DANE COUNTY DEPARTMENT of PUBLIC WORKS, HIGHWAY and TRANSPORTATION

County Executive	1919 Alliant Energy Center Way ◆ Madison, Wisconsin 53713	**Commissioner / Director**
Kathleen M. Falk	Phone: (608) 266-4018 ◆ Fax: (608) 267-1533	Gerald J. Mandli

February 27, 2009

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**ATTENTION ALL REQUEST FOR BID (RFB) HOLDERS
RFB NO. 109001**

ADDENDUM NO. 2

**DANE COUNTY JOB CENTER REMODEL
DANE COUNTY JOB CENTER
1819 ABERG AVENUE
MADISON, WISCONSIN**

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BIDS DUE: THURSDAY, MARCH 5, 2009, 2:00 PM. DUE DATE AND TIME ARE NOT CHANGED BY THIS ADDENDUM.

This Addendum is issued to modify, explain or clarify the original Request for Bid RFB and is hereby made a part of the RFB. Please attach this Addendum to the RFB.

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PLEASE MAKE THE FOLLOWING CHANGES:

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General:

If carpet is selected as an alternate, contractor shall purchase carpet for the project in a single lot purchase. The contractor may submit the carpet purchase for payment. A Certificate of Insurance and a purchase invoice must be provided to the Project Manager. The Project Manager must view and photograph the carpet.

Phasing Schedule: There are 7 phases. Phasing Schedule will be determined with General Contractor. There will be approximately two (2) weeks additional time between phases for moving staff, furniture, and equipment back into the completed phase and out of the next phase.

Instructions to Bidders:

Expand Instructions to Bidders Section, 19 Work by County to include:

    4. County will provide 4" high x 1/8" thick Johnsonite straight rubber base #20, with matching end stops and preformed or molded corner units at location of new carpet tile. Contractor shall be responsible for installation of base.

5. County will remove and store all moveable furniture and equipment per phase.

Bid Form: Replace existing Bid Form with new Bid Form enclosed.

Sample Public Works Contract: Replace existing Public Works Contract with new Public Works Contract form enclosed.

Basic Requirements:

Expand Section 01 00 00-Basic Requirements, Part 1 General, 1.2

A. Summary of Work to include: New suspended ACP grid system, and sprinkler head escutcheons temporary removal and reinstallation as well as minor plumbing work" (relocation of water softener and brine tank).

B. Work by owner to include:

3. County will provide 4" high x 1/8" thick Johnsonite straight rubber base #20, with matching end stops and preformed or molded corner units at location of new carpet tile. Contractor shall be responsible for installation of base.

4. County will remove and store all moveable furniture and equipment per phase.

Expand Section 01 00 00-Basic Requirements, Part 1 General, 1.22-Staging B. to include:

B. Storage of light fixtures shall be the responsibility of the contractor. Some on-site space may be available within each phase area and will be apportioned as needs dictate.

Expand Section 01 00 00-Basic Requirements, Part 1 General, 1.23 -Occupancy During Construction and Conduct of Work to include:

G. Temporary lighting shall be provided by contractor and shall be adequate for emergency egress. Temporary lighting shall be provided for all county work areas and shall have a minimum intensity of 40 foot candles.

Alternates:

Expand Section 01 23 00 – Alternates, Part 3 Execution, 3.1 Schedule of Alternates, page 01 23 00-2, Line 6 to include:

Alternate No.3 (Deduct): Deduct from Base Bid as specified on Drawing PS 201. Note #1 (carpet removal and replacement and add as alternate).

Alternate No. 4 (Deduct): deduct from Base Bid in lieu of carpet specified in Alternate Bid 3, Bid the following carpet: Carpet Tile, 100% nylon, solution dyed, minimum (1/10 gauge, 8.8 stitches per inch, .136 pile thickness), 20 oz. Tufted yarn weight, primary backing (100% woven synthetic), secondary backing (infinity modular reinforced vinyl composite closed cell polymer with recycled content), wear and backing warranty (limited lifetime warranty), minimum average density (5823), minimum weight density (128,117), size, standard manufacturer's sizes. Installation adhesive shall be low VOC compliant, releasable adhesive as recommended by carpet manufacturer and which complies with flammability requirements for installed carpet.

Specifications Sections:

Revise the following line items within specification section 09 68 13, Section 2.1 Carpet Tile

  A. Size Carpet tiles shall be per manufacturer's standard measurements.
  B. Backing:
    1. Per manufacturer's standard requirements

Add the following line item within specification section 09 68 13, Section 2.1 Carpet Accessories:

  I. Installation Adhesive: Low VOC compliant, releasable adhesive as recommended by carpet manufacturer and which complies with flammability requirements for installed carpet.

DELETE Section 23 09 23 – Direct Digital Control System for HVAC. Insert new sections enclosed:
      Section 23 09 23 – HVAC Controls and Instruments
      Section 23 09 24 – Direct Digital Control System for HVAC (DDCS)
      Section 23 09 25 – Integrated Automation System (IAS)

Section 23 52 00 – Condensing Boilers, Part 2 – Products, line 29
Revise line 29 to read: Manufacturers: Aerco, Thermal Solutions, Rheos, Camus.

Section 23 73 13- Packaged Roof Top Units , Part 2 –Products- Manufacturers:

Revise line 53 to read: Aaon or approved equal by Henneman Engineering prior to bid.

Drawings:

Drawing A102A-D: Add general note 8 to read: At the locations where the existing ceiling system runs over the top of the drywall stud partitions, provide temporary wall support bracing as required to keep the walls plumb while the existing ceiling system is removed. Field verify existing conditions to determine extent of temporary support.

Drawing A202, Clarification for Specific note #1: General Contractor shall infill existing roof opening with metal deck from the removal of the existing rooftop equipment and duct penetrations. Patching of existing TPO membrane per roofing manufacturer's requirements shall be completed by previously selected bid package #1 roofing contractor as stated in general note #2.

Drawing A301A and A301C, clarification for Specific note #2 . Note should read "<u>New</u> suspended ACP grid system with …"

Drawings A301A through A301D, Add general note #3: Existing sprinkler head escutcheons removed for ceiling tile replacement shall be reinstalled in the existing locations. Field verify existing conditions and extent of work as required. Refer to mechanical new work plans for additional information associated with the existing sprinkler heads.

Drawing M202, new construction notes #1 and #3, omit the reference to the "general contractor" for roof patching. Roof patching shall be by the County as stated in the specification summary of work and General Roof Plan note #2 on Drawing A202.

Drawing M203, new construction note " B" detail reference should read E/M401.

Drawing PS201, Provide alternate price for Specific Plan/Phasing Note #1 (carpet removal and replacement).

Drawing PS201:

  A. Revise the last sentence in specific plan/phasing note #1 to read: Carpet tile shall be installed at the end of each phase with all of the main corridor/perimeter aisles protected with a carpet protection film. There will be approximately a two (2) week period between phases for the County to move staff , furniture and partitions into the completed phase and out of the next phase.

  B. Expand specific plan/phasing note #1 to include the following: County will provide 4" high x 1/8" thick Johnsonite straight rubber base #20 - Charcoal 4, with matching end stops and preformed or molded corner units

at location of new carpet tile. Contractor shall be responsible for prep., adhesives, misc. materials, and installation of base. Install base in lengths as long as practical. Tightly bond base throughout length of each piece with continuous contact at vertical surfaces per manufacturer's requirements.

C. Expand the cross hatched carpet tile boundary as noted by specific plan/phasing note #1 to include the following two (2) locations:
   1.   90 square feet at the rear exit corridor J017 which currently has roll good carpeting.
   2.   426 square feet at Group Room J033 adjacent to the west vestibule.

D. Add specific plan/phasing note #5 and add keynote to the plan at corridor J036.
   1.   Note #5 to read: At existing " vending" corridor J036 remove the existing vinyl composition tile and resilient base for the installation of new carpet tile. Clean, patch, and prep floor as required for the installation of new carpet tile in this area.

   2.   Expand note on overall floor plan 1/PS201 at Phase 3 to include: Furniture and equipment shall remain in place and be protected during nights and weekend work.

Drawing PS201, remove the carpet cross hatch boundary from rooms J118, J119, J067, and J070. These rooms currently have VCT which shall remain.

Drawing PS201: General Plan/Phasing Note #7 to read: Contractor shall protect the existing floor finishes within Phase 6 and 7 as required to prevent damage from construction work above. Contractor shall be responsible for any damage to floor finishes below. Field verify extent of existing finishes as required.

If any additional information about this Addendum is needed, please call Tom Sracic at 608-266-4475, sracic@co.dane.wi.us.

Sincerely,

Thomas Sracic
Project Manager

Enclosures:
New Bid Form
Revised Sample Public Works Contract
Section 23 09 23 – HVAC Controls aand Instruments
Section 23 09 24 – Direct Digital Control Systems for HVAC (DDCS)
Section 23 09 25 – Integrated Automation System (IAS)

<div align="center">**BID FORM**</div>

BID NO. 109001

PROJECT: **DANE COUNTY JOB CENTER REMODEL**

   DANE COUNTY JOB CENTER

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

BASE BID - LUMP SUM:
Work includes construction services for electrical, carpeting, and for the replacement of the HVAC system and controls, new suspended ACP grid system, sprinkler head escutcheons temporary removal and reinstallation, as well as minor plumbing work. 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

ALTERNATE BID 1 - UNIT PRICING:

Base bid requires that all existing light fixtures have new ballasts and lamps installed to replace existing. Provide a unit cost per fixture for **not replacing** existing ballasts and lamps in fixtures that have been recently re-ballasted and re-lamped by Owner.

$_____/fixture
 Numeric Price (circle: Add or Deduct)

_____ and _____ /100 Dollars
 Written Price

ALTERNATE BID 2 – LUMP SUM:
Add for the removal of the 3 existing parking area post lights and the complete installation of the
3 new post lights as indicated on sheet numbers E1 and E2, Sheet Note 6.

$ _____

Numeric Price (circle: Add or Deduct)

_____and _____ /100 Dollars

Written Price

ALTERNATE BID 3 – LUMP SUM:
Deduct from Base Bid as specified on Sheet PS 201. Note #1 (carpet removal and replacement
and add as alternate).

$ _____

Numeric Price (circle: Add or Deduct)

_____and _____ /100 Dollars

ALTERNATE BID 4 – LUMP SUM:
Deduct from Base bid in lieu of carpet specified in Alternate Bid 3, Bid the following carpet:
Carpet Tile, 100% nylon, solution dyed, minimum (1/10 gauge, 8.8 stitches per inch, .136 pile
thickness), 20 oz. Tufted yarn weight, primary backing (100% woven synthetic), secondary
backing (infinity modular reinforced vinyl composite closed cell polymer with recycled content),
wear and backing warranty (limited lifetime warranty), minimum average density (5823),
minimum weight density (128,117), size, standard manufacturer's sizes. Installation adhesive
shall be low VOC compliant, releasable adhesive as recommended by carpet manufacturer and
which complies with flammability requirements for installed carpet.

$ _____

Numeric Price (circle: Add or Deduct)

_____and _____ /100 Dollars

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

Addendum No(s). _____ through_____

Dated _____

Dane County Human Services Department must have this project completed by June 1, 2011. Assuming this Work can be started by April 1, 2009, what dates can you commence and complete this job?

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

Name of Bidder: _____

Address: _____

Telephone No.: _____ Fax No.: _____

Contact Person: _____

SIGNATURE: _____
                              (Bid is invalid without signature)

BID CHECK LIST:
These items **must** be included with Bid or completed **before** bidding
☐ Bid Form ☐ Bid Bond ☐ Fair Labor Practices Certification
☐ Best Value Qualified Contractor ☐ Vendor Registration

The Contractor hereby acknowledges that a condition of this Contract is to provide equal benefits as required by Dane County Code of Ordinances sec. 25.016. Contractor hereby certifies that it will provide equal benefits as required by that ordinance to all required employees during the term of the Contract.

For more information:
http://www.danepurchasing.com/partner_benefit.aspx

COUNTY OF DANE

PUBLIC WORKS CONTRACT

Contract No. _____   Bid No. _109001_

Authority: Res. _____, ____2008-09

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

W I T N E S S E T H :

WHEREAS, COUNTY, whose address is c/o Associate Public Works Director, 1919 Alliant Energy Center Way, Madison, WI 53713, desires to have CONTRACTOR provide _Dane County Job Center Remodel at 1819 Aberg Ave, Madison, Wisconsin [including Alternate Bid[s] X, Y & Z (if applicable)]_ ("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 _Strang, Inc._ (hereinafter referred to as "the Architect / Engineer"), and as enumerated in the Project Manual Document Index, 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. 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.

4. 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) 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.

5. 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."

6. CONTRACTOR agrees to comply with provisions of Chapter 25.016 of the Dane County Code of Ordinances, which pertains to domestic partnership benefits.

7. 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.

8. CONTRACTOR agrees that all persons employed by CONTRACTOR or any subcontractor shall be paid no less than the minimum wage established under Chapter 40, Subchapter II, Dane County Code of Ordinances. CONTRACTOR agrees to abide by and comply with the provisions of Chapter 40, Subchapter II of the Dane County Code of Ordinances, and said Subchapter is fully incorporated herein by reference.

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.

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 Associate Public Works Director.

FOR COUNTY:

_____   _____
Kathleen M. Falk, County Executive   Date

_____   _____
Robert Ohlsen, County Clerk   Date

SECTION 23 09 23 - HVAC CONTROLS AND INSTRUMENTS

PART 1 - GENERAL

CONDITIONS OF THE CONTRACT
The Conditions of the Contract (General, Supplementary, and other Conditions) and the General Requirements (Sections of Division 1) are hereby made a part of this Section.

SCOPE
WORK INCLUDED
This Section in introductory to Sections 23 09 24 and 23 09 25 and includes equipment sequence of operation and BAS Points List.

This specification is intended to cover equipment for the automatic temperature control of the following:
- Roof top units
- Cabinet unit heaters
- Radiant ceiling panel
- Variable volume box
- Boiler/feed/combustion controls
- Equipment room ventilation
- Equipment interconnects and safety cutouts
- Hydronic pumping control
- Miscellaneous special system controls
- System controlled/tied in to new BAS (See Sections 23 09 24 and 23 09 25)

DESCRIPTION OF SYSTEMS/SEQUENCE OF OPERATION:
List of each system and sequence of operation shall be as indicated on the drawings.

Common Sensor: Whenever a single sensor controls multiple devices a separate control temperature setpoint shall be allowed for each device.

POINTS LIST
List of each control input and output, the device it is controlling, the location of the device, and the symbol or label of the control point in the software shall be as indicated on the drawings.

SUBMITTALS TO ARCHITECT/ENGINEER
Submit typewritten or printed operating and maintenance instructions per Division 1.

Submit shop drawings with written descriptions of systems sequence of control, annunciator panel layouts, and control diagrams of the system components' relation to each other.

REFERENCE STANDARDS
All wiring to be done in accordance with current National Electric Code.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS
(See Section 23 09 24 and Section 23 09 25)

PART 3 - EXECUTION

INSTALLATION
(See Section 23 09 24 and Section 23 09 25)

END SECTION 23 09 23

SECTION 23 09 24 - DIRECT DIGITAL CONTROL SYSTEM for HVAC (DDCS)

PART 1 - GENERAL

SUMMARY
Furnish all labor, materials, equipment, and service necessary for a complete and operating Direct Digital Control System (DDCS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.

All labor, material, equipment and software not specifically referred to herein or on the plans, that are required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.

SYSTEM DESCRIPTION
The entire Direct Digital Control System (DDCS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating via the LonTalk communication protocol to Network Area Controllers (NAC), provided under Section 23 09 25.

The DDCS shall include all Ethernet network wiring to create a control LAN that shall connect all NAC's, operator workstations, servers, printers, routers, switches and other network devices as indicated on the riser diagram and provided under Section 23 09 25.

Acceptable Manufacturers: TAC/Invensys, Seimens Staefa, Distech, Alerton, Tridium

Approved Vendors: Environmental systems Inc W223N603 Saratoga Ave Waukesha WI 262-544-8860, HC Energy Solutions 300 Mandan. Drive Waukesha WI 53188 262-364-8035, Modahl & Associates 721 Christensen Ave. Madison WI 53714 608-843-2954

SPECIFICATION NOMENCLATURE
Acronyms used in this specification are as follows:
FMCS   Facility Management and Control System
DDCS   Direct Digital Control System
NAC   Network Area Controller
IDC   Interoperable Digital Controller
ASC   Application Specific Controller
PCU   Programmable Control Unit
GUI   Graphical User Interface
WBI   Web Browser Interface
POT   Portable Operator's Terminal
PMI   Power Measurement Interface
DDC   Direct Digital Controls
LAN   Local Area Network
WAN   Wide Area Network
OOT   Object Oriented Technology
PICS   Product Interoperability Compliance Statement

DIVISION OF WORK
The DDCS Contractor shall be responsible for all controllers (IDC), control devices, control panels, controller programming, controller programming software, controller input/output wiring, power wiring, interlock and safety wiring, controller network wiring, and Ethernet LAN wiring, if applicable.

The Section 23 09 25 System Integrator shall be responsible for the Network Area Controller(s) (NAC), workstations, printers, servers, software and programming of the NAC, graphical user interface software (GUI), development of all graphical screens, setup of schedules, logs and alarms, LonWorks network management, global supervisory control applications, system integration and coordination of the NAC to the local or wide area network.

RELATED WORK SPECIFIED ELSEWHERE
Section 23 09 25, System Integration:
- Providing Network Area Controllers
- LonWorks network management
- Integration of LonWorks devices
- Graphical user interface software
- Global supervisory control sequences
- Integration of owner's existing control system (if applicable)

Division 26, Electrical:
- Providing motor starters and disconnect switches (unless otherwise noted).
- Power wiring and conduit (unless otherwise noted).
- Provision, installation and wiring of smoke detectors (unless otherwise noted).

AGENCY AND CODE APPROVALS
All products of the FMCS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable. UL-916; Energy Management Systems, ULC; UL - Canadian Standards Association, FCC, Part 15, Subpart J, Class A Computing Devices.

SOFTWARE LICENSE AGREEMENT
The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

DELIVERY, STORAGE AND HANDLING
Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

JOB CONDITIONS
Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to insure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

QUALITY ASSURANCE
The manufacturer of the digital controllers shall provide documentation supporting compliance with ISO-9001 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the digital controller manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar.

SUBMITTAL
Eight copies of shop drawings of the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and

installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package.

Submittal shall also include a complete point list of all connected points to the DDC system.

The DDCS Contractor shall provide catalog data sheets, wiring diagrams and point lists to the Section 23 09 25 System Integrator for proper coordination of work.

The DDCS contractor shall work with the Section 23 09 25 Systems integrator prior to programming equipment to insure all necessary points are provided at the time of programming for proper operation.

Upon completion of the work, provide a complete set of 'as-built' drawings and application software on magnetic floppy disk media or compact disk. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Eight copies of the 'as-built' drawings shall be provided in addition to the documents on magnetic floppy disk media or compact disk.

PART 2 - MATERIALS

GENERAL
The Direct Digital Control System (DDCS) shall be comprised of a network of interoperable, stand-alone digital controllers and other devices as specified herein.

OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES
The intent of this specification is to provide a peer-to-peer networked, distributed control system based on the LonTalk and/or BACnet communication protocols.

INTEROPERABLE DIGITAL CONTROLLERS (IDC)
IDC controllers shall be microprocessor based Interoperable LonMark™/LonWorks and/or BACnet controllers. Where possible, all Interoperable Digital Controllers shall bear the applicable LonMark™ interoperability logo on each product delivered.

Provide IDC's and ancillary devices as herein specified, as indicated on the drawings, and as necessary to perform the sequences of operation. The following equipment shall be controlled:
- Air Terminal Devices (i.e., VAV, Dual Duct, Fan Coil Units, etc.)
- Roof Top Units (fans, valve and damper actuators, sensors. etc.)
- Pumps
- Boilers (via interface provided by manufacturer)
- Connectors
- Exhaust Fans for ventilation and pressurization control
- Additional equipment outlined herein or on the Mechanical and Electrical Drawings.

Where applicable, control shall be accomplished using LonMark™ based devices where the application has a LonMark profile defined. Where LonMark devices are not available for a particular application, such as some freely programmable controllers, the manufacturer must provide an XIF file for the device to the Section 23 09 25 System Integrator. Publicly available specifications for the Applications Programming Interface (API) must be provided to the Section 23 09 25 System Integrator for each controller defining the programming or setup of each device. The DDCS Contractor shall provide all programming and documentation necessary to set up and configure the supplied devices per the specified sequences of operation.

The DDCS Contractor shall route the LonWorks and/or BACnet MSTP network trunk to the Network Area Controller (NAC) as indicated on the riser diagram in the bid documents. Coordinate locations of the NAC with the Section 23 09 25 System Integrator to ensure that maximum network wiring distances, as specified by the LonWorks and BACnet wiring guidelines, are not exceeded. A maximum of 70 devices may occupy any one LonWorks and/or BACnet MSTP trunk. LonWorks trunks must be installed using the appropriate trunk termination device. All LonWorks and LonMark devices must be supplied using FTT-10A LonTalk communication transceivers.

The Network Area Controller (NAC), supplied by the Section 23 09 25 System Integrator, will provide all scheduling, alarming, trending, and network management for the LonMark/LonWorks and/or BACnet-based devices.

The IDCs shall communicate with the NAC at a baud rate of not less than 32K baud. The IDC shall provide LED indication of communication and controller performance to the technician, without cover removal.

All IDCs shall be fully application programmable and shall at all times maintain their LONMARK certification, if so certified. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the IDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

The DDCS Contractor supplying the IDC's shall provide, at a minimum, the following documentation for each device:
- Network Variable Inputs (nvi's); name and type
- Network Variable Outputs (nvo's); name and type
- Network configuration parameters (nci, nco); name and type
- BACnet Object Type, Object Instance and description

It is the responsibility of the DDCS Contractor to ensure that the proper Network Variable Inputs and Outputs (nvi and nvo) and/or BACnet objects are provided in each IDC and are exposed for connection to them by the Section 23 09 25 System Integrator, as required by the point charts. Refer to the software point charts for the required functionality (read-only, write-only, read-write) for each data point. Use of manufacturer-specific Network Variables and/or BACnet objects shall not be permitted, unless software is provided to allow the use of them by any third-party network management tool.

All IDC's shall be capable of being managed (upload, download, discovery, reload, bindings, etc.), by any Lon network management tool. IDC's that can be managed only with LNS-based tools or plug-ins built exclusively for LNS, shall not be permitted.

The DDCS Contractor shall provide two copies of the IDC programming tool and configuration tool, with documentation, to the owner.
- This tool shall allow the owner to fully program, configure, diagnose and otherwise manage the controller, without limitations.
- The tool shall be of the latest revision currently in production release by the manufacturer.
- The tool shall be licensed to the owner and shall not require annual license renewal fees.
- The tool shall not be dependent on the LNS network management system in order to properly function and shall be capable of running as a stand-alone application on a Windows XP operating system. Use of LNS-based plug-ins for programming and configuration are not acceptable.

CONTROL SYSTEM HARDWARE
INTEROPERABLE DIGITAL CONTROLLERS

APPLICATION SPECIFIC CONTROLLER (ASC)

Each terminal unit shall have a LONWorks® and/or BACnet-based DDC Application Specific Controller (ASC) designed to provide the specified sequences. The controller shall be LONMark® certified, shall store all specific control sequences and program settings in non-volatile memory.

All ASC processors shall be Echelon based 3150 Neurons operating at 5 MHz or higher with 8K of RAM and 64K of Flash memory with a minimum 10 year memory retention between program downloads.

Each ASC shall perform all intended temperature control functions in a 'standalone' mode should the unit incur a loss of communications.

The complete ASC including accessory devices such as relay, transducers, power supplies, etc., shall be factory-mounted, wired and housed in a NEMA 1 enclosure or as required by the location and local code requirements.

Each ASC shall allow Peer-to-Peer communications over the LON utilizing free-topology transceivers over a single pair 22 AWG twisted, stranded cable, Category 5 or Level IV.

All ASC's shall be provided as self sufficient units to maximize reliability and shall include internal 'soft' clock, operating systems, communication timing and interrupt controls, and shall be suitable for the specified applications.

In the event of a power outage or controller reset, each ASC shall enter a preprogrammed state on power re-application. Upon application of power to the ASC, all control conditions will start from an 'off' / 'closed' position or the default state. This state will be maintained for an automatically adjusted amount of time. Once this time delay has passed, the ASC control sequence shall resume according to current values

Network and controller-to-controller communications must conform to LONTalk® standards.

All ASC's shall be provided with a communications port to allow connection of any industry standard laptop PC and custom configuration tools. Program access via this communications port allows direct field modification of the configuration parameters.

Digital Inputs:
- All digital inputs shall be over voltage protected.
- Digital input types supported by the CU:
  - Normally open contacts (24V and 120V).
  - Normally closed contacts (24V and 120V).
  - Current/no current.
  - Voltage/no voltage.
  - Pulse/Totalizer contacts.

Digital Outputs:
- All digital outputs shall be 24 volt AC, current sinking, 0.5 amp opto-isolated triacs.
- Digital outputs shall be capable of handling maintained as well as pulsed outputs for momentary or magnetic latching circuits. It shall be possible to configure outputs for 3-mode control (fast-slow-off) and 2-mode control.

Analog Inputs:
- All analog inputs shall be over voltage protected.
- The analog to digital resolutions shall be a minimum of 10 bit.
- Analog inputs shall accept the following temperature types: 10K Ohm thermistor, 20K Ohm thermistor, or 1K Ohm RTD.
- Inputs shall be configurable to accept a wide range of inputs including: 4-20mA, 1-5Vdc, 2-10Vdc, etc.

Analog Outputs:
- The ASC shall accommodate true analog outputs. Voltage (0-10V) and current (4-20 mA) outputs shall be accommodated.
- All analog outputs shall be proportional current or voltage type.
- The digital to analog resolution shall be a minimum of 10 bit.
- Outputs shall be configurable so that 0-100% output commands can represent any portion of the output voltage/current range.
- Outputs shall be reversible so that an increasing output command yields a decreasing electrical signal.

In addition to local physical or internal I/O, each ASC shall support distributed, or 'bound' I/O. This bound I/O can be used to allow the ASC to provide I/O data to another controller on the LON or to allow another controller to provide data to the controlling ASC.

The following modes of control shall be incorporated into each ASC:
- Occupied shall be a mode designed for normal occupied control of an area during regular business hours. This mode shall have unique heating and cooling setpoints associated with it.
- Unoccupied shall be a mode designed for after hours control of an area. This mode shall have unique heating and cooling setpoints associated with it.
- Override shall be a mode designed to invoke normal occupied control during after hours of an area. This mode shall use the occupied heating and cooling setpoints.
- Economy shall be a mode designed for normal occupied times when energy demand usage is high and control setpoints need to be adjusted for lower energy use. This mode shall have unique heating and cooling setpoints associated with it.
- Morning Warm-Up on units with a outdoor air economizer shall be a mode designed for the pre-heat/pre-cool time before normal occupancy occurs. This mode shall allow heating or cooling as required by the occupied setpoints but it will prevent outdoor air from entering the space. The outdoor air will move to its minimum position once the morning warm-up mode is over and the occupied mode is activated.
- Morning Warm-Up on VAV units shall be a mode designed for the pre-heat/pre-cool time before normal occupancy occurs. This mode shall allow heating or cooling as required by the occupied setpoints but it will prevent the VAV box from maintaining a minimum air flow until the morning warm-up mode is over and the occupied mode is activated.

VAV box ASC's shall have an integral damper actuator and shall be the manufacturer's standard VAV box controller.

It shall be the responsibility of the SI to verify that VAV box controllers will physically fit into the VAV box controls enclosure, and that the controllers can register the expected minimum and maximum flow rates utilizing the flow probe provided by the VAV box manufacturer.

Acceptable Manufacturers and approved Vendors: TAC/Invensys, Alerton, Seimens Staefa, Distech, Tridium, supplied by: Environmental Systems Inc. W223N603 Saratoga Ave Waukesha WI 262-544-8860, HC Energy Solutions 300 Mandan. Drive Waukesha WI 53188 262-364-8035, Modahl & Associates 721 Christensen Ave. Madison WI 53714 608-843-2954

PROGRAMMABLE CONTROL UNITS (PCU'S)

A LONWorks® based DDC Programmable Control Unit (PCU) shall be provided where required to perform the sequence of operation. The PCU shall be fully configurable by configuration tool. The controller shall be store all specific control sequences and program settings in non-volatile memory.

All PCU processors shall be Echelon based 3150 Neurons operating at 5 MHz or higher with 8K of RAM and 64K of Flash memory with a minimum 10 year memory retention between program downloads.

Each PCU shall perform all intended temperature control functions in a 'standalone' mode should the unit incur a loss of communications.

The complete PCU including accessory devices such as relay, transducers, power supplies, etc., shall be factory-mounted, wired and housed in a NEMA 1 enclosure or as required by the location and local code requirements.

Each PCU shall allow Peer-to-Peer communications over the LON utilizing free-topology transceivers over a single pair 22 AWG twisted, stranded cable.

All PCU's shall be provided as self sufficient units to maximize reliability and shall include internal 'soft' clock, operating systems, communication timing and interrupt controls, and shall be suitable for the specified applications.

In the event of a power outage or controller reset, each PCU shall enter a preprogrammed state on power re-application. Upon application of power to the PCU, all control conditions will start from an 'off' / 'closed' position or the default state. This state will be maintained for an automatically adjusted amount of time. Once this time delay has passed, the PCU control sequence shall resume according to current values

Network and controller-to-controller communications must conform to LONTalk® standards.

All PCU's shall be provided with a communications port to allow connection of any industry standard laptop PC and custom configuration tools. Program access via this communications port allows direct field modification of the configuration parameters.

Digital Inputs:
- All digital inputs shall be over voltage protected.
- Digital input types supported by the CU:
    - Normally open contacts (24V and 120V).
    - Normally closed contacts (24V and 120V).
    - Current/no current.
    - Voltage/no voltage.
    - Pulse/Totalizer contacts.

Digital Outputs:
- All digital outputs shall be 24 volt AC, current sinking, 0.5 amp opto-isolated triacs.
- Digital outputs shall be capable of handling maintained as well as pulsed outputs for momentary or magnetic latching circuits. It shall be possible to configure outputs for 3-mode control (fast-slow-off) and 2-mode control.

Analog Inputs:
- All analog inputs shall be over voltage protected.
- The analog to digital resolutions shall be a minimum of 10 bit.
- Analog inputs shall accept the following temperature types: 10K Ohm thermistor, 20K Ohm thermistor, or 1K Ohm RTD.
- Inputs shall be configurable to accept a wide range of inputs including: 4-20mA, 1-5Vdc, 2-10Vdc, etc.

Analog Outputs:
- The ASC shall accommodate true analog outputs. Voltage (0-10V) and current (4-20 mA) outputs shall be accommodated.
- All analog outputs shall be proportional current or voltage type.
- The digital to analog resolution shall be a minimum of 10 bit.
- Outputs shall be configurable so that 0-100% output commands can represent any portion of the output voltage/current range.
- Outputs shall be reversible so that an increasing output command yields a decreasing electrical signal.

In addition to local physical or internal I/O, each ASC shall support distributed, or 'bound' I/O. This bound I/O can be used to allow the ASC to provide I/O data to another controller on the LON or to allow another controller to provide data to the controlling ASC.

The following modes of control shall be incorporated into each PCU:

Occupied shall be a mode designed for normal occupied control of an area during regular business hours. This mode shall have unique heating and cooling setpoints associated with it.

Unoccupied shall be a mode designed for after hours control of an area. This mode shall have unique heating and cooling setpoints associated with it.

Override shall be a mode designed to invoke normal occupied control during after hours of an area. This mode shall use the occupied heating and cooling setpoints.

Economy shall be a mode designed for normal occupied times when energy demand usage is high and control setpoints need to be adjusted for lower energy use. This mode shall have unique heating and cooling setpoints associated with it.

Morning Warm-Up on units with a outdoor air economizer shall be a mode designed for the pre-heat/pre-cool time before normal occupancy occurs. This mode shall allow heating or cooling as required by the occupied setpoints but it will prevent outdoor air from entering the space. The outdoor air will move to its minimum position once the morning warm-up mode is over and the occupied mode is activated.

Morning Warm-Up on VAV units shall be a mode designed for the pre-heat/pre-cool time before normal occupancy occurs. This mode shall allow heating or cooling as required by the occupied setpoints but it will prevent the VAV box from maintaining a minimum air-flow until the morning warm-up mode is over and the occupied mode is activated.

Acceptable Manufacturers and approved Vendors: TAC/Invensys, Alerton, Seimens Staefa, Distech, Tridium, supplied by: Environmental systems Inc W223N603 Saratoga Ave Waukesha WI 262-544-8860, HC Energy Solutions 300 Mandan. Drive Waukesha WI 53188 414-659-5153, Modahl and Associates 721 Christensen Ave. Madison WI 53714

TEMPERATURE SENSORS AND TRANSMITTERS
General Sensor & Transmitter Requirements
- Provide sensors and transmitters required as outlined in the input/output summary and sequence of operation, and as required to achieve the specified accuracy as specified herein.
- Temperature transmitters shall be equipped with individual zero and span adjustments. The zero and span adjustments shall be non-interactive to permit calibration without iterative operations. Provide a loop test signal to aid in sensor calibration.
- Temperature transmitters shall be sized and constructed to be compatible with the medium to be monitored. Transmitters shall be equipped with a linearization circuit to compensate for non-linearities of the sensor and bridge and provide a true linear output signal.
- Temperature sensors shall be of the resistance type and shall be 10K or 20K Ohm Thermistor type.
    - Thermistors are acceptable provided the mathematical relationship of a thermistor with respect to resistance and temperature with the thermistor fitting constraints is contained with the controllers operating software and the listed accuracy's can be obtained. Submit proof of the software mathematical equation and thermistor manufacturer fitting constants used in the thermistor mathematical/expressions. Thermistors shall be of the Thermistor (NTC) Type with a minimum of 50 ohm/°C. resistance change versus temperature to insure good resolution and accuracy. Thermistors shall be certified to be stable ±0.13°C. over 5 years and ±0.2°C. accurate and free from drift for 5 years.
- The following accuracy's are required and include errors associated with the sensor, lead wire and A to D conversion.

Point Type	Accuracy
Outside Air	+/-3%
Chilled/Hot Water	+/-1%
Room Temperature	+/-1%
Steam	+/-5%
Duct Temperature	+/-3%

    - Sensors Used in Energy Water (BTU) or Process Calculations +/-1%
    - Sensors used in energy or process calculations shall be accurate to ±0.10°C over the process temperature range. Submit a manufacturer's calibration report indicating that the calibration certification is traceable to the National Bureau of Standards (NBS) Calibration Report Nos. 209527/222173.

Thermowells:
- When thermowells are required, the sensor and well shall be supplied as a complete assembly including well head and greenfield fitting, except where wells are to be installed under separate contract.
- Thermowells shall be pressure rated and constructed in accordance with the system working pressure
- Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
- Thermowells shall be constructed of the following materials:
    - Chilled and Hot Water; brass.
    - Steam; 316 stainless steel.
    - Brine (salt solutions): marine grade stainless steel.

Outside Air Sensors:
- Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
- Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.

- Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
- Solar load sensors shall be provided in locations shown. The use of a thermistor combined with a solar compensator is acceptable. Provide calibration charts as part of the O&M Manual.

Duct Type Sensors:
- Duct mount sensors shall mount in a hand box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. A neoprene grommet (sealtite fitting and mounting plate) shall be used on the sensor assembly to prevent air leaks.
- Duct sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. Duct sensors probe shall be constructed of 304 stainless steel.
- For outdoor air duct applications, use a weatherproof mounting box with weatherproof cover and gasket.

Averaging Duct Type Sensors:
- Where called out on the drawings and points lists, provide averaging type duct sensors. Thermistor sensors are acceptable. The sensor shall be multi-point sensitive through the length of the temperature conducting tubing. The thermistors shall be configured in a series / parallel method which creates an end result of total average resistance equal to the same span as a standard thermistor.
- Provide capillary supports at the sides of the duct to support the sensing element.

Acceptable Manufacturers: BAPI, Tac/Invensys, Staefa, ACI

RELATIVE HUMIDITY SENSORS/TRANSMITTERS
- The sensor shall be a solid state, resistance type relative humidity sensor of the Bulk Polymer Design. The sensor element shall be washable and shall resist surface contaminations.
- Humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2 wire isolated loop powered, 4-20ma, 0-10.0 VDC linear proportional output.
- The humidity transmitter shall meet the following overall accuracy including lead loss and A to D conversion.
    - Room Type Sensor ±2% RH
    - Duct Type Sensor   ±2% RH
- Outside air relative humidity sensors shall be installed in a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
- Provide a single point humidity calibrator, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
- Duct type sensing probes shall be constructed of 304 stainless steel and be equipped with a neoprene grommet, bushings and a mounting bracket.
- Acceptable Manufacturers: BAPI, ACI, Mamac, Visaila

DIFFERENTIAL PRESSURE TRANSMITTERS AND ACCESSORIES
General Air and Water Pressure Transmitter Requirements:
- Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.
- Pressure transmitters shall provide the option to transmit a 0 to 5V dc, 0 to 10V dc, or 4 to 20 mA output signal.
- Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device and shall be supplied with shutoff and bleed valves in the high and low sensing pick-up lines (3 valve manifolds).
- Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible.

- Low air pressure, differential pressure transmitters used for room pressurization control (i.e. laboratories, OR's clean rooms, etc.) shall be equipped with a LED display indicating the transmitter output signal.
- Duct sensing pressure applications where the velocity exceeds 1500 fpm shall utilize a static pressure traverse probes.

Low Air Pressure Applications (0 to 125 Pa)
- The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the room and reference static pressure input signals with the following minimum performance specifications.
  - Span: Not greater than two times the design space DP.
  - Accuracy: Plus or minus 0.5% of F.S.
  - Dead Band: Less than 0.3% of output.
  - Repeatability: Within 0.2% of output.
  - Linearity: Plus or minus 0.2% of span.
  - Response: Less than one second for full span input.
  - Temperature Stability: Less than 0.05% output shift per degree C change.
- The transmitter shall utilize variable capacitance sensor technology and be immune to shock and vibration.
- Acceptable Manufacturers: BAPI, Setra, Veris, Mamac

Medium to High Air Pressure Applications (125 Pa to 2500 Pa)
- The pressure transmitter shall be similar to the Low Air Pressure Transmitter except the performance specifications are not as severe. Provide differential pressure transmitters which meet the following performance requirements.
  - Zero & span: (% F.S./Deg. C): .05% including linearity, hysteresis and repeatability
  - Accuracy: 1% F.S. (best straight line)
  - Static Pressure Effect: 0.5% F.S. (to 700 KPa)
  - Thermal Effects: <±.05% F.S./Deg. C. over 5°C. to 40°C. (calibrated at 22°C.)
- Acceptable manufacturers: BAPI, Setra, Veris, Mamac

LOW DIFFERENTIAL, WATER PRESSURE APPLICATIONS (0 KPa to 5 KPa)
The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20mA output in response to variation of flow meter differential pressure or water pressure sensing points.

The differential pressure transmitter shall have non-interactive zero and span adjustments adjustable from the outside cover and meet the following performance specifications.
- 0 – 10 KPa input differential pressure range
- 4 - 20 mA output
- Maintain accuracy up to 20 to 1 ratio turndown
- Reference Accuracy: ± 0.2% of full span

Provide a two year warranty for each transmitter. Replace all transmitters found to be defective at no cost to the Owner during the warranty period. Acceptable Manufacturers: Tobar, Foxboro, Omega, Bailey, Modus, Setra

MEDIUM TO HIGH DIFFERENTIAL WATER PRESSURE APPLICATIONS (5 KPa to 700 KPa)
The differential pressure transmitter shall meet the low pressure transmitter specifications except the following:
- Differential pressure range: 5 KPa to 700 KPa.
- Reference Accuracy: ±l% of full span (includes non-linearity, hysteresis, and repeatability)
- Warranty: 1 year.

Acceptable Manufacturers: BAPI, Veris, Mamac, Setra

Bypass Valve Assembly: Mount stand-alone pressure transmitters in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with hi and low connections piped and valved. Air bleed units, bypass valves and compression fittings shall be provided

ELECTRONIC VALVE AND DAMPER ACTUATORS
General Requirements:
- Electronic actuators shall be electric, direct-coupled type capable of being mounted over the shaft of the damper. They shall be UL listed and the manufacturer shall provide a 2 year unconditional warranty from the date of commissioning. Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator nor 2 watts or 4 VA for VAV actuators. Sound level shall not exceed 45 dB for high torque nor 35 dB for VAV actuators.
- Electronic overload protection shall protect actuator motor from damage. If damper jams actuator shall not burn-out. Internal end switch type actuators are not acceptable. Actuators may be mechanically and electrically paralleled on the same shaft to multiply the available torque. A reversing switch shall be provided to change action from direct to reverse in relation to control signal as operation requires.
- Warranty must be two years by manufacturer on actuator as a whole and all components.
- Acceptable manufacturers: Belimo, Siemens, Tac/Invensys

Control Damper Actuators:
- OA (outside air), RA (return air), and EA (exhaust air) actuators shall be spring return type for safety functions. Individual battery backup or capacitor return is not acceptable.
- The control circuit shall be fully modulating using 2 - 10 volt or 4 - 20 mA signals. Accuracy and repeatability shall be within $\pm$ 1/21 of control signal. A 2 - 10 v or 4 - 20 mA signal shall be produced by the actuator which is directly proportional to the shaft clamp position which can be used to control actuators which are paralleled off a master motor or to provide a feedback signal to the automation system indicating damper position. Accuracy shall be within $\pm$ 2.5%.
- Face and bypass dampers and other control dampers shall be modulating using the same control circuit detailed above but shall not be spring return.

Miscellaneous Damper Actuators:
- OA combustion and ventilation air intake and EA damper actuators shall be 2 position spring return closed if any water piping, coils or other equipment in the space which the damper serves needs to be protected from freezing. Otherwise drive open, drive closed type 2 position may be used. The minimum torque for any actuator shall be 5 N-m.
- Provide auxiliary switches on damper shaft or blade switch to prove damper has opened on all air handling equipment handling 100% outside air and greater than 6 KPa TSP.

Air Terminals: Air terminal actuators shall be minimum 5 N-m torque and use fully modulating floating (drive open, drive closed) 3 wire control or use control circuit as detailed in control dampers depending on the controllers requirements.

Inlet Vanes Actuators: Inlet vane actuators shall provide at least 150% of the minimum torque specified by the manufacturer as necessary to operate vanes properly. Either direct coupled or gear train with linkages are acceptable as required. The control loop for static control of the actuator shall operate slowly enough to avoid hunting and maintain stable control. See automation system specifications for details.

Approved Vendors: Belimo, Seimens, Invensys

VALVE ACTUATORS
Control Valves Actuators (3 inch and smaller):
- Actuators shall have a gear release button on all non-spring return models to allow manual setting. The actuator shall have either an insulating air gap between it and the linkage or a non-conducting thermoplastic linkage. Care shall be taken to maintain the actuator's operating temperatures and humidity within its specifications. Pipes shall be fully insulated and heat shields shall be installed if necessary. Condensation may not form on actuators and shall be prevented by a combination of insulation, air gap, or other thermal break.
- The control circuit shall be fully modulating using 2 - 10 volt or 4 - 20 mA signals. Accuracy and repeatability shall be within 1/21 of control signal. A 2 - 10 v or 4 - 20 mA signal shall be produced by the actuator which is directly proportional to the shaft clamp position which can be used to control actuators which are paralleled off a master motor or to provide a feedback signal to the automation system indicating valve position.
- Valve body and actuators shall be shipped fully assembled and tested at the valve factory prior to shipment.

Control Valve Actuators (4 inch and larger):
- The valve actuator shall consist of a permanent split capacitor, reversible type electric motor which drives a compound epicycle gear. The electric actuator shall have visual mechanical position indication, readable from a distance of 8 meters, showing output shaft and valve position. Unit shall be mounting directly to the valves without brackets and adapters, or readily adapted to suit all other types quarter-turn valves.
- The actuator shall have an integral terminal strip, which, through conduit entries, will ensure simple wiring to power supplies. Cable entries shall have UL recommended gland stops within the NPT hole to prevent glands from being screwed in too far and damaging cable.
- The actuator shall be constructed to withstand high shock and vibrations without operations failure. The actuator cover shall have captive bolts to eliminate loss of bolts when removing the cover from the base. One copy of the wiring diagram shall be provided with the actuator.
- The actuator shall have a self-locking gear train which is permanently lubricated at the factory. The gearing shall be run on ball and needle bearings. Actuators with 70 N-m or more output torque shall have two adjustable factory calibrated mechanical torque limit switches of the single-pole, double-throw type. The motor shall be fitted with thermal overload protection. Motor rotor shaft shall run in ball bearings at each end of motor.
- The actuator housing shall be hard anodized aluminum for full environmental protection.
- The environmental temperature range of the actuator shall be -30°C to +60°C.
- For intermittent on/off service, the actuator shall be rated at a 20% duty cycle (i.e., 12 minutes extended duty in every hour, or alternatively; one complete cycle every 2 minutes). For more frequent cycling and modulating service, an actuator shall be rated for continuous duty. The actuator rated for continuous duty shall be capable of operating 100% of the time at an ambient temperature of 40°C.
- The actuator shall have an integral self-locking gear train. Motor brakes shall not be required to maintain desired valve position. Levers or latches shall not be required to engage or disengage the manual override. Mechanical travel stops, adjustable to 15° in each direction of 90° rotation shall be standard, as well as two adjustable travel limit switches with electrically isolated contacts. Additional adjustable switches shall be available as option.
- Single Phase Motor: The motor shall have Class B insulation capable of withstanding locked-rotor for 25 seconds without overheating. Wiring shall also be Class B insulation. An auto-reset thermal cut-out protector shall be embedded in the motor windings to limit heat rise to 80°C in a 40°C ambient. All motors shall be capable of being replaced by simply disconnecting the wires and then removing mounting bolts. Disassembly of gears shall not be required to remove the motor.

- Materials of Construction: The electric actuator shall have a pressure die-cast, hard anodized aluminum base and cover. The compound gear shall be made of die-cast, hard anodized aluminum or steel. An alloy steel worm gear shall be provided for manual override and torque limiting. Bearings for gears shall be of the ball and needle type; bronze bearings shall be used on the shafting parts.
- Accessories: Potentiometer for providing continuous feedback of actuator position at the controller (for valves specified position feedback).
- Acceptable manufacturers: Belimo, Siemens, Tac/Invensys

CONTROL VALVES
Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Valves with sizes up to and including 2 inches shall be "screwed" configuration and 2-1/2 inch and larger valves shall be "flanged" configuration. Electrically controlled valves shall include spring return type actuators sized for tight shut-off against system pressures and furnished with integral switches for indication of valve position (open-closed). Three-way butterfly valves, when utilized, shall include a separate actuator for each butterfly segment.

Acceptable manufacturers: Belimo, Siemens, Tac/Invensys

SWITCHES
Differential Pressure Switches:
- All pressure sensing elements shall be corrosion resistant. Pressure sensing elements shall be bourdon tubes, bellows, or diaphragm type. Units shall have tamper-proof adjustable range and differential pressure settings.
- Pressure sensor switch contacts shall be snap action micro-switch type. Sensor assembly shall operate automatically and reset automatically when conditions return to normal. Complete sensor assembly shall be protected against vibration at all critical movement pivots, slides and so forth.
- Differential pressure switches shall be vented to withstand a 50% increase in working pressure without loss of calibration.
- Acceptable Manufacturers: Mercoid, Dwyer, McDonnell Miller

Electric Low Limit Thermostat (Freeze Stat):
- Duct type, fixed 3 degrees Celsius differential, range 0 to 15 degrees Celsius. Sensing element shall be a 7 meter long capillary tube responding to the lowest temperature sensed along any 30 cm of bulb length. Switch shall be SPDT 120/240 volts AC, rated for 10 amps at 120 volts full load. Unit shall be manually reset. Provide one low limit thermostat for each 2 square meter or fraction thereof of coil surface area.
- Provide DPST switches, 1 NO, 1 NC contact.
- Provide manual type low limit thermostat set at 2 degrees Celsius on each air handling unit.
- Provide thermostat override on air handling units for smoke control in area being served.

Water Flow Switches:
- UL listed, suitable for all service application conditions. Body minimum working pressure rating shall equal or exceed service pressure. Switch electrical rating shall be 230 volts AC 3.7 ampere, 115 volts AC 7.4 ampere, and 125 VAC 115-230 VAC AC Pilot duty. Unit shall have two SPDT switches. Actuating flow rated shall be field adjustable for the specified and indicated service. Switch location shall preclude exposure to turbulent or pulsating flow conditions. Flow switch shall not cause pressure drop exceeding 2 psi at maximum system flow rate.
- Acceptable Manufacturer: McDonnel-Miller.

Strap-On Aquastat: UL listed, provided with a suitable removable spring clip for attaching aquastat to pipe and a snap-action SPDT switch. Switch setpoint shall be as indicated. Electrical rating shall be 5 amperes, 120 VAC.

Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

FLOW, PRESSURE AND ELECTRICAL MEASURING APPARATUS
Traverse Probe Air Flow Measuring Stations:
- Traverse probes shall be a dual manifolded, cylindrical, type constructed of 3003 extruded aluminum with an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching air flow and without the physical presence of forward projecting sensors into the airstream. The static pressure manifold shall incorporate dual offset static tips on opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as ±20° in the approaching airstream.
- The air flow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the airstream. Each airflow measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.
- Traverse probes shall be accurate to ±25% of the measured airflow range down to 60 Pa static pressure.
- Each flow measuring station shall be complete with its own dedicated microprocessor with a 4-line, 80 character, Alpha Numeric display and full function key pad. The panel shall be fully programmable and display calculated liters per minute directly on a LED monitor on the panel face.
- Provide 24 volt 1 phase power to each flow measuring station.
- Acceptable Manufacturers: Air Monitor, Ultratech, Air Sentinel, Ebtron

Shielded Static Pressure Sensor:
- Provide for each zone where required a shielded static pressure sensor suitable for ceiling surface mounting, complete with multiple sensing ports, pressure impulse suppression chamber with minimum volume of 800 cubic centimeters, airflow shielding, and 3/8" compression takeoff fittings, all contained in a welded stainless steel casing, with polish finish on the exposed surfaces.
- These probes shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow of 300 meters per minute from a radial source.
- The shielded static sensing devices shall be used for both reference and space pressure sensing.
- Pressure sensors used for outside air pressure reference purposes shall be equipped with a conduit seal for pneumatic tubing and bushings for a weather tight installation.

Static Pressure Traverse Probe:
- Provide multipoint traverse probes in the duct at each point where static pressure sensing is required.
- Each duct static traverse probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe. Pressure sensing points shall not protrude beyond the surface of the probe.

- The duct static traverse probe shall be of 304 stainless steel construction and (except for 3/4" dia. probes with lengths of 60 cm or less) be complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting. The static traverse probe shall be capable of producing a steady, non-pulsating signal of standard static pressure without need for correction factors, with an instrument accuracy of 21.
- Acceptable Manufacturers: Mamac, STAT-Probe/l, Veris, Setra, BAPI

Venturi Flowmeter
- Pressure drop on venturi type flowmeters shall not exceed 60 Pa. Each venturi low and high pressure taps shall be equipped with nipples, valves and quick disconnects.
- Equip each venturi with a metal identification tag indicating the size, location, Liters Per Minute (LPM) and meter reading for the LPM specified.
- Provide (1) dial differential pressure meter of the proper range to determine piping system flow rate. The meter shall be the property of the Owner.
- Venturi meters shall utilize flanged or screwed connections for removal purposes and shall be rated for the system operating pressures.
- The venturi flowmeter shall be factory calibrated to provide a minimum of flow accuracy between actual and factory flow calibration data.
- Acceptable Manufacturers: Barco, Gerand, Aeroquip

RELAYS AND CONTACTORS
Relays other than those associated with digital output cards shall be general purpose, enclosed type and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

Solid State Relays (SSR):   Input/output isolation shall be greater than IOE^9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz. The contact life shall be 10 x 10 E^6 operations or greater. The ambient temperature range of SSRs shall be -28 to +60°C. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.

Contactors: Contactors shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semipermanent magnets. Contractor shall be double-break-silver-to-silver type protected by arcing contacts. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

TEMPERATURE CONTROL PANELS
Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Panels shall conform to NEMA 1 standards, unless otherwise indicated.

Control panels shall meet all requirements of UL508A and shall be so certified.

All external wiring shall be connected to terminal strips mounted within the panel.

Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels and the identification number of the panel.

A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel. Danfoss

PART 3 - EXECUTION

INSTALLATION
All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the Direct Digital Control System manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative).

Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

Drawings of Direct Digital Control Systems are diagrammatic only and any apparatus not shown, such as relays, accessories, etc., but required to make the system operative to the complete satisfaction of the Engineer and Owner shall be furnished and installed without additional cost.

Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the DDCS Contractor in accordance with these specifications.

Equipment furnished by the HVAC Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the DDCS Contractor.

All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

All electrical control wiring and power wiring to the control panels shall be the responsibility of the DDCS Contractor.

The electrical contractor (Division 26) shall furnish all power wiring to electrical starters and motors.

All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. All DDCS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 26) unless otherwise allowed by the National Electrical Code or applicable local codes. Where DDCS plenum rated cable wiring is allowed, it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

WIRING
GENERAL REQUIREMENTS
Install low voltage power and LON and LAN communication trunks in conduit in the following locations regardless of local building code allowances otherwise.
• Mechanical rooms.
• Electrical rooms.
• Vertical risers (exception: fire rated continuous closet like a telephone closet).
• Open Areas where the wiring will be exposed to view or tampering.

Splices:

- Splices in shielded cables shall consist of terminations and the use of shielded cable couplers which maintain the integrity of the shielding. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties as specified herein. Splices are not permitted in the FMS LAN or LON communication cables.
- Follow manufacturer suggested procedures for proper slicing.

Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls

Tag all equipment, panels, cables, conduits, junction boxes, etc., as called out in the "Identification" section of this specification and as shown on the drawings.

Perform installation of all devices in the manner specified by each manufacturer. Aside from product submittal requirements, provide manufacturer's installation instructions for verification as requested by the DGS agent.

Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

- Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
- All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.

Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

Where Class 2 wiring is run exposed, wiring to be run parallel along a surface or perpendicular to it, and NEATLY tied at 3m intervals.

All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

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.

ETHERNET NETWORK REQUIREMENTS
Wired network communication shall be via channels consisting of Category 5E or Category 6 network cable installed in a 3/4" EMT.

Communication conduits shall not be installed closer than 2m from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.

Ethernet network wiring shall be installed as shown on riser diagram.

There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring.

Recommended CAT 5E and CAT 6 Ethernet wiring guidelines shall be followed and in no case shall the distance between any Ethernet switch, NAC or other Ethernet LAN device exceed 100 meters.

Ethernet wiring shall installed and rated for communications at 100mb.

LON NETWORK REQUIREMENTS
Wired network communication shall utilize approved Lon cable as indicated on the drawings. No substitutions will be allowed.

Communication conduits shall not be installed closer than 2m from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.

Lon network wiring shall be installed as shown on riser diagram.

There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring.

Recommended Lon wiring guidelines shall be followed for double-terminated bus topology, with repeaters provided as required, based on wiring distance and device quantity configuration. In no case shall the total network wiring distance from any NAC to the last Lon device on the network exceed 1,400 meters, with a maximum stub length of 3 meters.

INPUT / OUTPUT AND ANCILLARY HARDWARE WIRING
Input/Output Control Wiring:
• Thermistor wiring shall be two conductor, twisted, shielded, minimum 22 gauge.
• Other analog inputs shall be a minimum of number 22 gauge, twisted, shielded.
• Binary control function wiring shall be a minimum of number 18 gauge.
• Analog output control functions shall be a minimum of number 22 gauge, twisted, shielded cable, number of conductors as required.
• Binary input wiring shall be a minimum of number 22 gauge, twisted, shielded.
• 120V control wiring shall be #14 THHN in 1/2" conduit.

Provide interlock wiring between supply and return fans and electrical wiring for relays (including power feed) for temperature and pressure indication. Provide interlock wiring between refrigeration machines, pumps and condensing equipment as required for the specified sequence of operation and the refrigeration system integral controller(s). Do not provide interlock wiring if a dedicated digital output has been specified for the equipment or the sequence of operation requires independent start/stop.

Provide power wiring, conduit and connections for low temperature thermostats, high temperature thermostats, alarms, flow switches, actuating and sensing devices for temperature, humidity, pressure and flow indication, point resets and user disconnect switches for electric heating appliances controlled by this Section.

CONDUIT AND FITTINGS
Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.

Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

Set conduits as follows:
- Expanding silicone firestop material where conduit is run between floors and through walls of fireproof shaft.
- Oakum and lead, sealed watertight penetration through outside foundation walls.

Cap open ends of conduits until conductors are installed.

Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

IDENTIFICATION
Wire Tags:
- All multi-conductor cables, including those for all I/O devices, in all pull boxes and terminal strip cabinets shall be uniquely tagged at both ends. Keep a catalog of wire identification for submittal to the City of Chicago at the project's completion.
- Provide wire Tags as per Division 16.

Conduit Tags: Provide tagging or labeling of conduit so that it is always readily observable which conduit was installed or used in implementation of this Work.

Miscellaneous Equipment Identification:
- Screwed-on, engraved black lamacoid sheet with white lettering on all control panels and remote processing panels. Lettering sizes subject to approval.
- Inscription, subject to review and acceptance, indicating equipment, system numbers, functions and switches. For panel interior wiring, input/output modules, local control panel device identification.

Automatic Control Valve Tags:
- For valves, etc., use metal tags with a 2 inch minimum diameter, fabricated of brass, stainless steel or aluminum. Attach tags with chain of same materials. For lubrication instructions, use linen or heavy duty shipping tag.
- Tag valves with identifying number and system. Number valves by floor level, column location and system served.

- Prepare lists of all tagged valves showing location, floor level, tag number, use. Prepare separate lists for each system. Include copies in each maintenance manual.

WARRANTY
Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the DDCS Contractor at no expense to the Owner.

START-UP AND TESTING
It is the responsibility of the DDCS contractor to ensure the proper installation and performance of the Lon networks and to coordinate the start-up and testing of the networks with the Section 23 09 25 System Integrator to ensure the networks and attached devices are functioning properly. Once all devices are installed, programmed, configured and powered, the DDCS contractor shall notify the Section 23 09 25 System Integrator to schedule a start-up schedule. During the start-up, all IDC's supplied by the DDCS contractor shall be checked for proper communication, network bindings, and network traffic to ensure proper performance. The DDCS contractor shall correct any devices or performance found to be defective

The DDCS contractor, along with the Section 23 09 25 System Integrator shall reconfigure nodes as necessary to maintain traffic to no more than 50% of channel bandwidth capacity.

WARRANTY ACCESS
The Owner shall grant to the DDCS Contractor, reasonable access to the DDCS during the warranty period.

ACCEPTANCE TESTING
The DDCS Contractor shall verify that all IDC's are ready for operation. This inspection shall verify that the following items have been properly installed.
- Network connection.
- Power connection.
- Proper power supply voltage and type.
- Electrical installation conforms to local code authorities.
- Valves (normally open or closed).
- Fail safe devices are equipped with spring return operators.
- Device or control unit in a standalone mode accomplishes the following:
    - Operate smoothly throughout entire control range without binding or cogging.
    - Sensors have been calibrated to specifications.
    - Differential pressure transmitters have been zero and span adjusted.
- With application code loaded, execute specific control loops effectively without hunting or hysteresis.
- Point to point check of all digital I/O for continuity and correct execution of the functional operation.

Submit an Inspection Log, which enumerates the above in a check list form for all IDC's. Indicate corrective action for non-conforming or defective products and/or product installations.

The DDCS Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications. The Division 23 and Section 23 09 25 contractors are to coordinate the checkout of the system such that each Section has a representative present during system checkout.

The DDCS Contractor shall perform tests to verify proper performance of components, sequences of operation, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation. The Section 23 09 25 System Integrator shall have a representative present during system checkout by the DDCS Contractor.

Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

System Acceptance: Satisfactory completion is when the Temperature Control sub-contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

In conjunction with the work of other trades, thoroughly test all equipment and systems in a dynamic mode simulating all operating sequences including safety shutdown and emergency fire mode.

TESTING, ADJUSTING AND BALANCING REQUIREMENTS
SUMMARY:
This contractor shall work with the Section 23 05 93 test and balance contractor to secure the proper operation of all control systems and devices.

PART 4 - SEQUENCES OF OPERATION

SUMMARY
For each system listed, provide the sequence of operation as stated in Section 23 09 23.

CONTROL DIAGRAMS AND SCHEDULE
Refer to Drawings for information, which indicates the components and intended control functions and devices.

SI Contractor shall be responsible for all control wiring connections, auxiliary devices and control wiring diagrams to complete the control system and attain the described sequence of operation.

All set points of sensors, controllers and the like, that are not factory preset, shall be preset by the SI Contractor before system startup.

SEQUENCES OF OPERATION
Program each ASC, CU, etc, to perform the sequences of operation printed on the control drawings. Provide all necessary hardware on each piece of equipment in order for the equipment to perform the specified sequence and to meet the requirements of the points lists. (Points on the points list may be for monitoring and alarm purposes. They may not be required to perform the sequence. DDCS Contractor is responsible for providing these as well.)

SI Contractor shall be responsible for all control wiring connections, auxiliary devices and control wiring diagrams to complete the control system and attain the described sequence of operation.

END SECTION 23 09 24

Dane County Job Center
Project No. 2007070 (02/27/09)

SECTION 23 09 25 - INTEGRATED AUTOMATION SYSTEM (IAS)

PART 1 - GENERAL

SUMMARY
This section describes the Systems Integration scope of work for the project. This section also coordinates the responsibilities of the Mechanical and Electrical trade contractors pertaining to control products or systems, furnished by each trade that will be integrated by this Section.

All labor, material, equipment and software not specifically referred to herein or on the plans, that are required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.

SYSTEM DESCRIPTION
The Integrated Automation System (IAS) shall be comprised of Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the owner's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to LonTalk (IDC) controllers provided under Section 23 09 24.

SYSTEM INTEGRATION CONTRACTOR QUALIFICATIONS
General:
The System Integrator shall have a successful history in the design and installation of open control systems with browser based wide area network connectivity and shall provide evidence of this history as a condition of acceptance of bid.

The System Integrator shall have an office that is staffed with LONWORKS® and Internet Protocol (IP) trained engineers and technicians fully capable of providing instruction and routine emergency maintenance service on all system components within 24 hours of notification.

Contractor Service:
- System Integrator shall have a local service facility within a 90-mile radius of the job site, staffed with qualified service personnel, fully capable of providing instructions and routine or emergency maintenance service.
- Qualified Bidder: Environmental Systems, Inc., Waukesha WI 262-544-8860
- (This system will tie in to an established integrated automation system presently being developed throughout Dane County.)

SUBMITTAL
Eight copies of shop drawings of the IAS system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package.

Submittal shall include a network cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.

Upon completion of the work, provide a complete set of 'as-built' drawings and application software on compact disk and on the Network Supervisor (NS) hard drive. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Eight copies of the 'as-built' drawings shall be provided in addition to the documents on magnetic floppy disk media or compact disk. Section 23 09 24 and Division 26 contractors shall provide as-builts for their portions of work. Section 23 09 25 contractor shall be responsible for as-builts pertaining to overall IAS architecture and network diagrams.

SPECIFICATION NOMENCLATURE
Acronyms used in this specification are as follows:

IAS	Integrated Automation System
DDCS	Direct Digital Control System
NAC	Network Area Controller
NS	Network Supervisor
IDC	Interoperable Digital Controller
ASC	Application Specific Controller
PCU	Programmable Control Unit
IBC	Interoperable BACnet Controller
GUI	Graphical User Interface
WBI	Web Browser Interface
POT	Portable Operator's Terminal
PMI	Power Measurement Interface
DDC	Direct Digital Controls
LAN	Local Area Network
WAN	Wide Area Network
OOT	Object Oriented Technology
PICS	Product Interoperability Compliance Statement

DIVISION OF WORK
The DDCS Contractor shall be responsible for all controllers (IDC), control devices, control panels, controller programming, controller programming software, controller input/output wiring, power wiring, interlock and safety wiring, controller network wiring, and Ethernet LAN wiring, if applicable.

The System Integrator (SI) shall be responsible for the Network Area Controller(s) (NAC), workstations, printers, servers, software and programming of the NAC, graphical user interface software (GUI), development of all graphical screens, setup of schedules, logs and alarms, LonWorks network management, global supervisory control applications, system integration and coordination of the NAC to the local or wide area network.

The point of demarcation for the products to be provided by the System Integrator shall be up to and including the Network Area Controller (NAC).

WORK INCLUDED
Furnish and install the following application software as outlined in this section.
- User Interface software
- HVAC application software

The following will be developed:
- Provide custom set-up and development of the software to provide the functional and performance requirements specified. Develop system graphics for all specified mechanical and electrical systems, using animated objects to display all system variables and process valves, according to Owner standards.
- Provide supervisory control strategies for mechanical and electrical systems to permit the global sequence of operations specified herein.

RELATED WORK SPECIFIED ELSEWHERE
Section 23 09 24, Mechanical: Providing control devices and systems including but not limited to:
* Interoperable Digital Controllers and programming
* Control panels, devices and wiring
* Control device networks

Division 26, Electrical:
* Providing motor starters and disconnect switches (unless otherwise noted).
* Power wiring and conduit (unless otherwise noted).
* Provision, installation and wiring of smoke detectors (unless otherwise noted).

AGENCY AND CODE APPROVALS
All products of the IAS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable: UL-916; Energy Management Systems, ULC; UL - Canadian Standards Association, FCC, Part 15, Subpart J, Class A Computing Devices.

SOFTWARE LICENSE AGREEMENT
The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

DELIVERY, STORAGE AND HANDLING
Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

JOB CONDITIONS
Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to insure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

PART 2 - MATERIALS

GENERAL
The Integrated Automation System (IAS) shall be comprised of a network of interoperable, stand-alone Network Area Controllers, servers, operator workstations, graphical user interface software, printers, network devices and other devices as specified herein.

The installed system shall provide secure password access to all features, functions and data contained in the overall IAS.

OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES
The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet and LonWorks technology communication protocols in one open, interoperable system.

The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995, BACnet and LonMark to

assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file for the device. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet or MSTP.

All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs.   An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
- Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
- Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

NETWORKS
The Local Area Network (LAN) shall be a 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, and HTTP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

Local area network minimum physical and media access requirements:
- Ethernet; IEEE standard 802.3
- Cable; 10 Base-T, UTP-8 wire, category 5E or 6
- Minimum throughput; 10 Mbps, with ability to increase to 100 Mbps

NETWORK ACCESS
Remote Access: For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The owner shall provide a connection to the Internet to enable this access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

NETWORK AREA CONTROLLER (NAC)
The Section 23 09 25 contractor shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices provided under Section 23 09 24 and Division 26. It is the responsibility of the Section 23 09 25 contractor to coordinate with the Section 23 09 24 and Division 26 contractors to determine the quantity and type of devices.

The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:

- Calendar functions
- Scheduling
- Trending
- Alarm monitoring and routing
- Time synchronization
- Integration of LonWorks controller data and BACnet controller data
- Network Management functions for all LonWorks based devices

The Network Area Controller must provide the following hardware features as a minimum:

- One Ethernet Port – 10/100 Mbps
- One RS-232 port
- One LonWorks Interface Port – 78KB FTT-10A
- Battery Backup
- Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
- The NAC must be capable of operation over a temperature range of 0 to 55°C
- The NAC must be capable of withstanding storage temperatures of between 0 and 70°C
- The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 26 simultaneous users.

Event Alarm Notification and Actions:

- The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
- The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
- Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to: To alarm, Return to normal, To fault.
- Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
- Provide timed (schedule) routing of alarms by class, object, group, or node.
- Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

Control equipment and network failures shall be treated as alarms and annunciated.

Alarms shall be annunciated in any of the following manners as defined by the user:

- Screen message text
- Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on: Day of week, Time of day, Recipient.
- Pagers via paging services that initiate a page on receipt of email message
- Graphic with flashing alarm object(s)
- Printed message, routed directly to a dedicated alarm printer

The following shall be recorded by the NAC for each alarm (at a minimum):
- Time and date
- Location (building, floor, zone, office number, etc.)
- Equipment (air handler #, accessway, etc.)
- Acknowledge time, date, and user who issued acknowledgement.
- Number of occurrences since last acknowledgement.

Alarm actions may be initiated by user defined programmable objects created for that purpose.

Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

Provide a "query" feature to allow review of specific alarms by user defined parameters.

A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

DATA COLLECTION AND STORAGE
The NAC shall have the ability to collect data for any object and store this data for future use.

The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
- Designating the log as interval or deviation.
- For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
- For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
- For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
- Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

All log data shall be stored in a relational database and the data shall be accessed from a standard Web Browser.

All log data, when accessed from the Network Supervisor (NS), shall be capable of being manipulated using standard SQL statements.

All log data shall be available to the user in the following data formats:
- HTML
- XML
- Plain Text
- Comma or tab separated values

Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

The NAC shall have the ability to archive it's log data to a Network Supervisor on the network. Provide the ability to configure the following archiving properties, at a minimum:

- Archive on time of day
- Archive on user-defined number of data stores in the log (buffer size)
- Archive when log has reached it's user-defined capacity of data stores
- Provide ability to clear logs once archived

AUDIT LOG
Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive the log based on time to the Network Supervisor. For each log entry, provide the following data:

- Time and date
- User ID
- Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

DATABASE BACKUP AND STORAGE
The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

Copies of the current database and, at the most recently saved database shall be stored on the Network Supervisor. The age of the most recently saved database is dependent on the user-defined database save interval.

The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

WEB BROWSER CLIENTS
The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacturer-specific browsers shall not be acceptable.

The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the IAS, shall not be acceptable.

The Web browser client shall support at a minimum, the following functions:

- User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
- HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
- Storage of the graphical screens shall be in the Network Area Controller (NAC), the Network Supervisor (NS) or both, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
- Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
- Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
    - Modify common application objects, such as schedules, calendars, and set points in a graphical manner. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

- Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
  - View logs and charts
  - View and acknowledge alarms
  - Setup and execute SQL queries on log and archive information
- The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

NETWORK SUPERVISOR FUNCTIONS AND HARDWARE
A Network Supervisor (NS) shall be provided. The NS shall support all Network Area Controllers (NAC) connected to the control LAN.

Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1 or dial-up connection.

It shall be possible to provide access to all Network Area Controllers via a single connection to the Network Supervisor. In this configuration, each Network Area Controller can be accessed from a remote Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the Network Supervisor.

The Network Supervisor shall provide the following functions, at a minimum:
- Global Data Access: The Network Supervisor shall provide complete access to distributed data defined anywhere in the system.
- Distributed Control: The Network Supervisor shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.
- The Network Supervisor shall include a master clock service for its subsystems and provide time synchronization for all Network Area Controllers (NAC).
- The Network Supervisor shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.
- The Network Supervisor shall provide scheduling for all Network Area Controllers and their underlying field control devices.
- The Network Supervisor shall provide demand limiting that operates across all Network Area Controllers. The Network Supervisor must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy.   Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
- The Network Supervisor shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.
- Each Network Area Controller supported by the Network Supervisor shall have the ability to archive its log data, alarm data and database to the Network Supervisor, automatically. Archiving options shall be user-defined including archive time and archive frequency.
- The Network Supervisor shall provide central alarm management for all Network Area Controllers supported by the Network Supervisor. Alarm management shall include: Routing of alarms to display, printer, email and pagers, View and acknowledge alarms, Query alarm logs based on user-defined parameters.
- The Network Supervisor shall provide central management of log data for all Network Area Controllers supported by the Network Supervisor. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall

include: Viewing and printing log data, Exporting log data to other software applications, Query log data based on user-defined parameters.

Network Supervisor Hardware Requirements: The Network Supervisor hardware platform shall have the following requirements:
- The computer shall be an Intel Pentium based computer server-class machine (minimum processing speed of 2.8GHz with 2 MB RAM and a 120GB minimum hard drive). It shall include a 32X CD-ROM drive, 3.5" floppy drive, 2-asynchronous serial ports and 2-USB ports. A minimum 19", 28-dot pitch SVGA (1024 x 768) LCD color monitor with a minimum 80 Hz refresh rate shall also be included.
- Acceptable manufacturers: Dell PowerEdge.
- The Network Supervisor operating system shall be compatible with established systems at Dane County / Badger Prairie Health Care Center.
- Connection to the IAS network shall be via an Ethernet network interface card, 100Mbps.
- A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 8-PPM print speed minimum.
- For dedicated alarm printing, provide a dot matrix printer, either 80 or 132 column width. The printer shall have a parallel port interface.

SYSTEM PROGRAMMING
The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens.   Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

Programming Methods:
- Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
- Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
- The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
- All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.

- The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

LONWORKS NETWORK MANAGEMENT
The Graphical User Interface software (GUI) shall provide a complete set of integrated LonWorks network management tools for working with LonWorks networks. These tools shall manage a database for all LonWorks devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between LonWorks devices, known as "binding". Systems requiring the use of third party LonWorks network management tools shall not be accepted.

Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.

These tools shall provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.

The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

OBJECT LIBRARIES
A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

All control objects shall conform to the control objects specified in the BACnet specification.

The library shall include applications or objects for the following functions, at a minimum:
- Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
- Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
- Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals

- Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
- Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.
- Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.
- Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
- Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.
- Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
- Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
- PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
- Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.

- Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
- Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
- Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
- Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
- Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.

The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:
- LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.
- For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file and documentation for the device to facilitate device integration.
- For BACnet devices, provide the following objects at a minimum: BACnet AI, BACnet AO, BACnet BI, BACnet BO, BACnet Device.
- For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

PART 3 - EXECUTION

INSTALLATION
All work described in this section shall be performed by a system integrator that have a successful history in the design and installation of integrated control systems. The installing

office shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience.

Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

Drawings of IAS network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.

Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the Temperature Control sub-contractor in accordance with the specifications in Section 23 09 24 and Division 26.

WIRING
All electrical control wiring and power wiring to the NAC, computers and network components (routers, hubs, switches, etc.) shall be the responsibility of the Section 23 09 24, DDCS Contractor.

All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. All IAS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 26) unless otherwise allowed by the National Electrical Code or applicable local codes. Where IAS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

WARRANTY
Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of "substantial completion".

Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the Section 23 09 25 contractor at no expense to the Owner.

WARRANTY ACCESS
The Owner shall grant to the Section 23 09 25 contractor, reasonable access to the IAS during the warranty period. The owner shall allow the contractor to access the IAS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

ACCEPTANCE TESTING
Upon completion of the installation, the Section 23 09 25 contractor shall load all system software and start-up the system. The Section 23 09 24 contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications. The Section 23 09 24 and Section 23 09 25 contractors are to coordinate the checkout of the system such that each Section has a representative present during system checkout.

The Section 23 09 24 contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation. The Section 23 09 25 contractor shall have a representative present during system checkout by the Section 23 09 24 contractor.

Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

System Acceptance: Satisfactory completion is when the Section 23 09 24, Division 26, and Section 23 09 25 contractors have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

OPERATOR INSTRUCTION, TRAINING
During system commissioning and at such time acceptable performance of the IAS hardware and software has been established the Temperature Control sub-contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

The Section 23 09 25 contractor shall provide 40 hours of instruction to the owner's designated personnel on the operation of the IAS and describe its intended use with respect to the programmed functions specified. Operator orientation of the IAS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

The training shall be in three sessions as follows:
- Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.
- First Follow-Up Training: Two days (16 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
- Warranty Follow Up: Two days (16 hours total) in no less than 4 hour increments, to be scheduled at the request of the owner during the one year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.
- Completion of training shall be certified by the Owner
- All sessions will be videotaped by Owner and at owner's expense. This includes field installations, class room instruction and training on the computer.
- Sufficient advance notification of ALL training is required.

PART 4 - SEQUENCES OF OPERATION

SUMMARY
The Section 23 09 25 contractor shall refer to this Item under Section 23 09 24 to determine what level of control functionality the Network Area Controller, must provide, which is the responsibility of this Section. It is the responsibility of the Section 23 09 25 contractor to coordinate control functions, such as scheduling and supervisory-level global control with the Section 23 09 24 contractor.

PART 5 - POINT LISTS

SUMMARY
The Section 23 09 25 contractor shall refer to this Item under Section 23 09 24 to determine what data in the local controllers must be integrated into the Network Area Controller, which is the responsibility of this Section. It is the responsibility of the Section 23 09 25 contractor to coordinate control functions, such as scheduling and supervisory-level global control with the Section 23 09 24 contractor.

END SECTION 23 09 25