Addendum a
to ASHRAE Guideline 13-2000

ASHRAE GUIDELINE

Specifying Direct Digital Control Systems

Approved by the ASHRAE Standards Committee on June 25, 2005, and by the ASHRAE Board of Directors on June 30, 2005.

This guideline is under continuous maintenance by a Standing Guideline Project Committee (SGPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the guideline. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site, http://www.ashrae.org, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Guideline may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada).

ISSN 1049-894X

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle NE, Atlanta, GA 30329
www.ashrae.org

ASHRAE Standing Guideline Project Committee 13
Cognizant TC: TC 1.4, Control Theory and Application
SPLS Liaison: Donald B. Bivens

SPECIAL NOTE

This Guideline was developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). ASHRAE Guidelines are developed under a review process, identifying a guideline for the design, testing, application, or evaluation of a specific product, concept, or practice. As a guideline it is not definitive but encompasses areas where there may be a variety of approaches, none of which must be precisely correct. ASHRAE Guidelines are written to assist professionals in the area of concern and expertise of ASHRAE's Technical Committees and Task Groups.

ASHRAE Guidelines are prepared by project committees appointed specifically for the purpose of writing Guidelines. The project committee chair and vice-chair must be members of ASHRAE; while other members of the project committee may or may not be ASHRAE members, all must be technically qualified in the subject area of the Guideline.

Development of ASHRAE Guidelines follows procedures similar to those for ASHRAE Standards except that (a) committee balance is desired but not required, (b) an effort is made to achieve consensus but consensus is not required, (c) guidelines are not appealable, and (d) guidelines are not submitted to ANSI for approval.

The Manager of Standards of ASHRAE should be contacted for

a. interpretation of the contents of this Guideline,
b. participation in the next review of the Guideline,
c. offering constructive criticism for improving the Guideline,
d. permission to reprint portions of the Guideline.

DISCLAIMER

ASHRAE publishes Guidelines in order to provide assistance to interested parties on issues that relate to the design, testing, application, and/or evaluation of products, concepts, and practices where there may be more than one acceptable approach. Guidelines are not mandatory and only provide one source of information that may be helpful in any given situation.

ASHRAE INDUSTRIAL ADVERTISING POLICY ON STANDARDS

ASHRAE Standards and Guidelines are established to assist industry and the public by offering a uniform method of testing for rating purposes, by suggesting safe practices in designing and installing equipment, by providing proper definitions of this equipment, and by providing other information that may serve to guide the industry. The creation of ASHRAE Standards and Guidelines is determined by the need for them, and conformance to them is completely voluntary.

In referring to this Standard or Guideline and in marking of equipment and in advertising, no claim shall be made, either stated or implied, that the product has been approved by ASHRAE.

[This foreword is not part of the guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.]

FOREWORD

This addendum incorporates editorial changes and minor independent substantive changes (ISCs) to the current published version of the guideline. These changes are indicated in the text by underlined blue type (for additions) and ~~strikethrough~~ (for deletions).

Addendum a to ASHRAE Guideline 13-2000

Correct the spelling error in Section 4.4.4 as indicated.

Categories of Protocols. The word *standard* is often used in discussions of protocols. There are "degrees of propriety" to the standards continuum, and they can be explained as follows:

- *Industry recognized standard*—A protocol that is formally recognized and/or listed by an independent, industry standards organization as a set of operational criteria. Examples are BACnet (recognized by ASHRAE and ANSI) and LonTalk (EIA).
- ~~*Defect*~~ *Defacto* *standards*—Very popular proprietary protocols in the marketplace that have been embraced by users and manufacturers and are offered as communications options on a variety of equipment. Examples are ModBus, Allen Bradley DH+, and Opto 22.
- *Proprietary standards*—A manufacturer makes proprietary protocols available on a limited basis or shares the protocol with the public at large for use in integrating other products into that manufacturer's network.

These classifications may be helpful in understanding the type of endorsement and support a protocol may have but do not suggest how popular or how broad the base of users may be. Some protocols of major control system manufacturers are also implemented by a defined, but limited, number of other manufacturers to bring a broad-based, interoperable solution to the market. The size of that number may exceed the number of solutions possible through the use of an industry recognized or defacto standard.

Make the following editorial correction in Section 5.3.3.

The sequences should detail how the system operates in each mode—e.g., normal, occupied, summer, winter, and emergency. The system operation under safety trips, smoke control, and fire shutdown all must be defined. All setpoints and operating points also should be defined in the sequence.

Revise Section 7 as shown below and on the following pages.

7. SPECIFICATION PART 1: GENERAL

This part of the specification covers administrative issues such as system performance, approvals, and submittals. The subsequent parts of the specification—Products and Execution—are discussed in Clauses 8 and 9, respectively.

This specification section must be edited to reflect paragraphs and titles used in an actual project specification.

1.0 SECTION INCLUDES

.1 Products Furnished b~~B~~ut Not Installed u~~U~~nder This Section
.2 Products Installed ~~B~~but Not Furnished u~~U~~nder This Section
.3 Products Not Furnished or Installed under but I~~i~~ntegrated with the Work of This Section
.4 Related Sections
.5 Description
.6 Approved Control System Contractors and Manufacturers
.7 Quality Assurance
.8 Codes and Standards
.9 System Performance
.10 Submittals
.11 Warranty
.12 Ownership of Proprietary Material

7.1 Products Furnished b~~B~~ut Not Installed u~~U~~nder This Section

There are a variety of products furnished by a controls subcontractor that are best installed by another subcontractor within the construction team. "Best installed" means that the cost of installation and/or coordinating labor is typically reduced if specified for installation by another. These products include pipe-mounted devices that are best installed by the piping subcontractor and certain duct devices (e.g., dampers) that are best installed by the sheet metal subcontractor. This specification paragraph should be edited to list only those other specification sections that include installation instructions for the products involved. (See Clause 10, "Instructions to Other Contractors," for more information on these installation instructions.)

Project Considerations: The paragraph should be stricken for projects in which the controls subcontractor may be the prime contractor (e.g., a controls upgrade project). Also, the specifier needs to complete the listed section numbers (shown below as "15xxx") and edit the titles to match the actual sections used within the remainder of the specification.

1.1 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 15xxx—Hydronic Piping~~:~~
1. Control Valves
2. Flow Switches
3. Temperature Sensor Wells and Sockets
4. Flow ~~m~~Meters

B. Section 15xxx—Refrigerant Piping~~:~~
1. Pressure and Temperature Sensor Wells and Sockets

C. Section 15xxx—Ductwork Accessories~~:~~
1. Automatic Dampers
2. Airflow Stations
3. Terminal Unit Controls

7.2 Products Installed bBut Not Furnished uUnder This Section

A variety of HVAC equipment can be specified with manufacturer-furnished controls. This approach will become more common as the use of standard protocols permits integration of manufacturer-furnished DDC controllers into a single system. (Refer to Clause 10 for further discussion of the integration of these controls with the rest of the communication network.) Some of the controls furnished by an HVAC equipment manufacturer may require field installation efforts, for example, a space thermostat provided with a packaged air handler.

Project Considerations: This specification paragraph should be edited to list only those other specification sections that include products for installation under this section. The paragraph should be stricken for projects in which the controls subcontractor is the prime contractor (e.g., a controls upgrade project). Finally, the specifier needs to complete the listed section numbers (shown below as "15xxx") and edit the titles to match the actual sections used within the remainder of the specification.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 15xxx—Refrigeration Equipment:
1. Refrigerant Leak Detection System

B. Section 15xxx—Rooftop Air-Handling Equipment:
1. Thermostats
2. Duct Static Pressure Sensors

7.3 Products Not Furnished or Installed under but Integrated with the Work of This Section

DDC systems increasingly are relying on controls provided by a variety of subcontractors and/or suppliers to form an overall building automation system. These other controls range from chiller and boiler controls to non-HVAC controls such as fire alarm systems, fire/smoke dampers, and lighting control systems. If the building automation system design requires functions that involve the sharing of information between these various controls—or just some type of simple interlock—then it can be said that the DDC system is integrated with these other controls. Following are examples of functions that require integration.

- A boiler plant can use a digital output from the DDC system to enable/disable a boiler sequencing controller provided by the boiler manufacturer.
- Chiller setpoint reset can involve the output of an analog signal from the DDC system to the chiller controller provided by the chiller manufacturer. With a standard protocol such as BACnet, this can be handled through a communications network.
- A VAV terminal unit can be provided with a cross-flow velocity sensor that is used with a field-installed DDC controller for pressure independent control.
- Duct smoke detectors are typically interlocked by the controls subcontractor to the air handler for life safety shutdown.
- Fire/smoke dampers may be supplied with pneumatic actuators and therefore require control air to be supplied by the controls subcontractor.
- Smoke control can require extensive integration between the DDC system and the fire alarm system if the HVAC system is involved in smoke control.
- An HVAC system can be started and stopped based on a security system's card reader transactions.
- Operation of both HVAC and lighting controls from the same time schedule residing in either system.

The suppliers and/or subcontractors involved with the other systems should be both supplying and installing those systems. However, the various members of the construction team need to coordinate their efforts to successfully integrate the controls. The purpose of this paragraph is merely to direct the reader to these other controls. Other portions of the project design need to provide the details of this integration, including:

- this specification, Part 3: "Coordination";
- the DDC system drawings and sequences of operation, which should describe the functions required;
- the other sections of the specification (including other divisions), which should be edited to include reciprocal discussions of the integration required. (Again, refer to Clause 10 for discussion about wording to be included in these sections.)

Project Considerations: The following specification paragraph should be edited to include only the other specification sections that apply to the integration involved. Also, the specifier needs to complete the listed section numbers (shown below as "15xxx") and edit the titles to match the actual sections used within the remainder of the specification. Finally, a detailed discussion of the integration required should be included in Part 3, "Sequences of Operation."

1.3 PRODUCTS NOT FURNISHED OR INSTALLED UNDER BUT INTEGRATED WITH THE WORK OF THIS SECTION

A. Section 15xxx—Heat Generation Equipment:
1. Boiler Controls

B. Section 15xxx—Refrigeration Equipment:
1. Chiller Controls

C. Section 15xxx—Rooftop Air-Handling Equipment:
1. Discharge Air Temperature Control
2. Economizer Control
3. Volume Control

D. Section 15xxx—Unit Ventilators and Fan Coil Units:
1. Set Point Reset
2. Day/ and Night Indexing

E. Section 15xxx—VAV Terminal Units:
1. Cross-Flow Velocity Sensor

F. Section 15xxx—Variable Frequency Drives

7.4 Related Sections

Controls are typically field-installed on a variety of mechanical and other equipment. The installation efforts of other subcontractors must be coordinated with the efforts of the controls subcontractor. Therefore, this section should be used to direct the reader to all other portions of the specification that include equipment to be controlled by—or coordinated with—the DDC system. There may be a variety of specification sections outside the mechanical and electrical divisions that should be identified here, including kitchen equipment, fume hoods, irrigation systems, etc. These will depend on the level of building automation desired. This section also reminds the controls subcontractor that it is also subject to the general project terms and conditions found in Divisions 0 and 1.

Project Considerations: This section needs to be edited to list the actual sections and their titles used in the project specification.

1.4 RELATED SECTIONS

A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are ~~a~~ part of this specification and shall be used in conjunction with this section as ~~a~~ part of the contract documents. ~~Consult them for further instructions pertaining to this work. The Contractor is bound by the provisions of Division 0 and Division 1.~~

B. The following sections constitute related work:

1. Section 01xxx—Submittal Requirements

2.~~1.~~ Section - 01xxx—Commissioning

3.Section 13xxx—Security Access and Surveillance

4.Section 13xxx—Detection and Alarm

5.~~2.~~ Section 15xxx—Basic Mechanical ~~Requirements~~Materials and Methods

6.Section 15xxx—Heat Generation Equipment

7.~~3.~~ Section 15xxx—Refrigeration Equipment

8.~~4.~~ Section 15xxx~~—Air-Handling~~Heating, Ventilating, and Air-Conditioning Equipment

9.Section 15xxx—Air Distribution

10.~~5.~~Section 15xxx—Testing, Adjusting, and Balanceing

11.~~6.~~Section 16xxx—Basic Electrical ~~Requirements~~ Materials and Methods

~~7. Section 16xxx—Basic Electrical Materials~~

12.~~8.~~Section 16xxx~~—General~~ Wiring Methods

13.~~9.~~Section 16xxx~~—Equipment and Motor Wiring~~Electrical Power

14.Section 16xxx—Low-Voltage Distribution

~~10. Section 16xxx—Fire Alarm System~~
~~11. Section 16xxx—Security Systems~~
~~12. Section 16xxx—Uninterruptible Power Supply~~
~~13. Section 16xxx—Emergency Systems~~

7.5 Description of DDC System

This section should contain a narrative description of the system. This description could include the type of architecture, communication technology, panel layout, use of DDC vs. conventional controls, operator interfaces, and any special or unusual hardware or operating features. The purpose is to provide the reader with insight into the design intent. This section should be an overview of the project, highlighting any special requirements associated with its implementation. It is not meant to describe every detail of the control system design and installation.

Project Considerations: This section should be edited to describe the project.

1.5 DESCRIPTION

A. General: The control system shall ~~be as shown and~~ consist of a high-speed, peer-to-peer network of DDC controllers and an operator workstation. The operator workstation shall be a personal computer (PC) with a color monitor, mouse, keyboard, and printer. The PC ~~will~~ shall allow ~~a user~~operators to interface with the network via dynamic color graphics. Depict ~~E~~each mechanical system, building floor plan, and control device ~~will be depicted~~ by a point-and-click graphic~~s~~. Furnish ~~A~~a modem ~~will be provided~~ or network interface card for remote access to the network and for paging ~~the~~ operators when an alarm occurs.

B. The system will directly control each air-handling unit by maintaining discharge air temperature, duct and building static pressure, and outside air economizer control. The hot water boiler and pumping system will operate to reset the hot water supply temperature based upon outside air temperature and pump lead-lag control. The chiller and chilled water pump system will operate based on outside air temperature and pump lead/lag control. In addition, each terminal variable air volume (VAV) and fan-powered VAV unit will be controlled by individual DDC zone controllers networked with the primary DDC panels. Each zone controller will provide for occupied/unoccupied mode of operation by individual zone. For energy conservation, the system will be programmed for optimal Start/Stop of the air-handling units and hot and chilled water systems, night setback, and night purge control.

C. ~~The system will p~~Provide for future system expansion to include monitoring of ~~the~~ occupant card access, fire alarm, and lighting control systems.

7.6 Approved Control System Contractors and Manufacturers

7.6.1 General

The controls subcontractor chosen for the project is perhaps the single most important factor in the successful implementation of a DDC system. This is contrary to other specification sections where the emphasis is placed on manufacturers. Therefore, to help control the quality of the subcontractor chosen, it is good practice to limit the list of allowable bidders. Pre-qualification efforts can range from using a list of familiar subcontractors to undertaking a major pre-qualification effort. The issues considered might include the subcontractor's reputation, the quality of the subcontractor's documentation, the level of customer training provided, and history of service performance. Be advised that these issues can change over time for a specific subcontractor.

The list of approved controls subcontractors does not preclude the possibility that other controls subcontractors or DDC manufacturers may win the project. The specifier should review other sections or divisions of the specification for the rules concerning substitutions and prior approvals.

Technical Proposals

An alternative approach to controlling subcontractor quality is to request technical proposals from potential subcontractors and/or manufacturers. This is best used when price alone is not the sole issue in selecting the controls subcontractor. Such situations might include

- the first project in a campus upgrade,
- a client interested in learning more about DDC technology prior to selecting the control system contractor,
- critical applications where success cannot be entrusted to the low bid.

Be aware that this approach must be handled separately from a bid process. Once the control system contractor is selected and the price determined, the contract value may be assigned to the project. Once again, consult and review other sections or divisions of the specification concerning assignment of pre-selected subcontractors.

Technical proposals can be specified to include a wide variety of subcontractor and product information including:

- A profile of the controls subcontractor and manufacturer
- A profile of the product line, including its age and number of installations
- The control system contractor's approach to project planning and management
- Resumes of personnel
- References
- Examples of project documentation
- A proposed system architecture diagram
- Data sheets for major components
- Examples of actual system graphic screens for other projects
- Examples of actual custom application programs for other projects
- Samples of shop drawings for other projects
- A list of exceptions, clarifications, or deviations from the specification
- Proposed alternative methods of approach
- A sample of a typical service agreement
- Product list prices and discounts to be offered for the purposes of this project
- A demonstration of system operation
- A tour of a completed system installation

Once the technical proposals are received, an evaluation process must be undertaken to select the controls subcontractor. This process may involve a team of evaluators with a formal scoring method or something less formal. Either way, it should be clear that the technical proposal approach can involve extensive specification and evaluation efforts.

7.6.2 Listing Control System Contractors in the Specification

The pre-qualified control system contractors should be listed in the specification in alphabetical order so that no preference is implied. Also include the address or location of each subcontractor. This will help the prime contractor or mechanical subcontractor in contacting the firms and will avoid any confusion should the controls subcontractor have more than one office location. The last statement in the specification paragraph is provided to clarify that not all components of a DDC system are produced by the manufacturers listed.

1.6 APPROVED CONTROL SYSTEM CONTRACTORS AND MANUFACTURERS

A. The following are the approved Control System Contractors and manufacturers:

Company Name/ Manufacturer	Product Line	Address/ Location	Contact
Contractor A			
Contractor B			
Contractor C			

Note:

1. The above list of Contractors is alphabetical and does not display a preference.
2. The Contractor shall use only products from the corresponding manufacturer and product line listed.
3. The above list of manufacturers applies to operator workstation software, controller software, the custom application programming language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (e.g., sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

7.7 Quality Assurance

These paragraphs can provide a variety of requirements concerning the standards of practice that should apply to the controls subcontractor and his/her products and installation practices.

Project Considerations: This paragraph should only be used if the specifier is seeking additional bidders beyond those listed in the above discussion on "Approved Control System Contractors and Manufacturers." The example specification paragraph lists some of the items that might be considered for selecting additional bidders. The specifier may choose to add other requirements, depending on the need for more rigorous qualifications such as the criteria discussed in Part 1, "Approved Control System Subcontractors and Manufacturers."

1.7 QUALITY ASSURANCE

A. ~~Contractor~~Installer and ~~/~~Manufacturer Qualifications

1. ~~The~~ Installer shall have an established working relationship with ~~the~~ Control System Manufacturer of not less than three years.
2. ~~The~~ Installer shall have successfully completed Control System Manufacturer's ~~classes on the~~ control system training. Upon request, ~~The~~ Installer shall present ~~for review the~~ certification of completed training~~,~~ including ~~the~~ hours of instruction and course outlines. ~~upon request.~~

7.8 Codes and Standards

This paragraph should list only those codes and standards, along with the specific sections, used in the control system design. The paragraph should not be used for an exhaustive list of all codes and standards that might conceivably have something to do with controls. Also, the contractor should not be expected to determine what sections of a building (as opposed to mechanical) code apply to a project. Therefore, the specification lists the specific sections of the building code referenced. If this approach is not used, the specification will be difficult to enforce.

Project Considerations: The codes and standards that apply to a given project will vary with the application and jurisdiction. For example, the ICBO (Uniform) Codes are listed in the example; however, the project might be in a jurisdiction that is covered by the BOCA or Standard Building Codes or the National Building Code of Canada. Also the specific sections of a building code will vary with the code used, the application, and the edition of the code used. Therefore, the list must be edited for each project. Change “State” to “Provincial” or remove as required for location of the project.

1.8 CODES AND STANDARDS

A. ~~All w~~Work, materials, and equipment shall comply with the most restrictive of ~~the rules and regulations of all~~ local, state, and federal authorities’ codes and ordinances or ~~of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over~~ these plans and specifications. As a minimum, the installation shall comply with ~~the~~ current editions in effect 30 days prior to receipt of bids of the following codes:

1. National Electric Code (NEC)
2. Uniform Building Code (UBC)
   a. Section 608, Shutoff for Smoke Control
   b. Section 403.3, Smoke Detection Group B, Office Buildings and Group R, Division 1 Occupancies
   c. Section 710.5, Wiring in Plenums
   d. Section 713.10, Smoke Dampers
   e. Section 1106, Refrigeration Machinery Rooms
   f. Section 1107, Refrigeration Machinery Room Ventilation
   g. Section 1108, Refrigeration Machinery Room Equipment and Controls
   h. Section 1120, Detection and Alarm Systems
3. Uniform Mechanical Code (UMC)

7.9 System Performance

The specifier is always faced with the choice of being prescriptively detailed versus less exact in describing what is required for any system component. Sensors, for example, call for more detail than components whose desired results might be met by a wide range of products. When prescriptive language is used, it should

- be recognized by the client as important,
- cite realistic, deliverable values,
- *not conflict* with any products specified in Part 1, “Approved Control System Subcontractors and Manufacturers” and Part 2,
- be used sparingly or not all. Unless you know for certain that a specific performance standard is vital, do not use prescriptive language.

The system specifier will need to determine with the client what the desired system performance should be and what elements are important. A project that is controlling a critical process may need much quicker system reactions than one simply used for comfort cooling. The specifier should only state the required level of performance for the project. Specifying a higher level of performance may result in increased job costs for additional hardware or higher-grade devices than the client requires.

Graphic Display and Refresh: These factors impact how rapidly the system operator sees data on the screen. These rates also may impact the selection of PC hardware and network loading.

Object Command: This measures how long it takes for a commanded output to react to an operator-entered change.

Object Scan: Systems that implement a master/slave architecture typically scan the controllers periodically and store this information at the building controller level. This means that the operator may be looking at data that is only as current as the last time the controller was scanned. “Object scan” is the time it takes for any building controller to register and react to a change of state or value of any point, variable, or alarm on the system. It is a function of the communication network’s throughput and may be critical for reactions where a controller may be monitoring conditions caused by systems that are controlled by another controller.

Alarm Response Time: This is how long it takes for the operator to see an alarm. On a network-based system with a PC workstation on site, this time is typically less than 1 minute. When the PC workstation is remotely located and alarms are dialed out by modem, this time might be 1-3 minutes.

Program Execution Frequency: Many HVAC applications, such as time-of-day scheduling and demand limiting, do not need to run more often than once a minute. A system with sophisticated custom control, however, may need to run once every 5 seconds. Shorter frequencies will use additional system resources and may result in increased costs.

DDC Loop Frequency: DDC loops for most HVAC processes do not need to run more often than once every 30 seconds. If a project has a critical process, such as system static pressure control, then a shorter frequency (1-5 seconds) may be required.

Multiple Alarm Annunciation: This determines how quickly alarms are distributed. On a dial-up system, this number should be in the range of 1-5 minutes.

Reporting Accuracy: Reporting accuracy per application is listed for end-to-end performance. These include the effects of device accuracy, A/D (analog to digital) conversion in the controller, and any loss in data transmission. The values shown in Table 1 of the system performance excerpt below are shown for typical HVAC applications. Industrial and process applications may require higher accuracy. For example, the typical accuracy listed for a relative humidity sensor is ±5% in a comfort cooling and monitoring application. This can be met with a standard commercial grade device. However, a printing plant application may require humidity control of ±1%. Specifying this greater accuracy will result in the selection of an industrial grade device that may cost five to ten times more than the commercial sensor used for space monitoring.

Control Stability and Accuracy: The stability and accuracy of the controlled variable (e.g., temperature, pressure, humidity) is a function of the programming and tuning of the control loops of the working system. The stability is also dependent on properly sized and installed mechanical components.

Project Considerations: All of the performance values (e.g., times and accuracy) should be reviewed and possibly edited for a given project. In particular, the performance values may not be achievable by the product lines that are listed in Part 1, "Approved Control System Subcontractors and Manufacturers," or the products in Part 2. Even if they are achievable, the system required may be more expensive than a typical DDC system or that covered by the project budget.

1.9 SYSTEM PERFORMANCE

A. Performance Standards. ~~The s~~System shall conform to the following minimum standards over network connections:

1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 seconds.~~The system shall display a graphic with 20 dynamic points with all current data within 10 seconds.~~
2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 seconds. ~~The system shall update a graphic with 20 dynamic points with all current data within 8 seconds.~~
3. Object Command. Devices shall react to command of a binary object within 2 seconds. Devices shall begin reacting to command of an analog object within 2 seconds. ~~The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.~~
4. Object Scan. Data used or displayed at a controller or workstation ~~will~~shall have been current within the previous 6 seconds.
5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 seconds. ~~The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.~~
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. ~~The Contractor shall be responsible for s~~Selecting execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a ~~selectable~~ frequency adjustable down to~~of at least~~ once per second. ~~The controller shall scan and update the process value and output generated by this calculation at this same frequency.~~ Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. ~~All~~ Each workstations on the network ~~must~~ shall receive alarms within 5 seconds of ~~each~~ other workstations.
9. Reporting Accuracy. ~~The s~~System shall report ~~all~~ values with ~~an~~ the minimum end-to-end accuracy ~~as~~ listed ~~or better than those listed~~ in Table 1.
10. ~~Stability of~~ Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within ~~the~~ tolerances listed in Table 2.

7.10 Submittals

In general, submittals provide the specifier an opportunity to review the work of the contractor before construction begins or any control components are installed. Submittals also include the requirements of the contract closeout documentation. A submittal may be viewed as any documentation required from the contractor.

TABLE 1 Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5ºC (±1ºF)
Ducted Air	±0.5ºC (±1ºF)
Outside Air	±1.0ºC (±2ºF)
Dew Point	±1.5ºC (±3ºF)
Water Temperature	±0.5ºC (±1ºF)
Delta-T	±0.15º (±0.25ºF)
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Airflow (terminal)	±10% of full scale (*see Note 1*)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (*see Note 2*)
Electrical (A, V, W, Power Factor)	5% of reading (*see Note 3*)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO_2)	±50 ppm

Note 1: Accuracy applies to 10%–100% of scale
Note 2: For both absolute and differential pressure
Note 3: Not including utility-supplied meters

TABLE 2 Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) –25 to 25 Pa (–0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0ºC (±2.0ºF)	
Duct Temperature	±1.5ºC (±3ºF)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	0-1 MPa (1-150 psi) 0-12.5 kPa (0-50 in. w.g.) differential

The submittal process should be familiar to anyone involved with construction. It is a standard requirement of most projects, with the example specification providing a typical description of those requirements.

Completion of a DDC system submittal requires detailed interface information for the HVAC equipment to be controlled. Therefore, a controls subcontractor needs copies of the appropriate equipment submittals to determine equipment connections, choose appropriate controllers, and provide accurate programming. In a sense, the specifier becomes the information transfer hub between equipment manufacturers, suppliers, and subcontractors. The specifier should make sure that submittals are processed in a timely manner so that copies can be made and distributed to those needing this information for their own submittals and designs.

Project Considerations: Different types of submittal packages can be requested. The example specification represents the typical submittal for a DDC system. It is a package of information that completely describes the components and system to be provided. The submitting contractor should not start any installation work until the specifier grants approval. For large, fast-track, or design-build projects, the total submittal package can be broken down into partial (or early) submittals to accommodate the lead times that suppliers need to order material and gather the correct manpower. For projects where alternative approaches are available, pre-submittals provide a method for allowing the specifier to formally choose an alternative. More discussion of these two types of submittals is as follows:

- *Partial submittals*—These contractor-initiated submittals usually include items of long delivery lead time or items that are installed first in the project sequence. Valves, dampers, and rough-in material fall into this category. Once approval is granted on these items, that part of the submittal is complete.
- *Pre-submittals*—Information given in a pre-submittal is meant for complete approval. A submittal package of the complete system at a later date will again include this information for overall system approval. This allows the specifier to consider different approaches and give initial approval to an alternative approach but not approve the overall concept until the whole system is reviewed. This can be used to qualify systems (or system-level components) with which the specifier is not familiar, and it should occur early in the procurement process.

DDC systems that use color graphics to mix data with system schematics, color photos, floor plans, etc., may benefit from an additional component to the submittal: storyboards of the proposed color graphics. These provide conceptual sketches of each screen plan to be generated. They also commit the supplier to a certain number and quality of graphics to be generated. Each sketch should include the following:

- *Conceptual screen layout of data and pictures*. Blocks with a text descriptor (e.g., AHU-1 diagram) may be used to represent the picture. Blocks with a text descriptor (e.g., AHU-1 control points) also may be used for text area locators.
- *How one screen relates to another*. Indications should be given on how specific screens can be accessed from other screens. This gives the specifier a sense of how a system operator will use the graphics for additional information.

Subparagraphs A.1 and A.2 of the example specification below concern the submittal of manufacturers' information and product data for the DDC system's central and field hardware. Subparagraph A.3 requests the contractor to submit information to confirm that the controlled systems will perform in accordance with the requirements of the contract documents. This information must be submitted in time for adequate review and comment by the specifier. Take care to set a reasonable time for this review to take place. In the example below, the time allowed for submittal is 12 weeks after contract award. For smaller or fast-track projects, this time may be much shorter. Please edit for the requirements of the specific project.

The articles under Paragraph B and C involve project closeout materials. Once again, submittal of these items is central to the benchmark of project final completion, and final payment should be contingent upon their satisfactory delivery.

Other items for editing based on a specific project include:

- The Division 1 section governing submittals, the quantity of submittal copies requested, and the times allowed for ubmittal due dates.
- The type of specific electronic media (e.g., magnetic/optical) desired for copies of drawing files and software.
- Which release of AutoCAD should be used for shop drawings.
- Part 3 may not involve a system demonstration, so the submittal required for this process should be deleted.
- The system demonstration process described in Part 3 may be more extensive than that described in the example pecification. Therefore, the submittals discussed in the example may need to be modified to correspond.
- Delete the pressure test certification for projects that do not include pneumatics.

1.10 SUBMITTALS

A. Product Submittal ~~Data and Shop Drawings~~Requirements.~~:~~ Meet requirements of Section 01xxx on Shop Drawings, Product Data, and Samples. ~~In addition, Contractor shall p~~Provide six copies of shop drawings ~~or~~ and other submittals on ~~all~~ hardware, software, and equipment to be install~~ation~~ed ~~to be provided~~ or furnished. Begin ~~N~~no work ~~may begin on any segment of this project~~ until submittals have been ~~have been successfully reviewed~~ approved for conformity with ~~the~~ design intent. ~~Six copies are required.~~ All drawings shall be prepared on a CAD system that produces drawing files compatible with AutoCAD Release 12 or higher and be provided on magnetic/optical disk and as full-size mylar drawings. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate ~~the~~ applicable data ~~specifically applicable to the project shall be~~y highlight~~ed~~ing or ~~clearly indicated~~ by other means. ~~Each submitted piece of literature and drawings shall~~ C~~c~~learly reference ~~the~~ covered specification and~~/or~~ drawing on each submittal~~that the submittal is to cover~~. General catalogs shall not be accepted as cut-sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Provide ~~S~~submittals ~~shall be provided~~ within 12 weeks of contract award on the following:~~. Submittals shall include:~~

1. Direct Digital Control System Hardware~~:~~
   a. ~~A c~~Complete bill of materials ~~of equipment to be used~~ indicating quantity, manufacturer, model number, and ~~other~~ relevant technical data of equipment to be used.
   b. Manufacturer's description and technical data~~,~~ such as performance curves, product specification sheets, and installation and ~~/~~ maintenance instructions for ~~the~~ items listed below and for ~~other~~ relevant items not listed below:
      1. Direct d~~D~~igital c~~C~~ontrollers (controller panels)
      2. Transducers and ~~/T~~transmitters
      3. Sensors (including accuracy data)
      4. Actuators
      5. Valves
      6. Relays~~/~~ and ~~S~~switches
      7. Control ~~P~~panels
      8. Power s~~S~~uppl~~y~~ies
      9. Batteries
      10. Operator ~~I~~interface ~~E~~equipment
      11. Wiring
   c. Wiring diagrams and layouts for each control panel. S~~. S~~how ~~all~~ termination numbers.
   d. ~~Schematic diagrams for all field sensors and controllers. Provide f~~Floor plan schematic diagrams indicating ~~of all~~ field sensor ~~locations~~ and controller ~~hardware~~ locations.
2. Central System Hardware and Software~~:~~
   a. ~~A c~~Complete bill of material ~~of equipment used,~~ indicating quantity, manufacturer, model number, and ~~other~~ relevant technical data of equipment used.
   b. Manufacturer's description and technical data, such as product specifications ~~sheets~~ and installation and ~~/~~maintenance instructions for ~~the~~ items listed below and for ~~other~~ relevant items furnished under this contract not listed below:
      1. Central Processing Unit (CPU)
      2. Monitors
      3. Keyboards
      4~~5~~. Power s~~S~~upply
      5~~6~~. Battery ~~B~~backup
      6~~7~~. Interface e~~E~~quipment b~~B~~etween CPU and c~~C~~ontrol p~~P~~anels
      7~~8~~. Operating System s~~S~~oftware
      8~~9~~. Operator ~~I~~interface s~~S~~oftware
      9~~10~~. Color ~~Graphic~~ graphic s~~S~~oftware
      10~~1~~. Third-p~~P~~arty s~~S~~oftware
   c. Schematic diagrams ~~for~~of ~~all~~ control, communication, and power wiring~~. Provide a schematic drawing of the~~ for central system installation. Label ~~all~~ cables and ports with computer manufacturers' model numbers and functions. Show ~~all~~ interface wiring to ~~the~~ control system.
   ~~d. Riser diagrams of wiring between central control unit and all control panels.~~
   d~~e~~. ~~A l~~List of ~~the~~ color graphics ~~screens~~ to be provided. ~~For each screen, p~~Provide ~~a~~ conceptual layout of pictures and data for each graphic, ~~and~~ showing or explaining which other ~~screens~~ graphics can be directly accessed.
3. Controlled Systems~~:~~
   a. ~~A s~~Schematic diagram of each controlled system. ~~The schematics shall have all~~Label control points ~~labeled~~ with point names ~~shown or listed. The schematics shall g~~Graphically show ~~the~~ locations of ~~all~~ control elements ~~in the system~~.
   b. ~~A s~~Schematic wiring diagram ~~for~~ of each controlled system. ~~Each schematic shall have all elements labeled~~Label control elements and terminals. Where a control element is ~~the same as that~~ also shown on ~~the~~ control system schematic, use ~~it shall be labeled with~~ the same name. ~~All terminals shall be labeled.~~
   c. ~~An i~~Instrumentation list for each controlled system. List ~~E~~each control system element ~~of the controlled system shall be listed~~ in a table ~~format~~. ~~The table shall s~~Show element name, type of device, manufacturer, model number, and product data sheet number.
   d. ~~A m~~Mounting, wiring, and routing plan-view drawing ~~. The drawing shall be done~~ in ¼ in. scale. ~~The design shall t~~Take into account HVAC, electrical, and other systems' design and elevation requirements. ~~The drawing shall s~~Show ~~the specific~~ locations of ~~all~~ concrete pads and bases and ~~any~~ special wall bracing for panels to accommodate this work.
   e. ~~A c~~Complete description of ~~the~~ control system operation ~~of the control system,~~ including sequences of operation. ~~The description shall i~~Include and reference ~~a~~ schematic diagram of ~~the~~ controlled system.
   f. ~~A p~~Point list for each system controller including ~~both~~ inputs and outputs (I/O), point numbers, ~~the~~ controlled device associated with ~~the~~ each I/O point, and ~~the~~ loca-

tion of ~~the~~ I/O device. Indicate alarmed ~~Software flag points,~~ and trended ~~alarm~~ points~~, etc~~.

~~4. Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.~~

~~5~~4. ~~A d~~Description of ~~the proposed~~ process, ~~along with all~~ report formats, and checklists to be used in Part 3: "Control System Demonstration and Acceptance."

~~6~~5. ~~A~~ BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface ~~included in the submittal~~.

B. Schedules~~:~~

1. ~~Within one month of contract award, provide a s~~Schedule of ~~the~~ work provided within one month of contract award indicating ~~the following~~:
   - a. Intended sequence of work items~~.~~
   - b. Start dates of ~~individual~~ each work items~~.~~
   - c. Duration of ~~individual~~ each work items~~.~~
   - d. Planned delivery dates for ~~major~~ ordered material and equipment and expected lead times~~.~~
   - e. Milestones indicating possible restraints on work by other trades or situations~~.~~
2. ~~Provide m~~Monthly written status reports indicating work completed and~~,~~ revisions to expected delivery dates~~, etc. An~~. Include updated ~~project~~ schedule of work. ~~shall be included.~~

C. Project Record Documents~~:~~ ~~Upon completion of installation, s~~Submit three copies of record (as-built) documents upon completion of installation ~~. The documents shall be submitted~~ for approval prior to final completion. Submittal shall consist of: ~~and shall include:~~

1. Project Record Drawings. These shall be as-built versions of the submittal shop drawings. One set of magnetic media including CAD, .DWG, or .DXF drawing files also shall be provided.
2. Testing and Commissioning Reports and Checklists. Completed versions of ~~all~~ reports, ~~and~~ checklists, and ~~along with all~~ trend logs~~,~~ used to meet ~~the~~ requirements of Part 3: "Control System Demonstration and Acceptance."
3. Certification of ~~the~~ pressure test required in Part 3: "Control Air Tubing."
4. Operation and Maintenance (O & M) Manual. ~~-~~
   - ~~a. This shall include a~~As-built versions of ~~the~~ submittal product data. ~~In addition to the information required for submittals, the O & M manual shall include:~~
   - b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for ~~installing~~ equipment and ~~the~~ control systems ~~and service representatives of each~~.
   - c. Operator's ~~M~~manual with procedures for operating ~~the~~ control systems: ~~, including~~ logging on~~/~~ and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and ~~other~~ variables.
   - d. ~~One set of~~ Programming ~~Manual~~manual or set of manuals with ~~a~~ description of ~~the~~ programming language and ~~(including~~ syntax~~)~~, of statements ~~descriptions~~ for ~~(including~~ algorithms and calculations used~~)~~, of point database creation and modification, of program creation and modification, and of editor use ~~of the editor~~.
   - e. Engineering, ~~I~~installation, and ~~M~~maintenance ~~M~~manual or set of manuals~~(s)~~ that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration ~~procedures~~; how to debug hardware problems; and how to repair or replace hardware.
   - f. ~~A listing and d~~Documentation of all ~~custom software~~ programs created using ~~the~~ custom programming language~~,~~ including ~~the~~ setpoints, tuning parameters, and object database. ~~One set of magnetic/optical media containing files of the software and database also shall be provided.~~
   - g. Graphic files, programs, and database on ~~One set of~~ magnetic or~~/~~ optical media. ~~containing files of all color graphic screens created for the project.~~
   - h. ~~A l~~List of recommended spare parts with part numbers and suppliers.
   - i. Complete ~~original~~ original-issue documentation, installation, and maintenance information for furnished ~~all~~ third-party hardware ~~provided,~~ including computer equipment and sensors.
   - j. Complete ~~original~~ original-issue ~~diskettes~~ copies of ~~for all~~ furnished software ~~provided~~, including operating systems, custom programming language, operator workstation software, and graphics software.
   - k. Licenses, guarantees, and warranty documents for ~~all~~ equipment and systems.
   - l. Recommended preventive maintenance procedures for ~~all~~ system components, including ~~a~~ schedule of tasks such as inspection, cleaning, and calibration~~, etc.),~~; time between tasks;~~,~~ and task descriptions.

D. Training Ma~~nuals:~~terials. ~~The contractor shall p~~Provide ~~a~~ course outline and ~~training~~ manuals for ~~all~~ each ~~training~~ classes at least six weeks before ~~prior to the~~ first class. ~~The e~~Engineer ~~may~~ will modify ~~any or all of the training~~ course outlines and ~~training~~ ma~~terials~~nuals if necessary to meet Owner's ~~the~~ needs ~~of the owner~~. Engineer will ~~R~~review and approve course outlines and manuals ~~al by the engineer shall be completed~~ at least three weeks before ~~prior to the~~ first class.

7.11 Warranty

The warranty is usually a written guarantee of the integrity of a product and/or service and the good faith of the manufacturer and/or installer given to the purchaser. It generally specifies that the manufacturer and/or installer will, for a period of time, be responsible for the repair or replacement of defective parts—and will sometimes also provide periodic servicing.

When preparing the warranty section for your project, the following should be included and/or referenced in describing the terms and conditions.

7.11.1 The General Conditions of the Specification

The general conditions define the warranty terms and conditions for the entire project and should be referenced in any warranty conditions listed in the controls specification.

7.11.2 The Guarantee

A guarantee that the temperature control system will be "free from defects in workmanship and material."

7.11.3 Warranty Period

The warranty period will vary with the type of project and the owner's requirements. A typical warranty period is one year after system acceptance, although some owners may desire up to five years. After the first year of acceptance, each additional year may increase the cost of the project. It is generally observed that malfunctions and problems in electronic equipment occur in the first year after installation. Thus, the economic value of extending the warranty may not be justified. However, an owner may have other financial considerations that justify an extended warranty.

7.11.4 Commencement of the Warranty

The DDC system warranty begins upon acceptance of the system. The system can be accepted through one of three common methods:

- The owner uses the system before the completion of the project, thereby receiving beneficial use from the system. This can constitute acceptance.
- The system can be accepted after the completion of each phase of a multi-phase project.
- Acceptance occurs after an agreed-upon completion of a demonstration or acceptance test of the system. An "acceptance test" could include an endurance test, commissioning, and/or some other means of testing the performance of the system.

After any of the above methods of acceptance, written documentation is initiated by the manufacturer and/or installer, placing the system and its components into warranty. The document should stipulate the start date and duration of the warranty period, as well as any additional services and/or support provided to the purchaser that may exceed the terms and conditions of the project. The warranty document may include warranty registration cards covering various pieces of hardware (to be completed and returned to the manufacturer and/or installer) and any software licensing agreements required by the manufacturer and/or installer. In addition, the warranty may include a recommended spare parts list for the owner.

7.11.5 Notification of Failure and/or Defects

The owner should contact the (prime) contractor during the contract warranty period. If the control system warranty exceeds the contract's warranty, calls made after the contract's warranty expires should be made to the extended warranty provider.

7.11.6 Response Time to Correct Failures and/or Defects

Response time to a warranty call shall indicate the time required to reach the job site following a call from the owner to the contractor. A typical response time to a job site is 24 hours during normal business hours, with exceptions being one hour, twenty-four hours a day, seven days a week, for critically operated facilities. Different response times could be established for business hours, after hours, weekends, holidays, etc. To avoid any confusion, establish one acceptable response time within a specific time frame.

7.11.7 Cost

To avoid additional cost to the owner, state that a warranty response and the repair or replacement of a defective or failed component should be made at no charge to the owner.

7.11.8 Software/Firmware Updates

To ensure that the owner will have the most current operating system provided by the manufacturer, it should be stated in the specification that the manufacturer/installer shall provide and install, at no charge to the owner, the latest firmware and software applicable for this project before the expiration of the warranty period. Including this statement may increase the cost of a project.

7.11.9 Periodic Preventive Maintenance Service

Depending upon the owner's needs and requirements for the project, regular preventive maintenance of the system may be necessary during the warranty period to ensure the proper operation of the system. If regular maintenance is required, it should be stated in the specification that during the warranty period, the contractor shall provide normal maintenance service as recommended by the manufacturer. Maintenance shall include, but not be limited to, control components/instruments, accessories, hardware, and software. The addition of preventive maintenance will increase the cost of a project.

1.11 WARRANTY

A. Warrant ~~all~~ work as follows:

1. Warrant ~~L~~labor and materials for ~~the~~ specified control system ~~specified shall be warranted~~ free from defects for a period of 12 months after final ~~completion and~~ acceptance. Control system failures during ~~the~~ warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to ~~the o~~Owner. ~~The contractor shall r~~Respond during normal business hours within 24 hours ~~to~~of ~~the o~~Owner's warranty service request. ~~for warranty service within 24 hours during normal business hours.~~
2. ~~All w~~Work shall have a single warranty date, even ~~when the~~ if ~~o~~Owner ~~has~~ receive~~d~~s beneficial use due to ~~an~~ early system start-up. If ~~the~~

specified work ~~specified~~ is split into multiple contracts or a multi-phase contract, ~~then~~ each contract or phase shall have a separate warranty start date and period.

3. If Engineer determines that equipment and systems operate satisfactorily ~~A~~at the end of ~~the~~ final start-up, testing, and commissioning phase, ~~if equipment and systems are operating satisfactorily to the engineer, the e~~Engineer will ~~shall sign certificates~~ certify in writing that ~~the~~ control system~~'s~~ operation has been tested and accepted in accordance with the terms of this specification. ~~The d~~Date of acceptance shall begin ~~the start of~~ warranty period.
4. Provide updates to ~~Operator~~ operator workstation software, project-specific software, graphic software, database software, and firmware ~~updates~~ that resolve Contractor-~~known~~ identified software deficiencies ~~as identified by the contractor shall be provided~~ at no charge during ~~the~~ warranty period. If available, Owner can purchase in-warranty service agreement to receive ~~Any~~ upgrades for functional enhancements associated with ~~the~~ above-mentioned items ~~also can be provided during the warranty period for an additional charge to the owner by purchasing an in-warranty service agreement from the contractor~~. Do not install updates or upgrades without Owner's ~~W~~written authorization ~~by the owner must, however, be granted prior to the installation of any of the above-mentioned items.~~
5. Exception: ~~The c~~Contractor shall not be required to warrant reused devices~~,~~ except ~~for~~ those that have been rebuilt ~~and~~/or repaired. ~~The contractor shall warrant all i~~Installation labor and materials shall be warranted.~~,~~ ~~however, and shall demonstrate~~ Demonstrate operable condition of ~~that all~~ reused devices ~~are in operable condition~~ at ~~the~~ time of E~~e~~ngineer's acceptance.

7.12 Ownership of Proprietary Material

The purpose of this paragraph is to cover ownership of the items developed for or supplied as part of a DDC project that go beyond the DDC hardware, including software and documentation. Unless there is a clear requirement to the contrary, a contractor may retain ownership of some of these items. Without full ownership, the owner may experience unexpected costs when future modifications to the system are undertaken. Therefore, it is important to explicitly state that all materials developed specifically for this project become the property of the owner upon completion of the project. The owner should also be consulted regarding his/her desire to retain any or all tools required for system maintenance or modification.

It is neither reasonable nor important for the owner to obtain ownership of all software, such as the source code for the operating systems and standard control software. These items will rarely be useful to anyone other than the manufacturer and therefore may be of little value to the owner. On the other hand, this source code is proprietary material, of significant commercial value to the manufacturer and may be the source of a competitive advantage in the market. However, it *is* important for the owner to be provided with the source code of all application programming created specifically for this project (e.g., custom control or energy management sequences), a requirement covered in the following specification by the item "Project-specific application programming code."

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

A. ~~All p~~Project-~~developed~~ specific software and documentation shall become ~~the~~ Owner's property ~~of the owner~~. ~~These~~is include~~s~~, but ~~are~~ is not limited to:
1. ~~Project g~~Graphics ~~images~~
2. Record drawings
3. ~~Project d~~Database
4. ~~Project-specific a~~Application programming code
5. ~~All d~~Documentation

Revise Section 8 as shown below and on the following pages.

8. SPECIFICATION PART 2: PRODUCTS

This clause of the guideline provides description and explanation of specific articles that would appear in the products part of a DDC system specification. The guideline discusses the rationale for including (or excluding) particular specification wording, notes to the designer, other approaches, related costs/benefits, and project considerations. Example specification language follows the guideline text.

The products part includes specification of the materials that are to be provided under the requirements of this section.

Project Considerations: The specifier should take care to include only products that will be used in his/her project. Do not include products that will not be part of the project.

2.0 SECTION INCLUDES

.1 Materials
.2 Communication
.3 Operator Interface
.4 Controller Software
.5 Building Controllers
.6 Custom Application Controllers
.7 Application Specific Controllers
.8 Input and~~/~~ Output Interface
.9 Power Supplies and Line Filtering
.10 Auxiliary Control Devices
.11 Wiring and Raceways
.12 Fiber Optic Cable System
.13 Compressed Air Supply—Pneumatic

8.1 Materials

In general, it is important to specify that the products and materials that are provided should be new, part of the manufacturer's current product line, and that they will be supported for at least five years.

Project Considerations: The requirement for the use of new materials and equipment in this article should be reviewed and coordinated with the requirements of Part 3, especially the article on Existing Equipment" that is reused in retrofit or renovation projects. This example also requires that the systems installed use technology that has been in use for at least two years. The technology used in this industry changes rapidly, so it may be worthwhile to consider reducing this time period. The specifier should strive to review the technology offerings available before the specification is out for bid to avoid the embarrassment of specifying systems or equipment that may no longer be available.

2.1 MATERIALS

A. All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. Do not use ~~This~~ this installation ~~shall not be used~~ as a product test site ~~for any new products~~ unless explicitly approved in writing by ~~the~~ Owner or ~~o~~Owner's representative ~~in writing~~. Spare parts shall be available for at least five years after completion of this contract.

8.2 Communication

8.2.1 Network Arrangement

The arrangement of the controllers and how they are linked together in a network is called system "architecture" or network "topology." Selection of the physical media (wires) and data link layers (called communication "buses") is very much an individual choice at each installation.

There are generally three types of communication buses related to building control systems:

a. Communication between workstations.

b. Communication between controllers (and the workstation-to-controller communication).

c. Communication between secondary level controllers (such as terminal unit controllers or interfaces to third-party equipment such as switchgears, packaged HVAC equipment, etc.) that provide communication to the workstation, routed through a primary controller (or other interface).

Note that while the different functions of these three buses reside within all DDC systems, some systems accomplish these functions with two or even one bus.

Many DDC systems use commercially available local area network (LAN) technologies (e.g., Ethernet) for system communication. These LAN technologies are also popular for use in office or factory automation communication, sometimes referred to as an "intranet." Therefore, the designer is confronted with the choice of installing a dedicated LAN for the DDC system or sharing the LAN with other systems. Unfortunately, a definitive analysis of whether a shared LAN will have sufficient capacity for all systems is not an easy task. It requires an intimate knowledge of how each one of the systems uses the LAN, both *in general* and for the *specific* installation involved. Therefore, a final decision is best made through consultation with the manufacturers of the DDC equipment and the other equipment involved. Given that this type of consultation is not always possible, the safest choice for a DDC system is to use a dedicated LAN.

8.2.2 Workstation Communication

This type of communication is high speed and data rich. While communication between workstations may not be frequent, it usually involves large blocks of data, particularly file exchanges, that must occur at high speed. This bus also may be part of the facility-wide intranet, where other office or factory automation traffic occurs. The communication between controllers and workstations also can occur on this bus—alarm reporting and acknowledgement, graphic display updates, and so on. Once again, consultation with the owner and information system managers is critical if this communication is to occur on a shared intranet.

8.2.3 Controller Communication

This bus can have the greatest effect on overall system throughput. All global objects will communicate over this bus, as well as alarms. Additionally, operator-entered commands and requests for information are transmitted over this bus. This bus must be responsive enough to guarantee timely alarm reporting while still processing regular activities such as reports and global objects. Response time in seconds is still the best measure.

8.2.4 Secondary Bus Communication

Speed for this bus must be evaluated on an application basis. The most common use for this bus is for terminal unit controllers. As space temperature has a large capacity and does not change rapidly, bus response can be relatively slow in many cases. It typically does not create large errors if the reported information is 30 or even 60 seconds old.

A building operator can work with these delays without frustration; however, some method must be provided whereby commands can be issued to (and information retrieved from) a specific controller without having to wait for the entire polling cycle. Otherwise, delays of several seconds will be extremely frustrating.

In other cases, such as when the bus is used to monitor switchgear or packaged computer room control systems, fast throughput is necessary for alarm reporting.

8.2.5 System Architecture

The system architecture, topology, or arrangement of devices on the networks that makes up a building automation system is a function of many decisions made by the engineer, system supplier, and owner. No one topology is universally the best for all system applications.

When specifying a system, it may be necessary to determine the network architecture required to ensure that the products of several vendors on a project will be able to interoperate. This may require the use of some more definitive prescriptive language. The extent to which a specification can be perfor-

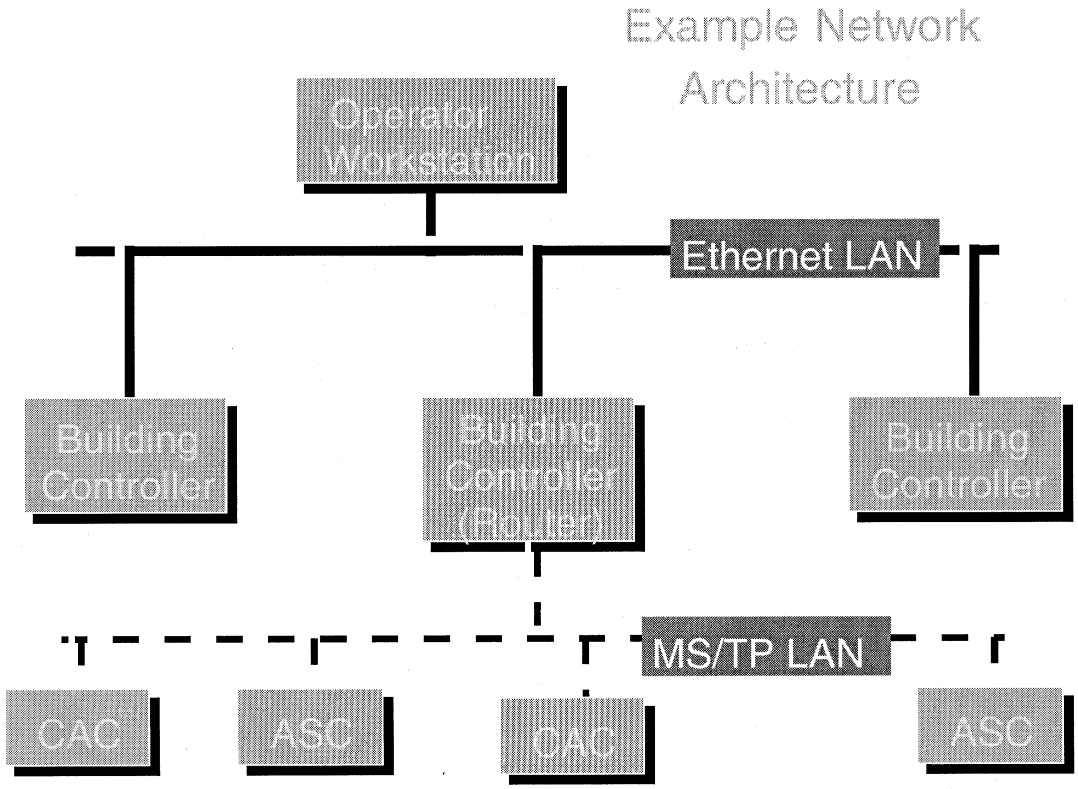

Figure 6 System architecture.

mance-based or prescriptive depends on the nature of the project. Examples of this include:

1. *New installation, entire system provided by one vendor*: A pure performance-based specification should be used. This will allow the most economical solution to be applied. Future additions to the project will follow the same network communications options as provided in the first phase.
2. *New installation, system provide by various suppliers*: For example, this might be a system where the HVAC controls are bid and provided under section 15950, but the chillers that communicate with the system are bid in another section, and the fire alarm that also communicates with the system is bid in a third section. Make the specification prescriptive in describing the networking architecture in each of these sections.
3. *Expansion of an existing installation*: Make the specification highly prescriptive because the new equipment must connect to the existing systems.

The example specification illustrates a system where various suppliers may provide various systems. It uses a two-tiered topology, where the operator workstations and building controllers operate as peers on a BACnet Ethernet LAN. Application specific controllers (shown as "ASC" in Figure 6) and custom application controllers (CAC) operate as peers on a number of subnetworks that each use a BACnet MS/TP LAN. The building controllers act as routers to connect the MS/TP subnetworks to the higher speed Ethernet LAN, forming a BACnet internetwork.

It is easy to imagine many variations of this example. Each installation invariably will have unique characteristics about its network arrangement. The contract documents must clearly indicate this topology so that the proposals submitted will be evaluated fairly against each other. It is also especially important to have defined the topology and character of the network if control devices specified elsewhere, such as boiler controls and packaged chiller controllers, are to be linked to the network. If the choice of LAN types is left to the supplier of the DDC system, then coordinating the connection of control devices specified elsewhere becomes problematic.

The example specification also cites the use of peer-to-peer communication, where each device on a segment of the network has the ability to communicate with any of its peers on an as-needed, as-required basis. This is in contrast to a poll-and-response communication, in which devices on the network segment cannot communicate unless polled by a "master" device.

8.2.6 Communication Performance

DDC system communication is tied most directly to the "Communication" article of the example specification but also deals with other areas of the specification, most notably the "System Performance" article.

8.2.7 Communication Protocols

8.2.7.1 Interoperability

It is important to note that the goal of interoperability between different manufacturers' control system components is the reliable and timely function of reading and writing data between the devices. This functionality is required at all the levels of the network where different manufacturers' devices must interoperate.

Other functions, such as the exchange and manipulation of alarms, schedules, and trends, also may need to occur in the multi-vendor environment. Invariably, however, this communication happens at the operator workstation and building controller levels.

There is a broad range of functions for use in DDC systems. In an interoperable system, several of these functions may be required.

8.2.7.1.1 Data Exchange

The exchange of data between two devices (e.g., PC workstations, building controllers, custom application controllers, or application specific controllers) is the most basic of interoperable functions. This function allows for both the viewing (or reading) of data as well as making changes (or writing) to these data. This can be accomplished by a number of methods. The most basic of these is a pair of services called "Read Property" and "Write Property." In some open protocols, data are modeled as "objects." Each of these objects has a series of "properties" defined. For example:

An ABC protocol-compatible building controller has a temperature sensor that measures the outdoor air temperature. This is modeled as an ABC protocol analog input object. This object, as defined in the ABC protocol, has several standard properties including "Name" and "Present Value." To view the outdoor air temperature, one could use an ABC protocol-compatible PC workstation and ask for (read) the present value of the analog input named "Outdoor Air Temperature."

In the same manner, one can change set points (write) to the present value property of analog and binary output objects. These basic functions can be used to share set points between controllers, provide graphics data on a PC workstation, command the lights to come on, or sample data in a trend.

In fact, entire interoperable systems can be built just by using these basic functions. Similar functions are also provided by many interoperable protocols including BACnet, LonMark, and ModBus.

8.2.7.1.2 Advanced Interoperable Functions

While the data exchange function is able to achieve a wide variety of functions, there are more efficient ways to accomplish a number of system functions. These are required for large installations and for use in remote operations of multiple buildings.

(1) Alarms and Events

This function allows for the exchange of alarm information in an interoperable system. A controller that has determined that an alarm has occurred is able to send an alarm message to a predetermined location. For example:

A building controller is connected to a network of application specific controllers. On one of these controllers, the space temperature becomes too high. In the building controller, a program periodically compares the space temperature to a user-entered alarm limit. When the temperature exceeds that limit, the building controller generates an alarm and sends it to the PC workstation. At that workstation, an operator reads the alarm and acknowledges it.

The protocol defines how the alarms are generated, how they are sent, and what they should contain. This function is typically done between a building controller and a PC workstation but could also occur in other controllers on the intranet. This function also might be used to trigger a control action or record an operator override.

(2) Schedules

This set of functions allows for the editing and creation of schedules on a PC workstation that will be executed in a controller. For example:

The operator wants to change the fan's stop time in the auditorium from 6:00 p.m. to 9:00 p.m. Using the scheduling function, the operator is able to load the schedule from the controller, select the stop time, and change that parameter.

This function will typically occur between a PC workstation and a building controller but also could occur on other controllers on the intranetwork.

(3) Trends

The ability to sample, store, and read trends is a valuable function. Trending is a valuable tool for collecting data on system performance and energy usage. While trends are typically stored on a PC workstation, there are a number of reasons to initially store them in a controller. This will minimize network traffic and also will allow for sampling of data if a PC is not continually connected to the controller.

(4) Network Management

The final interoperable function is the ability to manage the devices on the network. This includes tasks such as monitoring for a loss of communication and coordinating the time settings on the clocks in each controller.

8.2.7.2 Network Communications

While the example specification uses the BACnet standard to help define communication within the DDC network, the use of a communication protocol is a choice made by the specifier. The specifier may find it most advantageous—either because of cost constraints, standard purchasing agreements, or other circumstances—to specify that the network communication can be conducted on a proprietary network. Or if there is no need for devices specified elsewhere to communicate on this network, it may be reasonable to leave the network type and media type completely to the discretion of the contractor.

A number of other open protocols exist in the marketplace. If the specifier wishes to use one of these protocols, it is strongly recommended that the specifier make extensive use of the resources available from the promoters of that protocol in the writing of their project-specific application. The ASHRAE BACnet protocol has been used as the basis for the example specification.

The BACnet standard allows the selection of several different LAN types:

- Ethernet, a high-speed, high-performance network
- ARCNET, a moderately high-speed network
- BACnet MS/TP, an RS-485 LAN, a modest-performance network
- LonTalk, with special BACnet constraints
- PTP (a point-to-point, dial-up style connection), fairly low-speed and meant for very modest amounts of data exchange typically using dial-up remote communications

Any or all of these LAN types can exist in a BACnet-compliant internetwork, but routers are required to connect the different types of LAN segments. As mentioned above and as cited in the example specification, it is critical to specify which type of network is supported at each device in the network, including those devices mentioned elsewhere in the specification.

Project Considerations: Specifying an interoperable system can be a challenge. While there are many very good options available, such as BACnet, LonTalk, and ModBus, none is what would be considered a "plug and play" solution. In order to properly specify and apply an interoperable system, a good deal of knowledge of the protocol and network architecture is required. For example, all interoperable protocols do a good job defining how to share information (data) between systems. However, it is often not as clear how to share common alarm messages, schedules, or trends.

A specifier should be aware that an interoperable system should allow the user to do a series of daily functions. However, these tasks may be more easily accomplished in a single-vendor system then in an interoperable one. Performing more advanced functions, such as configuring a controller or a network, may require several proprietary tools and specialized training.

To find more information on how to specify a particular protocol, the specifier should contact the sponsoring organization for that protocol. They will typically have detailed information on how to apply their protocol. For BACnet information, check *www.ashrae.org* or *www.bacnet.org*. For LonMark, check *www.lonmark.org*.

8.2.8 Integrating a Proprietary System with an Open Protocol System

8.2.8.1 Method

The integration of open and proprietary systems might include the following scenario:

An existing building or campus that uses a single-vendor DDC energy management system, with a proprietary communication protocol, is to be expanded so that the new control system uses an open protocol.

In practice, if the existing system uses a protocol that is not open, it may not be possible to be fully interoperable without physically changing the electronics that perform the communication in the existing devices. It is also possible that the actual physical media that connect the existing devices would not be one of the standard physical links allowed in the chosen open protocol.

The most likely solution would be to use a device that acts as a gateway between the existing, proprietary network and the new open network. This gateway would possess enough memory and intelligence to translate the vocabulary and grammar rules of the open protocol to the existing proprietary protocol—and back again. The gateway also would contain a map of the existing points that were to be readable and/or writable on the open internetwork. In effect, all existing points that are of interest to the open internetwork would reside as software objects in the gateway. Use the object list to identify these objects and properties to be communicated through the gateway. The gateway would then use the proprietary protocol to query and update the actual hardware (or software) points in the existing network.

In order to make the gateway as affordable and usable as possible, the system specifier should limit the number of different points that the gateway must make available from the existing network to the new open network. The system specifier also should thoroughly describe any graphics or reporting features he/she desires that use objects (points) from the existing network.

Gateways may not conform to any present standard, so great care must be taken to fully describe the performance of information exchange between the proprietary network and the new open network. A system integrator should perform much of this work. This integrator could be a service provided by the supplier of the new open network or by a third-party consultant.

8.2.8.2 System Integrator

If using a system integrator to perform the work of integrating systems that use one communication protocol with systems using another protocol, the specifier will need to define the duties and functions of this service. At a minimum, the specifier should include the following steps:

- Contact the existing system manufacturer to secure documentation and programming information n the existing system. The integrator also may require the existing system's protocols. The existing system's manufacturer also may be called upon to provide the hardware and software of the gateway.
- Coordinate the assignment of device and network identification.
- Commission the network integration up to and including the use of network "sniffers" to verify network message packet ntegrity. Sniffers, or protocol analyzers, are devices used to analyze the content of message packets.
- Provide the final documentation of the integrated internetwork.

Project Considerations:

- The use of a 28,800 baud modem in the example specification is a specifier preference. The technology is moving apidly to higher speeds and non-telephony (e.g., direct Internet) connectivity solutions. Consult with the owner oncerning any specific requirements.
- The future expansion capacities listed in the example reflect a relatively large single building probably in

excess of 100,000 m^2 or 1 million ft^2). Other projects may require a smaller number of future connections r, in the case of an extensive campus, many more. Care should be taken in choosing this number since it could have an ffect on the system cost.

- The example specification uses BACnet to specify its communication requirements for interoperability. There are many ther methods, both proprietary and open, such as LonMark-compliant, CAB, and ModBus to accomplish these same requirements.

2.2 COMMUNICATION

A. All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to *ANSI/ASHRAE Standard 135-~~1995~~2004, BACnet*.

B. Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device as defined in this section.

C. The contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the internetwork.

D. All controllers shall have a communication port for connections with the operator interfaces using the BACnet Data Link/Physical layer protocol.

E. A device on the internetwork shall be provided with a 28,800 baud modem that will allow for remote operator interface using the BACnet PTP Data Link/Physical layer protocol. Remote operator interface via this modem shall allow for communication with any and all controllers on this network as described in Paragraph F below.

F. Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:

1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.
2. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.

G. All system devices with real-time clocks shall use the BACnet Time Synchronization service. The system shall also automatically synchronize all system clocks daily from an operator-designated device in the system via the internetwork. The system shall automatically adjust for daylight savings and standard time, if applicable.The time clocks in all controllers shall be automatically synchronized daily via the internetwork. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the internetwork.

H. The internetwork shall have the following minimum capacity for future expansion:

1. Each building controller shall have routing capacity for 50 controllers.
2. The building controller network shall have capacity for 50 building controllers.
3. The system shall have an overall capacity for 12,500 building controller, custom application controller, and application specific controller input/output objects.

8.3 Operator Interface

The operator interface section of this clause describes what the system operator will see when he/she interfaces with the system. This discussion is tightly coupled with the controller software section that follows.

8.3.1 Number of Operator Interface Devices Required

This simply sets the desired number of operator interface devices (workstations) that will be provided. The location of these devices should be clearly shown in the project plans. If portable operator devices are specified, then designate the quantities to be provided.

Project Considerations: The number of workstations is very much an individual project-specific requirement. Many projects only require one workstation, so the wording of this article should be carefully prepared to reflect that. Remember that in this example, the workstations and the building controllers are both connected to the same high-speed network. Other system architectures are possible and will require different specification descriptions here.

2.3 OPERATOR INTERFACE

A. Operator Interface. ~~Furnish two~~ PC-based workstations shall reside on high-speed network with building controllers as shown on ~~the~~ system drawings. Each ~~of these~~ workstation~~s~~ or each standard browser connected to server shall be able to access all system information~~ in the system. These workstations shall reside on the same high-speed network as the building controllers.~~

8.3.2 Physical System Connection

On a small project, the operator interface device may be connected directly to a panel or may be remotely located and connected by dial-up phone modem. On a larger project, where several operator interface devices are required, they will typically be connected on a high-speed LAN.

Project Considerations: The example specification requires an Ethernet LAN (ISO 8802-3). Exercise caution in specifying connection via dial-up. Communication speed is much slower over a dial-up connection.

B. Workstation and controllers shall communicate ~~information access shall~~ using~~e~~ ~~the~~ BACnet protocol. Workstation and control network backbone shall ~~C~~communicati~~on~~e ~~shall~~ using~~e~~ ~~the~~ ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in *ANSI/ASHRAE 135-2004, BACnet,* Annex J.

8.3.3 System Hardware

For most projects, the operator interface will be a personal computer (PC). This is an economical, commonly available device that can be used for other functions by the owner, including word-processing, maintenance management, and other common functions. The specification for the personal computer needs to be updated to reflect the current state of the art. This typically changes once or twice a year. The elements that are subject to change are the processor and speed, as well as memory and hard drive capacity.

Accessories required with the PC also should be specified in this section. This will typically include the printer and modem for remote communication.

Project Considerations: Buildings that will have on-site operations should include at least one PC workstation. Larger facilities may have several PCs that are conveniently located throughout the building. Consult with the owner to verify the need and location of these workstations. Smaller buildings and those that do not have on-site operators may not require an on-site PC. For these projects, several options are available. The most basic option is to use a simple LCD display. This typically consists of an LCD display panel and a keypad, which allows operators to see objects' status, view alarms, and change set points and schedules. A second option is not to have any local operator interface but to rely on remote communication and a portable operator's terminal. This would require the specification of a modem for the project and the use of a new or existing remote PC workstation for monitoring and control. Finally, since the technology curve for personal computers is very steep, the speed, memory, and storage capacity requirements require careful review each time a specification is written for a new project.

If this project justifies the need for interoperability with other systems during future expansion, such as a campus setting or large, complex building that undergoes frequent expansion and renovation (hospitals and/or research laboratories), include the BACnet paragraph.

C. Hardware. Each operator workstation and custom programming workstation shall consist of the following:

1. Personal Computer. Furnish IBM compatible PCs as shown. The CPU shall be a minimum of an Intel Pentium and operate at a minimum of 120 MHz. A minimum of 16 megabytes of RAM, one 1.44 megabyte 3.5-inch diskette drive, and an 800-megabyte hard disk with a minimum access time of 12 milliseconds shall be provided. A two-button mouse also will be provided. Furnish all required serial, parallel, and network communication ports and all cables for proper system operation. The PC shall have a minimum of a 14-in. VGA monitor.
2. Modems. Furnish one auto-dial telephone modem per workstation and associated cables for communication to remote buildings and workstations. The modem shall transmit at a minimum of 28,800 baud and communicate over voice-grade telephone lines.
3. Printers. Each workstation shall have one printer with tractor feed and associated cables. Each printer shall be capable of a minimum 160 characters per second operation and be compatible with standard parallel or serial communication. Supply one box of 2000 sheets minimum of printer paper and two printer ribbons or cartridges.
4. BACnet. The workstation shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of *ANSI/ASHRAE Standard 135-~~1995~~2004* to communicate with BACnet objects in the internetwork.

8.3.4 System Software

This section only details the software that runs on the PC workstation. All of the other functions described under system applications are edited and archived at the PC workstation but are actually executed at the system controllers. Refer to Clause 8.4 of this document, "Controller Software."

8.3.4.1 Operating System

The operating system for the PC workstation should be multi-tasking and support the use of other current off-the-shelf programs. This is one place where the specifier may want to be prescriptive in stating the allowable operating systems that will support the other programs the system operator may wish to use. Be sure that the allowable manufacturers are able to support the specified operating system.

D. System Software

1. Operating System. Furnish a concurrent multi-tasking operating system. The operating system also shall support the use of other common software applications ~~that operate under DOS or Windows~~. Examples include ~~Lotus 123,~~ Microsoft Excel, WordPerfect, and ~~Paradox~~Microsoft Access. Acceptable operating systems are Windows ~~95~~2000, Windows ~~NT~~XP, Windows Server 2003, Linux, and UNIX~~,~~ ~~and OS/2~~.

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its Handbook, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.