINITIONS

- A. References to "WISDOT Std. Spec." shall mean Wisconsin Department of Transportation, Standard Specifications for Highway and Structure Construction, latest edition, including current Supplemental Specifications.

1.03 NOTIFICATION

- A. Notify A/E at least 24 hr prior to placing any concrete.

1.04 SUBMITTALS

- A. Mix Design: Submit mix design for review at least 10 days prior to use. Mix design shall be derived from tests performed by a qualified testing laboratory or from previous tests performed on aggregate from same source.
- B. Joint Plan: If joint locations are not shown on Drawings, submit jointing plan in accordance with "Joints" article, below.
- C. Product Data and Certificates of Compliance: Submit product data and material certifications for joint fillers and sealers.
- D. Test Reports: Submit reports for laboratory and field tests required under "Testing" article. Test reports for base course shall be submitted prior to placing concrete pavement.
- E. Make submittals in accordance with Section 01.

1.05 TESTING

- A. Contractor shall arrange and pay for base course compaction testing by a qualified testing agency, acceptable to Owner and independent of Contractor. Determine laboratory density of base course material. Perform at least one field density test for every 2,000 sq ft of paved area, but in no case less than three tests.

PART 2 PRODUCTS

2.01 BASE COURSE

- A. Crushed stone or crushed gravel meeting requirements of WISDOT Std. Spec., Section 305, for 1-1/4 in. base.

2.02 CONCRETE

- A. Concrete shall be in accordance with Section 03 30 00, Class AA.

Class	Min, Comp Strength @ 28 days, p.s.i.	Max Slump	Max. Agg. Size	Min. Cement, Bags/C.Y.	Max. Water-Cement Ratio	Air Content % by Volume
AA	4,500	3-1/2"	3/4"	6	0.45	5-7%*

*1-1/2" max. aggregate size may be used if allowed by ACI 318. If used, air entrainment shall be 4-6%.

2.03 REINFORCING STEEL

- A. Reinforcing Bars and Tie Bars: ASTM A615, Grade 60, deformed steel bars, epoxy-coated in accordance with ASTM A775.

2.04 FORMS

- A. Provide forms of steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects, extending full depth of concrete.
- B. Use flexible spring steel forms or laminated boards to form radius bends as required.
- C. Coat forms with a form release agent which will not discolor or deface surface of concrete.

2.05 JOINT MATERIALS

- A. Expansion joint filler (1/2 in. thick, unless otherwise indicated) meeting requirements of WISDOT Std. Spec., Subsection 415.2.
- B. Joint sealer shall be hot-poured elastic type or cold-poured silicone type. Hot-poured elastic sealant shall comply with ASTM D6690, Type II. Cold-poured silicone sealant shall comply with ASTM D5893, Type SL.

2.06 CURING COMPOUNDS

- A. Curing compounds and curing agents meeting requirements of WISDOT Std. Spec., Subsection 415.2.

2.07 TRAFFIC MARKING PAINT

- A. Factory mixed, non-bleeding, waterborne traffic marking paint complying with FS TT-P-1952, Type II, with a drying time of less than 45 minutes. Color shall be white, except where yellow is designated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Shape and compact subgrade to uniform density and to required alignment and cross-section. Foundation shall be smooth and at proper elevation and contour to receive base course.
- B. Whenever new work adjoins existing pavement, saw cut existing pavement to form a straight, vertical joint line.

3.02 PLACING BASE COURSE

- A. Place base course to grade as shown with proper allowance for concrete pavement. Base course shall be compacted to 95% maximum density at optimum moisture content in accordance with ASTM D698 or AASHTO T99.
- B. Base course in excess of 8 in. thickness shall be compacted in two lifts.

3.03 PAVEMENT CONSTRUCTION

- A. Construct concrete pavement in accordance with Section 03 30 00 and WISDOT Std. Spec., Subsection 415.3, except as otherwise designated.
- B. Slope pavement as shown on Drawings.
- C. Final surface finish shall be light brush finish.

3.04 JOINTS

- A. Locate joints where shown on Drawings. If not shown, prepare and submit a jointing plan based on the following:
 - 1. Locate contraction joints at a maximum of 15 ft. on center each way. Joints shall be continuous across slab, unless interrupted by an expansion joint. Extend joints completely through curb. Saw joints to the initial and final configuration shown.
 - 2. Locate expansion joints as required to isolate fixed objects abutting or within paved area.
- B. Provide tie bars and dowel bars as follows:
 - 1. At construction joints, provide No. 6 tie bars, 2'-0" long, spaced 1'-0" o.c. and centered vertically in pavement.
- C. Install expansion joint materials in accordance with manufacturer's recommendations.

3.05 SEALING JOINTS

- A. Seal construction, contraction, and expansion joints with joint sealer placed in accordance with manufacturer's recommendations.
- B. Seal shall be 1/2 to 5/8 in. wide and 3/4 in. deep, with backer rod as required.

3.06 PROTECTION

- A. Properly protect work by barricades to prevent damage to freshly placed concrete until pavement has cured.

3.07 LANE AND PARKING MARKING

- A. Paint line work on concrete paving and concrete curbs as designated by Owner.
- B. Clean surface in areas to receive markings. Paint markings and symbols with traffic marking paint. Apply paint with mechanical equipment to produce uniform straight edges. Apply one coat at manufacturer's recommended rate to achieve a minimum wet film thickness of 15 mils.

END OF SECTION

SECTION 32 31 10

CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SUMMARY

- A. Provide chain link fences, gates, and appurtenances as shown and as specified. Comply with applicable provisions of Divisions 00 and 01.

1.02 SUBMITTALS

- A. Shop Drawings: Submit shop drawings for fence, gates, and appurtenances. Include plan layout; fence height; location and sizes of posts, rails, braces, gates and footings; product data; and erection procedures.

1.03 QUALITY ASSURANCE

- A. Provide chain link fence and gates as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings, and fastenings.

PART 2 PRODUCTS

2.01 FABRIC

- A. Fabric shall be 9 gage (0.148 in.) steel wire in a 2-in. mesh. Fabric 5 ft high and under shall be knuckled at both selvages. Fabric 6 ft and over shall be knuckled at one selvage and twisted and barbed at other selvage. Provide one-piece fabric widths for fence up to 12 ft.
- B. Fabric shall be one of the following:
 - 1. Aluminum-coated before weaving, ASTM A491, with not less than 0.40 oz aluminum per sq ft of surface.
 - 2. Galvanized before or after weaving, ASTM A392, Class 2, with not less than 2.0 oz zinc per sq ft of surface.
- B. Fabric shall be galvanized before or after weaving, ASTM A392, Class 1, with not less than 1.2 oz zinc per sq ft of surface.
- B. Fabric shall have minimum 6 mil PVC plastic resin finish, ASTM F668, Class 2, thermally bonded to galvanized steel; color as selected by Owner.

2.02 FRAMEWORK, GENERAL

- A. Framework shall be steel. Strength requirements shall conform to ASTM F1043.
- B. Pipe sizes indicated are commercial pipe sizes. Tube sizes are nominal outside dimension. H-section sizes are nominal flange dimensions. Roll-formed section sizes are nominal outside dimensions.
- C. Steel framework and appurtenances shall be galvanized as follows:

1. Pipe: ASTM F1083 (1.8 oz. zinc psf).
2. Square Tubing, H, and Formed Sections: ASTM A123 (2.0 oz zinc psf).
3. Hardware and Accessories: ASTM A153 (zinc weight per Table I).

2.03 POSTS

- A. End, corner, and pull posts shall be of minimum sizes and weights as follows:
1. Up to 6-ft fabric height:
 - a. 2.375-in. O.D. pipe weighing 3.65 plf.
 - b. 2-in. square tubing weighing 3.60 plf.
 - c. 3.5-in. x 3.5-in. roll-formed section weighing 4.85 plf.
 2. Over 6-ft fabric height:
 - a. 2.875-in. O.D. pipe weighing 5.79 plf.
 - b. 2.5-in. square tubing weighing 5.10 plf.
 - c. 3.5-in. x 3.5-in. roll-formed section weighing 4.85 plf.
- B. Line posts shall be of minimum sizes and weights as follows:
1. Up to 6-ft fabric height:
 - a. 1.90-in. O.D. pipe weighing 2.72 plf.
 - b. 1.875-in. x 1.625-in. H-section weighing 2.70 plf.
 - c. 1.875-in. x 1.625-in. roll-formed section weighing 2.28 plf.
 2. Over 6-ft fabric height:
 - a. 2.375-in. O.D. pipe weighing 3.65 plf.
 - b. 2.25-in. x 1.70-in. H-section weighing 3.26 plf.
 - c. 2.25-in. x 1.70-in. roll-formed section weighing 2.70 plf.
- C. Gate posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths shall be as follows:
1. Up to 6-ft wide:
 - a. 2.875-in. O.D. pipe weighing 5.79 plf.
 - b. 2-1/2-in. square tubing weighing 5.10 plf.
 - c. 3-in. x 3-in. H-section weighing 6.50 plf.
 - d. 3.5-in. x 3.5-in. roll-formed section weighing 4.85 plf.
 2. Over 6 to 13-ft wide:
 - a. 4.0-in. O.D. pipe weighing 9.11 plf.

2.04 TOP RAILS

- A. Top rails, unless otherwise shown, shall be as follows:
1. 1.660-in. O.D. pipe weighing 2.27 plf.
 2. 1.625-in. x 1.25-in. roll-form sections weighing 1.35 plf.
- B. Furnish in manufacturer's longest lengths, with expansion type couplings approximately 6-in. long for each joint. Provide means for attaching top rail securely to each gate, corner, pull, and end post.

2.05 BRACES

- A. Use 1.660-in. O.D. pipe weighing 2.27 plf for horizontal braces and 3/8-in. diameter rod with turnbuckle for diagonal trusses.

- B. Provide bracing assemblies at end and gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Provide manufacturer's standard galvanized steel or cast iron cap for each end.

2.06 TENSION WIRE

- A. 7 gage coil spring steel wire, finish to match fabric.

2.07 WIRE TIES

- A. 9 gage steel wire or 6 gage preformed steel clips, finish to match fabric.

2.08 STRETCHER BARS

- A. One piece lengths with minimum length 2 in. less than full height of fabric, with a minimum cross-section of 3/16 in. x 3/4 in. Provide one stretcher bar for each gate and end post, and two for each corner and pull post, except where fabric is integrally woven into post.

2.09 POST TOPS

- A. Steel, wrought iron, or malleable iron, designed as a weather tight closure cap (for tubular posts). Provide one cap for each post. Furnish caps with openings to permit through passage of top rail.

2.10 GATES, GENERAL

- A. Fabricate perimeter frames of gates from metal and finish to match fence framework. Assemble gate frames by welding. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware, and accessories. Space frame members maximum of 8 ft apart, unless otherwise indicated.
- B. Provide same fabric as for fence, unless otherwise indicated. Install fabric with tension bars and bands at vertical edges and at top and bottom edges.
- C. Install diagonal cross-bracing consisting of 3/8-in. diameter adjustable-length truss rods on gates to ensure frame rigidity without sag or twist.
- D. Where barbed wire is indicated above gates, extend end members of gate frames 12 in. above top member and prepare to receive three strands of wire. Provide necessary clips for securing wire to extensions.

2.11 SWING GATES

- A. Swing gates shall comply with ASTM F900.
- B. Gate frame members shall be as follows:
 - 1. Up to 6-ft high, leaf width 8-ft or less:
 - a. 1.66-in. O.D. pipe weighing 2.27 plf.
 - b. 1.5-in. square tubing weighing 1.90 plf.
 - 2. Over 6-ft high and 8-ft wide:
 - a. 1.90-in. O.D. pipe weighing 2.72 plf.
 - b. 2-in. square tubing weighing 2.60 plf.

- C. Hinges shall be pressed or forged steel or malleable iron to suit gate size, non-lift-off type, offset to permit 180 deg gate opening. Provide 1-1/2 pair of hinges for each leaf over 6-ft nominal height.
- D. Latch shall be forked type or plunger-bar type to permit operation from either side of gate. Provide padlock eye as integral part of latch.
- E. Provide keeper for all vehicle gates, which automatically engages gate leaf and holds it in open position until manually released.
- F. Provide gate stops for all double gates, consisting of mushroom type flush plate with anchors. Set in concrete to engage center drop rod or plunger bar. Provide locking device and padlock eyes as an integral part of latch, permitting both gate leaves to be locked with a single padlock.

2.12 CONCRETE

- A. Comply with Section 03 30 00.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install fence in compliance with ASTM F567. Do not begin installation and erection before final grading is completed, unless otherwise permitted.

3.02 EXCAVATION

- A. Excavate post holes to minimum diameters as recommended by fence manufacturer, but not less than four times largest cross-section of post. Space line posts evenly, 10 ft or less apart, unless otherwise indicated.
- B. Excavate holes approximately 3 in. lower than post bottom, with bottom of posts set not less than 36 in. below surface when in firm, undisturbed soil. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.
- C. Spread soil from excavations uniformly adjacent to fence line, or on adjacent areas of site, as directed.

3.03 SETTING POSTS

- A. Remove all loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
- B. Center and align posts in holes 3 in. above bottom of excavation.
- C. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation. Check each post for vertical and top alignment; hold in position during placement and finishing operations.
- D. Trowel finish tops of footings, and slope or dome to direct water away from posts. Extend footings for gate posts to underside of bottom hinge. Set keeps, stops, sleeves and other accessories into concrete as required.

- E. Keep exposed concrete surfaces moist for at least 7 days after placement, or cure with membrane curing material, or other acceptable curing method.

3.04 FENCE ERECTION

- A. Allow concrete to attain at least 75% of its minimum 28 day compressive strength, but in no case sooner than 7 days after placement, before rails, tension wires, barbed wire, or fabric are installed. Do not stretch and tension fabric and wires, and do not hang gates, until concrete has attained its full design strength.
- B. Run top rail continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.
- C. Install braces so posts are plumb when diagonal rod is under proper tension.
- D. Install tension wire within 6 in. of bottom of fabric before stretching fabric and tie to each post with not less than same gage and type of wire. Pull wire taut, without sags. Fasten fabric to tension wire with 11-gage hog rings of same material and finish as fabric wire, spaced maximum 24 in. o.c.
- E. Leave approximately 2 in. between finish grade and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.
- F. Thread stretcher bars through or clamp to fabric 4 in. o.c., and secure to posts with metal bands spaced 15 in. o.c.
- G. Tie fabric to line posts with wire ties spaced 12 in. o.c. Tie fabric to rails and braces with wire ties spaced 24 in. o.c. Tie fabric to tension wires with hog rings spaced 24 in. o.c. Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two full turns. Bend ends of wire to minimize hazard to persons or clothing.
- H. Install nuts for tension band and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- I. Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage, as recommended by fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.
- J. Repair damaged coatings in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 33 32 26

SUBMERSIBLE PUMP LIFT STATION

PART 1 GENERAL

1.01 SUMMARY

- A. Provide lift station, complete with submersible leachate pumps, piping, and appurtenances, as shown and as specified. Comply with applicable provisions of Division 00.

1.02 RELATED SECTIONS

Division 26 - Electrical.
40 05 33 HDPE Pipe

1.04 SUBMITTALS

- A. Shop Drawings: Submit shop drawings for pumps and accessories.
- B. O/M Manuals: Submit O/M manuals for pumps.
- C. Test Report: Submit written report for factory pump test.
- D. Startup Letter: Submit service representative's letter concerning startup services.
- E. Warranty: Submit written warranty for pump.
- F. Make submittals in accordance with Section 01 00 00.

1.05 WARRANTY

- A. Pump manufacturer shall warranty pump workmanship and materials in accordance with its standard 5-year limited warranty.

PART 2 PRODUCTS

2.01 LIFT STATION, GENERAL

- A. Provide totally submersible, electrically operated, leachate pumps with hydraulic sealing discharge connection, and pump lifting wire with hooks. Provide piping, valves and accessories, as designated.
- B. Design shall be such that pumps will be connected to discharge piping when lowered into place. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastening devices to be removed, and no need of personnel to enter pump well.
- C. Pumps and motors shall be UL-Approved for use in Class I, Div. 1, Group D hazardous location as defined by National Electrical Code.
- E. Miscellaneous metals and hardware within lift station wet well shall be stainless steel.

2.02 PUMPS

- A. Acceptable Manufacturers: EPG, QED, or approved equal.
- B. Each pump shall have capacity of 20 gpm at total design head of 55 ft. Each pump motor shall be 1/2 hp (maximum), 230 v, 3 ph, 60 hz, service.
- C. Pump motors shall have cooling characteristics suitable to permit continuous operation in totally, partially, and non-submerged conditions. Motors shall have integral overload element embedded in winding to protect motor against overcurrent and overheating due to overload and failure to start. Overload element shall automatically reset when motor cools.
- D. Pump motor power and control cables shall be provided by pump supplier. Cables shall be neoprene or PVC jacketed and suitable for submersible wastewater and landfill applications. Power cable shall have ground wire and be of size as recommended by manufacturer and as required by code. Control cables shall be of size and number of conductors as required to perform functions specified. Cables shall be potted into a steel connector with polyurethane resin, or other suitable means shall be used to provide a leakproof seal.
- E. Power cable and control wiring shall be of sufficient length to reach control panel without splices and shall allow complete removal of pumps from pump well without disconnection of wiring.

2.03 PUMP TEST

- A. Manufacturer shall perform standard inspections and tests before shipment; submit a written report of test data.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install pumps and accessories in accordance with shop drawings and manufacturer's recommendations. Mount equipment as indicated on Drawings.
- C. Extend piping and terminate with a suitable coupling adapter to mate with discharge force main.

3.02 OPERATION OF SYSTEM

- A. Electrical connections and controls will be provided under Division 26.

3.03 MANUFACTURER SERVICES

- A. Equipment manufacturer shall provide services of a factory-trained service representative for a minimum of 1 day to:
 - 1. Review the installation.
 - 2. Check and adjust equipment prior to operation.
 - 3. Check integral equipment supplied by other manufacturers.
 - 4. Observe field tests of equipment.
 - 5. Train Owner's operator(s) in operation of equipment.

- B. Notify A/E and Owner when this initial service will be performed.
- C. After start-up of equipment, service representative shall furnish a letter to A/E and Owner confirming that the installation is in accordance with manufacturer recommendations, necessary alignments and adjustments have been made, and equipment is operating properly.
- D. In addition to initial services, manufacturer shall provide for a 1-day inspection trip after 6 months of operation to inspect and adjust equipment.

3.04 SYSTEM TESTS

- A. Prior to acceptance, conduct an operational test, under observation of A/E, to demonstrate that installed equipment meets purpose and intent of Specifications. Performance shall be demonstrated throughout operating range.
- B. Demonstrate that equipment is not defective electrically, mechanically, or otherwise, and is in a safe and satisfactory operating condition.
- C. Check for excessive vibration, leaks in piping and seals, electrical power input in kilowatts, and correct operation of control system and equipment.

END OF SECTION

SECTION 33 42 00

CULVERTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Culverts as shown and specified.

1.2 SUBMITTALS

A. Submit shop drawings of culverts.

PART 2 PRODUCTS

2.1 MATERIALS

A. Culvert pipe shall be of material and type indicated in the Drawings or Special Provisions. If not designated, select one of the materials listed below. Each pipe shall be stamped or indelibly marked with its type and class and the manufacturer's name or mark.

B. CORRUGATED STEEL PIPE AND PIPE ARCH CULVERTS

1. Corrugated steel pipe (CSP) and corrugated steel pipe arch (CSPA) shall conform to AASHTO M36/ASTM A760, except reinforcement of ends is not required. Provide accessories as shown.
2. Corrugations shall be annular or helical, minimum size 2-2/3 in. x 1/2 in. Minimum sheet thickness for steel material shall be as follows:

<u>Circular Pipe</u>		<u>Pipe Arch</u>	
<u>Dia. (in.)</u>	<u>Min. Gage</u>	<u>Dia. (in.)</u>	<u>Min. Gage</u>
12 to 24	16	17 x 13 to 28 x 20	16
30 to 36	14	35 x 24 to 42 x 29	14
42 to 54	12	49 x 33 to 64 x 43	12
60	10	71 x 47	10

C. REINFORCED CONCRETE PIPE AND PIPE ARCH CULVERTS

1. Reinforced concrete pipe (RCP) shall conform to AASHTO M170/ASTM C76, Class III, unless otherwise indicated. Reinforced concrete pipe arch (RCPA) shall conform to AASHTO M206/ASTM C506, Class A-III, unless otherwise indicated. Size per Drawings.

D. CORRUGATED POLYETHYLENE PIPE CULVERTS

1. Corrugated polyethylene (PE) pipe shall conform to AASHTO M294, Type S, having a corrugated outer wall and smooth inner liner. Size per Drawings

PART 3 EXECUTION

3.1 INSTALLATION

- A. Contractor shall be responsible for temporary drainage during installation.
- B. Install culverts in open trenches to line and grades as shown.
- C. Where culverts are located in new embankments, grade shall be brought up to at least as high as the top of culvert and shall not exceed 2 ft above top of culvert when culvert is installed.
- D. Excavate trench sides as nearly vertical as possible. From bottom of trench to an elevation 1 ft above top of culvert, trench width shall not exceed diameter of pipe plus 24 in. Bottom of trench shall be shaped by hand methods or by a suitable template so that lower one-tenth of diameter of culvert will be in contact with bottom of trench. For concrete pipe, excavate for bell holes. Culverts shall be bedded with existing materials, unless otherwise indicated.
- E. Where rock, hardpan, or boulders are encountered at bottom of trench excavation, excavate an additional 8 in. below bottom of culvert and backfill with granular materials approved by A/E.

F. INSTALLING CULVERT SECTIONS

- 1. Lay riveted corrugated steel culverts so that flow is over lap of sheets. Lay concrete pipe with bell or grooved ends facing upstream.
- 2. Culverts shall be placed in a straight line, and at a grade which will accurately maintain the bed of water course or channel. Allow a slight camber in middle of length so that after completion of additional embankment above pipe there will be no sags or depressions in entire length of culvert.
- 3. Corrugated steel pipe sections shall be joined with a band bolted into place in accordance with manufacturer's directions. Concrete pipe sections shall be carefully fitted together so that joints are tight and preclude infiltration of surrounding soil. Corrugated polyethylene pipe shall be joined with a soil-tight coupling in accordance with manufacturer's directions.

G. BACKFILLING

- 1. Backfill with select excavated material, free from large lumps, rocks, rubbish, wood, organic material and frozen material. Carefully place backfill on both sides of culverts and structures in layers not exceeding 6 in. depth. Thoroughly tamp and compact each layer to density of surrounding soil. Place successive 6 in. layers to an elevation 12 in. above top of pipe.
- 2. Remaining backfill may be deposited from top of trench by mechanical means. Backfill material in no case shall be dropped from such height or in such a volume that its impact upon pipe will cause damage.
- 3. Compact backfill under roadways and walks to 95% of Standard Proctor density (ASTM D698). Compact backfill elsewhere to 90% of Standard Proctor density.
- 4. A minimum depth of 2 ft of earth cushion shall be maintained over top of covered pipes during succeeding operations until placement of base or surface courses.

END OF SECTION

SECTION 33 56 22

STEEL ABOVEGROUND STORAGE TANKS

PART 1 GENERAL

1.01 SUMMARY

- A. Provide steel aboveground storage tanks as shown and as specified. Comply with applicable provisions of Divisions 00 and 01.

1.03 ABBREVIATIONS

AWWA – American Water Works Association

1.04 SUBMITTALS

- A. Product Data: Submit product data for tanks and accessories.
- B. O/M Manuals: Submit operation and maintenance manuals for equipment.
- C. Make submittals in accordance with Section 01.

1.07 WARRANTY

- A. Tank manufacturer shall warranty pump workmanship and materials in accordance with its standard warranty against leakage from corrosion.

PART 2 PRODUCTS

2.01 STEEL TANK

- A. CST Storage Tank - 11.00 Foot Diameter x 17.76 Foot nominal sidewall height factory coated welded carbon steel Fire Protection Tank. Nominal Capacity 12,626 gallons and designed to store water for fire protection and designed in accordance with CTT Specifications, Seismic Zone 0 per AWWA, 115 MPH wind load per AWWA, 25 PSF live deck load. Flat bottom, anchoring stirrups with anchor bolts (cast in place type), design pressure 8.00 oz., vacuum 1.00 oz. per square inch, 10 degree deck slope. Hot Rolled Sheet and Plate – ASTM A1011 Grade 40 or Equal. Structural Shapes – ASTM A36 or ASTM A992.

- B. Coatings:

Interior coating: Epoxy, 2.0 mils AVG DFT per SSPC PA-2

Exterior Primer: Epoxy, 2.0 mils AVG DFT per SSPC PA-2

Exterior Topcoat: Performance Urethane, 1.5 mils AVG DFT

Coatings are applied over an SSPC-SP 6 commercial blast and thermally cured. All CST Storage coating are to be applied within a controlled environment and blast is achieved using steel grit.

- C. Accessories
 - 1. Welding: Class 1:
 - 2. Cylinder: All vertical and circumferential welds shall be full penetration double-butt welds.
 - 3. Skirt: Same as cylinder
 - 4. Deck to cylinder: Double fillet weld
 - 5. Hopper to cylinder: Full penetration single bevel weld
 - 6. Appurtenances & nozzles: Double fillet weld
 - 7. Interior grind requirements: CTT standard - smooth not flush
- D. Other Accessories:
 - 1- CST Storage decal installed on top ring
 - 2- 24" Diameter shell manway with bolt-on hinged cover
 - 1- Mushroom vent with 1/2" mesh screen
 - 1- 24" Square roof manway with hinged cover
 - 1- Name Plate, Liquid Tank
 - 1- 4" Diameter 150# FFSO single flanged nozzle
 - 1- 4" Diameter 150# FFSO single flanged nozzle
 - 1- 4" 150# FFSO Flanged nozzle with elbow and vortex breaker
 - 1-6" Overflow assembly with internal weir cone, piping to ground, and flap valve
 - 16- 3/4" Anchor Bolts
 - 1- 24ft of 4" inlet riser piping
 - 1- Deck perimeter guardrail - OSHA - HDG posts & toeboard with two aluminum handrails (CST std. construction)
 - 1- Bolted outside ladder with safety cage, lockable hoop entry and safety swing gate for deck access - OSHA - HDG (CST std. construction)

PART 3 EXECUTION

3.01 TANK INSTALLATION

- A. Install tanks in accordance with shop drawings, manufacturer's recommendations.
- B. Particular care will be taken to protect the baked-on powdered coated panels from damage (i.e., scratches, abrasion) during field installation.

3.02 FIELD TESTING

- A. Following completion of erecting and cleaning the tank, the structure shall be tested for liquid tightness by filling the tank to its overflow elevation
- B. The contractor in accordance with the manufacturer's recommendations shall correct any leaks disclosed by this test.
- C. The owner shall furnish water required for testing at the time of tank erection completion, and at no charge to the tank erector.

END OF SECTION

SECTION 33 92 19

PRECAST CONCRETE MANHOLES/VAULTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Precast vault sections, jointing materials, bases, tops, connections, and appurtenances for the leachate control system and stormwater system.

1.2 SUBMITTALS

- A. Submit shop drawings of precast vault and manhole sections, jointing materials, bases, tops, and appurtenances for the leachate system and stormwater system.

PART 2 PRODUCTS

2.1 MATERIALS

A. Precast Concrete Vaults

1. Vault and Manhole Base: Precast concrete, complying with ASTM C478 standard specifications for Precast Reinforced Concrete Manhole sections. Bottom sections of manholes shall be monolithic with manhole base.
2. Joints: Gasketed and damp-proofed on exterior.
3. Pipe Connections: Core and boot seals and epoxy grout.
4. Epoxy coating on interior of manholes.

B. Access Lid: Type and Size per Drawings.

C. Mortar: Three parts masonry sand and one part Portland Cement by volume.

D. Epoxy Coating: Coal tar epoxy protective coating designed for immersion, interior or exterior corrosion resistance. Epoxy coating to be applied by the manufacturer.

E. Rubber Gaskets: ASTM C 443 Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

F. Flexible Plastic Gaskets: Type B AASHTO M 198 Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets, Type B Flexible Plastic Gaskets.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Pipe Connection: Provide core-n-seal boots, link seals, or smooth, watertight connection of mortar around pipe where indicated on the drawings.
- B. Install in accordance with manufacturer's recommendations to line and grade shown on the Drawings.

C. Backfill in accordance with Section 31 00 00.

END OF SECTION

SECTION 40 05 12

DUCTILE IRON PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Detailed requirements for various ductile iron piping products. Some products specified in this Section may not be required for this Contract. Refer to the Drawings and Part VII - Water Mains and Service Laterals section outlined in the City of Madison Standard Specifications for Public Works Construction, 2017 Edition, or latest edition to determine particular ductile iron piping products to be provided under this Contract.

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA A21.51, latest revision.

B. American National Standard

1. ANSI C151, C111, latest revision

1.3 SUBMITTALS

- ###### A. Section 01 00 00 - Submittal Procedures: Requirements for submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

- ###### A. Conform to the requirements specified herein for the type and class of material named. The Engineer reserves the right to reject any materials not meeting these Specifications as being defective.
- ###### B. Inspection: Accept piping and appurtenances on-Site in manufacturer's original packaging and inspect for damage.
- ###### C. Store materials according to manufacturer instructions.
- ###### D. Do not drop or bump materials against the ground.

PART 2 PRODUCTS

2.1 Pipe

- ###### A. Liquid Pipe: AWWA C151/A21.51, ductile iron.
- ###### B. Pipe Requirements
1. Class 52 ductile iron
 2. Cement lined
 3. Push-on joint

4. Furnished with all necessary accessories
5. Bonding strap to provide electrical conductivity

C. Gaskets

1. Gaskets shall conform to the requirements of ANSI/AWWA C111/A21.11
2. Gasket Requirements:
 - a. Plain rubber gaskets
 - b. Retrained-joint locking gaskets
 - i. Use restrained joint locking gaskets when electing to *or* are otherwise required to meet thrust-restraint requirements by means of restrained-joint pipe.
 - ii. Retrained-joint locking gaskets must be certified as compliant for use with the furnished pipe material by the pipe manufacturer.
3. Nitrile or Fluorocarbon gaskets may be required if water mains are near contaminated soils.

D. Polyethylene Encasement

1. Polyethylene encasement materials shall conform to the requirements of the American National Standard for Polyethylene Encasement for Ductile Iron Pipe Systems (ANSI/AWWA C105/A21.5 - latest revision).
2. Polyethylene Encasement Requirements:
 - a. 8-mil thickness (minimum)
 - b. Furnish in either tube or sheet form

E. Fittings and Accessories:

1. Mechanical Joint Fittings:
 - a. Mechanical joint fittings are to conform to the requirements of American National Standard for Ductile Iron and Gray Iron Fittings, 3-inch through 48-inch, for Water (ANSI/AWWA C110/A21.10 - latest revision).
 - b. Mechanical Joint Fitting Requirements:
 - i. Class 250 mechanical joint pipe fittings.
 - ii. Cement lined
 - iii. All bells
 - iv. Entire fitting tarred
 - v. Conductive mechanical joint (no lead)
 - vi. Furnish all necessary accessories (rubber gaskets, flanges, bolts, etc.)
2. Mechanical Joint Restraints
 - i. EBAA Iron Inc. - MEGALUG® Series 1100, or approved equal.
3. Nuts and Bolts:
 - a. Comply with AWWA C111/A21.11. - latest revision.
 - b. Ensure that bolts are of sufficient length such that a minimum of ½-inch of threads are exposed beyond the end of the nut when tightened.
 - c. Refer to the following table for the numbers, diameters, and lengths of bolts to be used:

Pipe Diameter (inches)	No. of Bolts Required	Bolt Diameter (inches)	Bolt Length (inches)	Bolt Length for MEGALUG® (inches)
4	4	3/4	3-1/2	4
6	6	3/4	3-1/2	4

4. Solid Sleeves:
 - a. Class 52 ductile iron.

- F. Services and Stops and Accessories.
 1. Service Laterals – 4 inch diameter
 - a. Class 52 ductile iron in accordance with Section 2.1 A&B

- G. Corporation Stops and Service Fittings.
 1. Curb Boxes
 - a. Ensure that all curb boxes are complete, with covers marked “WATER.”
 - b. Curb Box Assemblies shall include the following:
 - i. Brass screws.
 - ii. 2½-inch new style flush fit cover.
 - iii. 54-inch rods and guide rings.
 - iv. 2½-inch screw type shaft.
 - v. 37-inch bottom section.
 - vi. 29-inch top section.
 - vii. 16-inch center section.

- H. Disinfection Commercials – NOT USED

- I. Hydrants:
 1. Hydrants are required to have “breakaway” capability
 2. Acceptable models include:
 - i. AFC Waterous, Model Pacer WB-67
 - ii. Mueller, Model Super Centurion A423
 3. Nozzle Requirements
 - i. Side nozzles: Two at 2½-inch diameter.
 - j. Pumper nozzle: One at 4½-inch diameter.
 - k. National Standard threads.
 - l. Chains attaching the caps to the hydrant.
 - m. Embossed with the word OPEN and an arrow showing that the hydrant opens left.
 - n. Valve opening: 5¼-inch with National Standard operating nut shape.
 - o. Painted red with blue nozzle caps – Waterous color M4152 (Houston Blue), or equal. 8. 360-degree top rotation.
 - p. “Dry top” operating threads to be sealed when open.
 - q. 6-inch mechanical joint bottom connection with conductive mechanical joint (no lead) gasket and necessary accessories.
 4. Upper valve plate requirements:
 - a. Brass with a brass-to-brass foot valve.
 5. Drain valve facing requirements:
 - a. Furnish hydrant with plastic drain valve facing (otherwise, drain tube/drain valve assembly).
 6. Operating nut requirements:
 - a. One-piece operating nut.
 7. Reflective locating device:
 - a. “Hydra-Finder” manufactured by RoDon Corp.
 8. Extensions: Per manufacturer’s recommendations.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Construct water main and appurtenances in accordance with AWWA C600, latest revisions, except when otherwise required in these specifications.
- B. Construct water mains and appurtenances in open trenches and in a manner to protect the pipe and appurtenances from unusual stresses at all times.
- C. In accordance with trenching, Backfilling of Utilities Section 31 23 33.
- D. Bell Holes:
 - 1. Provide holes for pipe bells at each joint
 - 2. Holes should be no larger than necessary for joint assembly, including installing the required overlaps for polyethylene encasement, and assurance that the pipe will lay flat within the trench.
- E. Thrust Restraint:
 - 1. Provide thrust restraint for all fittings by one of two methods:
 - i. A combination of concrete thrust blocking and mechanical joint restraint.
 - ii. A combination of push-on restrained joint pipe, and mechanical joint restraint.
 - 2. Regardless of the restraint method employed, restrain all mechanical joints using MEGALUG® Series 1100 or approved equal retainer glands installed per the manufacturer recommendations and additionally include concrete blocking at all hydrant installations, cut-in connections, branch tee connections and live-tap connections, per Standard Detail Drawing 7.13 of the City of Madison Standards.
 - 3. Concrete Thrust Blocking:
 - i. Where concrete blocking serves as the thrust restraint method, block all hydrants and fittings, except vertical down bends, per the required bearing area in the table below and Standard Detail Drawing 7.13. Block vertical down bends per Standard Detail Drawing 7.14. Restrain per Standard Detail Drawing 7.15 of the City of Madison Standards only where specified or approved by the Engineer.

Required Undisturbed Bearing Area of Concrete Thrust Blocking (Square Feet)					
Fitting Size(In)	Tee, Wye, Hydrant, Plug or Cap	90° Horizontal Bend, Plugged Cross or Tee (Plugged on Run)	45° Horizontal Bend	22-1/2° Horizontal Bend	11-1/4° Horizontal Bend
4	0.9	1.3	0.7	0.4	0.2
6	2.1	3.0	1.6	0.8	0.4

Note: Listed areas are based on a test pressure of 150 psi and an allowable soil bearing pressure of 3,000 pounds per square foot. To compute bearing areas for different test pressure, use the following equation:
 Bearing area = (Test Pressure ÷ 150) x (Table Value)

- 4. Concrete thrust blocking must be at least two-feet thick over the entire bearing area.
- 5. On hydrants and fittings requiring less than 4-square feet bearing area use either cast-in place concrete or solid concrete blocks placed between the appurtenance and the undisturbed wall of the trench. Fill all voids with compacted clear stone or screenings.
- 6. For fittings requiring 4-square feet bearing area or greater, use only cast-in-place concrete meeting the requirements of Article 301 of City of Madison Standards and a minimum

strength of 3,000 psi at 7-days. Protect the concrete from freezing for a minimum of 24-hours after placement.

7. Do not perform pressure testing within 72-hours of pouring the thrust block. A 9-bag concrete mix may be authorized by the Engineer upon request.
8. Do not extend the concrete blocking beyond the joint. Protect all nuts and bolts from the concrete during pouring so they can be removed without damaging the thrust block.
9. Do not backfill over thrust restraint blocking until it has been inspected by the Engineer.

F. Joint Restraint

1. Where joint serves as a thrust restraint method, with the exception of vertical bends, restrain all push-on joints within the lengths specified in the 'Required Joint Restraint Distance from Fitting' table below. Restrain vertical bends per Standard Detail Drawing 7.16 of the City of Madison Standards.
2. Restrain push-on joints with the pipe manufacturer's approved joint restraint locking gasket per Article 702 of the City of Madison Standards.
3. Restrain all mechanical joints per Article 702 and Article 703 – 'Mechanical Joint Pipe and Fittings' of the City of Madison Standards.

REQUIRED JOINT RESTRAINT DISTANCE FROM FITTING (FEET)								
FITTING TYPE	4-IN	6-IN	8-IN	10-IN	12-IN	16-IN	20-IN	24-IN
TEE: RUN OR CROSS:	10	10	10	10	10	20	20	20
TEE: BRANCH	10	10	10	10	10	10	10	10
CAP/PLUG ON DEAD END	30	45	60	70	80	110	140	160
90° HORIZONTAL BEND	10	15	20	25	25	30	40	50
45° HORIZONTAL BEND	5	10	10	10	15	15	20	25
22.5° HORIZONTAL BEND	5	5	5	5	10	10	10	15
11.25° HORIZONTAL BEND	3	3	3	3	5	5	5	5
REDUCER: SIZE x 4"	-	25	45	60	75	100	130	150
REDUCER: SIZE x 6"	-	-	25	45	60	90	120	145
HYDRANT	RESTRAIN ALL JOINTS ON HYDRANT LEAD							
NOTES:								
SOIL TYPE = GM (SILTY GRAVELS & GRAVEL/SILT/SAND MIXES)					DEPTH OF BURY = 6-FT			
SAFETY FACTOR = 1.5			TRENCH TYPE = 4		TEST PRESSURE = 150 PSI			

- G. Installation Standards: Install Work according to applicable City of Madison Standards and Details.

3.2 FIELD QUALITY CONTROL

- A. Inspect for damage to pipe lining or coating, and for other defects that may be detrimental as determined by the Architect/Engineer. Repair damaged piping, or provide new, undamaged pipe.
- B. After installation, inspect for proper supports and interferences.
- C. Testing:
 1. Perform Hydrostatic pressure test and Conductivity test on piping according to City of Madison standards. No disinfection required.

3.3 CLEANING

- A. Keep pipe interior clean as installation progresses.
- B. Clean pipe interior of soil, grit, loose mortar, and other debris after pipe installation.

END OF SECTION

SECTION 40 05 33

HIGH-DENSITY POLYETHYLENE (HDPE) PIPE

PART 1 - GENERAL

1.1 Section Includes

- A. HDPE Pipe and Fittings

1.2 Submittals

- A. Submit Shop Drawings and Material Certification for all materials are supplied by the CONTRACTOR

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. HDPE Pipe/Manholes:

1. Plexco
3240 N. Mannheim Road
Franklin Park, Illinois 60131
2. Poly Pipe Industries, Inc.
Drawer HH
Gainesville, Texas 76240
3. Phillips Driscopipe, Inc.
2929 North Central Expressway
Richardson, Texas 75083

- B. Valves:

1. ASAHI/AMERICA
425 Riverside A venue
Medford, Massachusetts 02155

- C. Substitutions under provisions Section 01 00 00

2.2 Single Walled HDPE Materials

- A. All HDPE Pipe and fittings as shown on Drawings: Smooth wall pipe made from an HDPE material having a minimum designation code of PE 4710. The material shall meet the requirements of ASTM D 3350, and shall have a minimum cell classification of PE445474C. Sizes per Drawings.
- B. Joints: heat fusion process (ASTM D3261) as per manufacturer instruction. In inaccessible areas, electro fusion joints will be allowed on a case by case basis. Mechanical joints are

acceptable at manhole inlets of differing material. No branch saddle connections unless approved by OWNER. Use full size tees / crosses with reducers.

- C. Bends shall be molded. Pre-fabricated fittings must be specifically approved by the ENGINEER.

2.3 Dual Containment HDPE Pipe

- A. All HDPE Pipe, centralizers and fittings as shown on Drawings: Smooth wall pipe made from an HDPE material having a minimum designation code of PE 4710. The material shall meet the requirements of ASTM D 3350, and shall have a minimum cell classification of PE445474C. Sizes per Drawings.
- B. All joints shall be heat fusion welded, except in inaccessible areas where electrofusion joints will be allowed on a case by case basis if requested by the Contractor. Mechanical joints are acceptable at manhole inlets of differing material. No branch saddle connections unless approved by OWNER. Use full size tees / crosses with reducers.
- C. Centralizers welded to carrier pipe shall support carrier pipe within containment pipe. Centralizer support spacing and other pipe system requirements shall be in accordance with the Drawings.
- D. End termination fittings shall be used to seal piping system at ends other than manholes. Fitting shall be simultaneously butt fused to carrier and containment pipe to seal the annular space. No other closure or termination will be allowed. This fitting shall also provide transition to single wall piping.

2.4 PVC Materials

- A. Non-perforated and perforated PVC pipe and fittings as shown on drawings: ASTM D1785, Type I, Grade 1, Schedule 80, complete with required couplings, molded fittings, and well screen size, sizes per drawings.
- B. Joints: Per Drawings. Solvent welds per ASTM D2855. Vanstone flanges for connections to HDPE.
- C. Solvents: ASTM D2564, heavy-bodied solvent cement.

2.5 Valves

- A. Gate Valves:
 - 1. Corrosion-resistant thermoplastic gate valve rated for 150 psi compatible with HDPE and PVC pipe.
 - 2. EPDM seals.
- B. Check Valves:
 - 1. Corrosion-resistant thermoplastic ball check valve rated for 150 psi compatible with HDPE and PVC pipe.
 - 2. EPDM seats and seals.
- C. Butterfly Valves:
 - 1. Corrosion-resistant thermoplastic butterfly valve rated for 150 psi compatible with HDPE and PVC pipe.

2. Nitrile seats and seals.
- D. Ball Valves:
1. Corrosion-resistant thermoplastic ball valve rated for 150 psi compatible with HDPE and PVC pipe.
 2. Teflon® seats with EPDM backing cushions and EPDM seals.

2.6 Hardware

- A. Hardware (bolts, flanges, back-up rings, etc.) used for flanges / mechanical joints shall be 316 stainless steel where buried in waste. Bolts shall be anti-seize type. Galvanized, zinc-plated bolts shall be used above grade or where outside the limits of waste. Ductile iron back-up rings shall be used above grade or where outside the limits of waste.

PART 3 - EXECUTION

3.1 Inspection

- A. Inspect pipe, fittings, and other appurtenances before installation to verify quality of material.
- B. Bends to be molded or prefabricated. Field fabricated fittings not allowed unless specifically approved by OWNER.

3.2 Preparation

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove dirt and foreign material, inside and outside, from pipe and fitting materials before assembly.
- C. Make straight field cuts without chipping or cracking pipe.
- D. Seal pipe ends to keep clean during construction breaks overnight.

3.3 Installation

- A. Make PVC solvent cement joints in accordance with ASTM D2855 and PPI-TR10.
- B. Install PVC pipe and fittings to the line and grade specified on the drawings with bell end upstream.
- C. Make HDPE butt fusion welds in accordance with manufacturers recommended procedures.
- D. Install manholes, pipe, and fittings to the line and grade specified on the drawings, in accordance with manufacturer's recommendations.
- E. Lay pipe from the low end toward the high point. Provide continuous smooth invert. Cut in and connect to existing pipe as required. Consult with OWNER if adjustments to inverts are required at connections to existing pipe. Tape or otherwise seal open pipe ends when handling on site to minimize potential for debris to collect in pipe.
- F. The maximum allowable tolerance for grade is 0.05 foot.
- G. Construct bedding material and specified Backfill Materials over pipe with care, to avoid damage to pipe. Minimize traffic and turning of traffic over pipe.

3.4 Mechanical Connections

- A. Mechanical Connections shall consist of the following unless otherwise noted:
- B. HDPE Flanged Connections shall be butt-fused to HDPE pipe. Outside diameter and drillings shall comply with ANSI B16.1. Back-up flanges shall be ductile iron and comply with ANSI B16.6 unless otherwise specified.

3.5 Field Quality Control

- A. Allow ENGINEER to observe pipe alignment and joints prior to backfilling.
- B. Maximum allowable depth of cuts, gouges, or scratches on the exterior surface of pipe or fittings shall be limited to 10% of the wall thickness. Interior of the pipe shall be free of cuts, gouges, and scratches.
- C. Jet clean pipe with water using sewer cleaning equipment when construction is completed, prior to final acceptance.
- D. Pressure testing: Commence test procedures when the following conditions have been met:
 - 1. Pipe section to be tested is clean and free of dirt, sand or other foreign material.
 - 2. Plug pipe outlets with test plugs. Brace each plug securely to prevent blowouts. Use concrete if necessary.
 - 3. Add compressed air slowly.
 - 4. Pressurizing equipment shall be continuously monitored and include a regulator set to avoid over-pressurizing and damaging an otherwise acceptable section of pipe.
 - 5. Provide necessary pipe connections between the section of line being tested and the compressed air supply, together with test pressure equipment, meters, pressure gauge, and other equipment, materials, and facilities necessary to perform the specified tests.
 - 6. Furnish and install bulkheads, flanges, valves, bracing, blocking or other temporary sectionalizing devices that may be required.
 - 7. Remove temporary sectionalizing devices after tests have been completed.
- E. Testing Equipment
 - 1. Contractor shall provide all equipment required for this testing procedure.
 - 2. Testing Equipment shall include, but may not be limited to:
 - a. Polyethylene flange adapter with steel blind flange.
 - b. Temperature gauge (0°C to 100°C) tapped and threaded into blind flange.
 - c. Pressure gauge (0 to 200 psi) ASME Standard B40.1 Grade 2A (accuracy of $\pm 0.5\%$ of full scale) with minor graduation marks no greater than 1 psi.
 - d. Inlet valve to facilitate compressed air hose.
 - e. Ball valve to release pipe pressure at test completion.
 - f. Polyethylene reducers to be used to adapt test flange to size of pipe being tested.
 - g. Air compressor shall provide adequate air supply for testing.

- h. Pressurizing equipment shall include a regulator set to avoid over-pressurizing and damaging otherwise acceptable pipe.
 3. Provide verification and results of gauge calibration prior to test.
- F. Testing
 1. Owner and Engineer shall be given 48-hr notification prior to test.
 2. Appropriate Safety precautions must be in-place.
 3. Pipe Test Segments:
 - a. Butt-fusion weld pipe segments.
 - b. Less than 2000 feet in length.
 - c. Blind flange with test apparatus on one end and fused cap or blind flange assembly on opposite end.
 4. Environment:
 - a. Bury test segment or lay test segment on ground surface and allow it to reach ambient temperature before test.
 - b. Perform test during period when pipe segment will be out of direct sunlight and not subject to heating or cooling, to minimize pressure changes as a result of temperature fluctuations.
 5. Test (observed by Engineer):
 - a. Apply test pressure of 10 psi or 1.1 times operating pressure, whichever is greater, to test segment.
 - b. Observe test pressure for 1-hour.
 - c. Mathematically correct pressure drop for temperature change.
 - d. Temperature corrected pressure drop over 1-hour period should not exceed 1%.
 6. Test Failure
 - a. If retest is necessary, allow pressure to relax to 0 psig for at least 8 hours prior to retest.
 - b. Perform the following when pipe segment fails test.
 - i. Check entire length of pipe and fusion welds for cracks, pinholes, valves leaks, perforations or other possible leakage points.
 - ii. Check blocked risers and capped ends for leakage and check gaskets at blind flanges.
 - iii. Verify leaks by applying a soapy water solution and observe for bubble formation.
 - iv. Repair pipe and fused joint leaks by cutting out leak areas and refusing suitable segments.
 - v. After the leaks are repaired, retest the pipe after the 8 hour relaxation period.
 7. Test Reporting
 - a. Each test shall be reported in writing, on Attachment 1 included with this section.

- b. Include following information if failure occurs:
 - i. Location of failure segment.
 - ii. Nature of leaks.
 - iii. Details of repairs performed.
 - iv. Retest results

G. Dual Contained Pressure and Leakage Testing

1. General: Carrier and containment pipe shall be subjected to the following testing. Testing shall be the responsibility of Contractor.
2. Pressure Test: After pipe has been installed, fusion completed, and trench partially backfilled (leaving joints exposed for examination), carrier pipe shall be filled with water in a manner to expel all air. Pipeline shall be subjected to a test pressure of 1.5 times the system operating pressure for a period of a least 1 hour. Add and measure the amount of make-up water required to return to the test pressure and compare this with the maximum allowances stated in Underground Installation of Polyolefin Piping as published by the Plastics Pipe Institute.
3. Containment Pipe Testing: Carrier pipe shall be brought up to and held at system test pressure while containment pipe is leak tested. Based on the lowest pressure rated fitting or component in system, air pressure of no higher than 10 psi shall be used. Do not over pressurize annular space. Pipe shall be brought up to test pressure and held for 10 minutes or until the pressure stabilizes. Test shall begin when the pressure stabilizes and lasts for 10 minutes. If no significant pressure drop is noted, the pipe has passed the test.
4. Retesting: If deficiencies are revealed during tests, such deficiencies shall be corrected. Tests shall be reconducted until the results of tests are within specified allowances with no additional cost to Owner.
5. Visual Test: All exposed joints, fittings, and valves shall be examined for leaks. Visible leaks shall be stopped and/or the defective pipe, fitting, joint, or valve shall be replaced.

**ATTACHMENT 1 TO SECTION 33 91 00
FORM
HDPE PIPE PRESSURE TEST REPORT**

Project Name/No.: _____ Date: _____

Contractor: _____ Time: _____

Person Performing Tests: _____

Description/Location of Test Segment: (Pipe Diameter, Length, and SDR's)

Location of Pipe Test Segment

Station From: _____ Station To: _____

- T_i = Initial Temperature = _____ °F
- P_i = Initial test pressure = _____ psi
- P_c = Initial Pressure in mb corrected for temperature (T_i) at time "t"
- t = Time in minutes from initiation of test
- T_t = Temperature in °F at time 't'
- P_t = Test pressure in psi at time 't'

- P_c = $\frac{(P_i + 14.7)(T_t + 459.67)}{(T_i + 459.67)} - 14.7$

$$\text{Percent Pressure Drop} = \frac{P_c - P_t}{P_c} \times 100$$

Time (min)	T_t Temp Reading (°F)	P_t Gauge Pressure (psi)	P_c Corrected Pressure (psi)	Pressure Drop (%)
0				
20				
30				
40				
50				
60				

Pass/Fail: _____ Retest (yes/no) _____

Description/Nature of leaks repair of retest segment:

END OF SECTION

