ASHRAE Addenda b, d, l, m, n, p, and q to
ASHRAE Guideline 13-2000

ASHRAE GUIDELINE

Specifying Direct Digital Control Systems

Approved by the ASHRAE Standards Committee on June 23, 2007, and by the ASHRAE Board of Directors on June 27, 2007.

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SPECIAL NOTE

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The Assistant Director of Technology for Standards and Special Projects 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, or
d. permission to reprint portions of the Guideline.

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

FOREWORD

This addendum modifies the example AHU control schematic, sequence of operation, and points list (Figures 3, 4, and 5) so that they represent a consistent example (diagram, sequences, and points list are all for the same example application.) and adds discussion on writing styles used in control sequences.

Problems identified with the existing Figure 4 include:

1. *Outdoor air percentage calculation is incorrect. Moreover, this sequence is typically not consistent with code and is usually not practical. All building codes and Standard 62 require that outdoor air rate in CFM, not percent, be maintained. The calculation error in the proposed equation also blows up when the temperatures are close (e.g., when outdoor air temperature is approximately equal to return air temperature), resulting in unrealistic results such as negative values and values greater than 100%.*
2. *No heating coil is mentioned even though the supply air temperature reset range implies one.*
3. *Standard 90.1 has specific requirements for economizer high limits (Table 6.3.1.1.3B). The fixed 68°F high limit does not meet 90.1 requirements for any climate.*
4. *Standard 90.1 does not allow a single space setpoint (unless this is a process application). Two setpoints are required to provide a deadband.*
5. *Standard 90.1 does not allow economizers to be controlled from mixed air temperature to prevent fighting with CHW loop and due to difficulties measuring mixed air temperature.*
6. *Sequence does not relate at all to points list in Figure 5. The example would be clearer if the sequences, schematic, and points list address a consistent example.*
7. *Example sequences used only one style (component vs. mode). Both styles should be used and discussed.*

Changes to Figure 5 include:

1. *Points list format was modified so hardware points were more clearly distinguished from software points.*
2. *Alarms were eliminated because they are included in sequence of controls. This allows alarms to have interlocks (e.g. supply air temperature deviation from setpoint alarms are only triggered when then AHU has operated for a given time period to avoid false alarms).*
3. *Trends include desired time interval of change of value.*

Addendum b to ASHRAE Guideline 13-2000

Note: In this addendum, changes to the current guideline (as modified by any published addenda on the ASHRAE web site) are indicated in the text by underlining and blue type (for additions) and ~~strikethrough~~ and red type (for deletions) unless the instructions specifically mention some other means of indicating the changes.

In paragraph 5.3.2, delete Figure 3 sample control diagram (not shown) and replace with new sample control schematic:

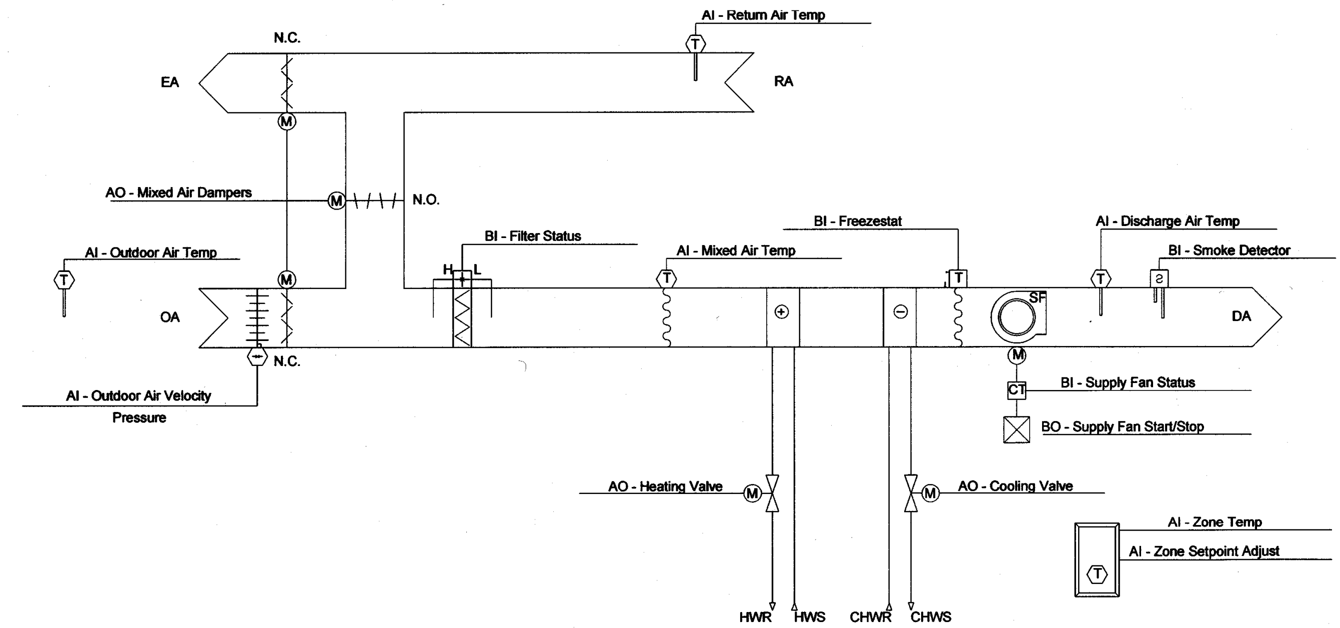

Figure 3 Sample control ~~drawing~~schematic.

Revise paragraph 5.3.3 to read:

5.3.3 Sequences of Operation

The sequences of operation describe how the system shall function and are the designer's primary method of communication to the control system programmer ~~(see Figure 4)~~. A sequence should be written for each system to be controlled. In writing a sequence, care must be taken to describe all operational modes and to ensure that all I/O devices needed to implement the sequence are shown on the object list and drawings.

~~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 set points and operating points also should be defined in the sequence.~~

5.3.3.1 Writing Control Sequences

Writing clear, unambiguous, concise yet comprehensive sequences of controls is very difficult. It first requires a clear understanding of how controls work, the limitations of the specific controls hardware specified, the limitations of the HVAC system design, and a knack for clear thinking and writing. It also takes practice and experience. The following are suggestions to assist in developing successful control sequences:

- Provide a description of the system at the beginning of each section to assist the reader in understanding the system. This should include unusual or custom system or control requirements to help explain the rationale behind sequences
- Organize sequences into the logical hierarchy of systems and the subsystems they serve. The most energy efficient sequences usually start at the lowest level and feed operational requests upwards. For example, zone VAV control logic determines the need for heating and cooling, which is conveyed to the air handler that serves them so that they operate as desired. The air handler control logic in turn conveys the need for chilled and hot water to the central cooling and heating plants. In this way systems operate efficiently and only when needed.
- Use tables and diagrams where possible to assist in conveying sequencing logic.
- Show formulas in the sequences if they are to be used in calculations.

- Write the sequences in such a way that it will make it easy to use the document to verify control system functionality during construction and testing.
- Control loop initial or default setpoints should be provided.
- Keep the sequences as simple as reasonably possible, but without compromising energy conservation and other performance goals.
- Use sequences that have been used successfully on similar projects as a template; don't "reinvent the wheel." Sample control sequences for several common HVAC system types are available on CD published by ASHRAE called "*Sequences of Operation for Common HVAC Systems*." Sequences for common systems are also available from control system manufacturers.

5.3.3.2 Organizing Control Sequences

There are two basic methods of organizing a sequence of operation: by operating mode or by component. In a sequence that is structured by operating mode (Figure 4a), the major paragraphs are broke into operating modes (such as occupied, unoccupied, and morning startup), with descriptions of how each component of the system behaves in that mode. In a sequence that is structured by component (Figure 4b), the major paragraphs are broken into components (such as valves and dampers), with descriptions of how the component behaves in each operating mode.

Done correctly, both formats provide the same information. Sequences that are organized by operating mode are generally easier to understand because they describe how the entire system will operate under a given set of conditions. The drawback to this format is that it can be difficult to program a controller from this sequence as details about how each component should operate are scattered throughout the sequence. Sequences that are organized by component may be easier for a programmer to use because most control programs are structured by component. Similarly, many technicians find the component structure more useful as a troubleshooting tool because they are generally troubleshooting a specific component. The question, "why is the heating valve open?" is easier to answer if all information about the heating valve is contained in one section.

The decision of which format to use should primarily be determined by the intended use of the sequence. If the intent is to explain operating concepts and highlight differences between the operating modes, the sequence should be organized by operating mode. If the intent is to provide specific programming instructions and to provide maintenance documentation, the component approach should be used. As a secondary consideration, if the designer needs to provide sequences for multiple variations of a piece of equipment (ex: unit ventilators with hot water heat, gas heat, or electric heat) the component approach may be easier to produce since only the affected component needs to be rewritten.

Delete Figure 4 (example sequence of operation) and replace with new sequences Figure 4a (Sequence of Control, Mode Style) and Figure 4b (Sequence of Control, Component Style).

~~The supply fan shall operate in occupied hours based on a user-adjustable time-of-day schedule. The system will incorporate an optimum start routine that will start the unit at the latest possible time to have the space at the occupied setpoint at start of occupancy.~~

~~Supply air temperature will be reset from space condition and will be maintained between 10°C and 32°C (50°F and 90°F).~~

~~Space temperature shall be maintained at 23°C (73°F).~~

~~Cooling coil shall be modulated in sequence with the mixing damper to maintain supply air temperature at its setpoint. The cooling coil valve will not be allowed to open until the mixing dampers are either fully open or in their minimum position for the required outside air flow when the outside air temperature is above 20°C (68°F).~~

~~Outside air quantity – the percentage of outside air delivered by the system shall be calculated by using the formula~~ $\cancel{Q_{oa} = (T_{mix} - T_{outside}) / (T_{mix} - T_{return})}$~~. The air-handling system shall deliver a minimum of 18% outside air when operating in occupied hours.~~

~~The mixing dampers shall be modulated to maintain mixed air temperature at its setpoint but shall not allow the outside air quantity to reduce below the set minimum. The outside air damper shall be closed when the unit is not operating.~~

~~A low-temperature trip or smoke detection device shall close the outdoor air damper and stop the fan.~~

~~**Figure 4 Example sequences of operation.**~~

Sequence of Control written in the component style

Run Conditions:

The unit shall run according to a user-definable time schedule in the following modes:

Occupied Mode: The unit shall maintain the zone cooling setpoint of 74°F (adj.) and the zone heating setpoint of 70°F (adj.). The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

Unoccupied Mode (night setback): The unit shall cycle on and off to maintain the zone cooling setpoint of 85°F (adj.) and the zone heating setpoint of 65°F (adj.) with a 3ºF deadband.

Optimal Start: The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

Alarms shall be provided as follows:

High Zone Temp: If the zone temperature is 5°F greater than the cooling setpoint.

Low Zone Temp: If the zone temperature is 5°F less than the heating setpoint.

Freeze Protection:

The unit shall shut down and generate an alarm upon receiving a freeze-stat low temperature limit status. Manual reset shall be required to restart the system.

Smoke Detection:

The unit shall shut down and generate an alarm upon receiving a smoke detector status. Manual reset shall be required to restart the system.

Supply Fan:

The supply fan shall run anytime the unit is commanded to run. The fan shall run for a minimum of 5min (adj.) and be off a minimum of 5min (adj.) unless shutdown on safeties.

Alarms shall be provided as follows:

Supply Fan Failure: Commanded on, but the status is off.

Supply Fan in Hand: Commanded off, but the status is on.

Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit.

Cooling Coil Valve:

The controller shall measure the zone temperature and modulate the cooling coil valve open on rising temperature to maintain its cooling setpoint.

The cooling coil valve shall be enabled whenever:

Outside air temperature is greater than 60°F (adj.).

AND the zone temperature is above cooling setpoint.

AND the fan status is on.

AND the heating is not active.

The cooling coil valve shall open to 50% (adj.) whenever the low temperature limit is on.

Heating Coil Valve:

The controller shall measure the zone temperature and modulate the heating coil valve open on dropping temperature to maintain its heating setpoint.

The heating coil valve shall be enabled whenever:

Outside air temperature is less than 65°F (adj.).

AND the fan status is on.

AND the zone temperature is below heating setpoint.

AND the cooling is not active.

The heating coil valve shall open to 100% (adj.) whenever:

Supply air temperature is less than 35°F (adj.).

OR the low temperature limit is on.

Economizer Dampers:

The controller shall measure the zone temperature and modulate the economizer dampers and cooling coil valve in sequence to maintain space temperature at the zone cooling setpoint.

The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off.

The economizer shall be enabled whenever:

Outside air temperature is less than 65°F (adj.) (see Standard 90.1 for setpoint appropriate for climate)

AND the outside air temperature is less than the return air temperature.

AND the fan status is on.

The economizer shall close to 0% (adj.) whenever:

Mixed air temperature is less than 35°F (adj.).

OR on loss of fan status.

OR the low temperature limit is on.

Alarms shall be provided as follows:

High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).

Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).

Minimum Outside Air Ventilation:

When in the occupied mode, the controller shall measure the air flow and modulate the economizer dampers to maintain the minimum air flow setpoint (adj.), overriding normal economizer damper control.

Alarms shall be provided as follows when unit has operated for a minimum of 15 minutes:

High Discharge Air Temp: If the discharge air temperature is greater than setpoint by 5°F (adj.).

Low Discharge Air Temp: If the discharge air temperature is less than setpoint by 5°F (adj.).

Filter:

An alarm shall be generated if the filter differential pressure switch exceeds its setpoint.

Figure 4a Example Sequence of Operation - Component Style.

Sequence of control written in the Mode style

A. General

1. The occupancy mode (Occupied or Unoccupied) shall be determined through a user-definable time schedule.

2. Whenever the supply fan is de-energized, as sensed by the status switch, the outside and exhaust air dampers shall be closed and the return air damper shall be open, the heating and cooling valves shall be closed or positioned as described below.

B. Occupied Mode

1. The supply fan shall be energized. There shall be adjustable minimum on and off times initially set at 5 minutes. Safety trips shall override the minimum on and off times.

2. There shall be separate heating and cooling space temperature setpoints. The setpoints shall be initially set at 74°F cooling and 70°F for heating. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

3. The heating coil valve, economizer, and cooling coil valve shall modulate in sequence to maintain space temperature setpoint. The cooling valve shall be enabled only when the outside air temperature is above 60°F (adjustable), the fan status is on, the zone is calling for cooling and heating is not active. The heating valve shall be enabled whenever the outside air temperature is less than 65°F, the fan status is on, the zone is calling for heating, and cooling is not active.

4. Whenever the outside air temperature is less than 65ºF (adj.) (see Standard 90.1 for setpoint appropriate for climate), the outside air temperature is less than the return air temperature, and the fan status is on, modulation of the economizer dampers shall be enabled. There shall be a mixed air low limit function to close the economizer dampers to prevent the mixed air temperature from dropping below 35°F (adj).

5. When in the occupied mode, the controller shall measure the air flow and modulate the economizer dampers to maintain the minimum air flow setpoint (adj.), overriding normal economizer damper control.

B. Unoccupied Mode

1. Unoccupied Off: The supply fan shall be de-energized except when operation is called for as described below. Outside air dampers and exhaust dampers shall be closed and return air damper open. Heating and cooling valves shall be closed except as described below.

3. Unoccupied Setback Heating: The supply fan shall cycle on with the outside and exhaust dampers closed when the space temperature drops below the unoccupied space temperature setpoint of 65°F (adjustable). When the fan is energized, the heating valve shall modulate to maintain space temperature. The cooling valve shall be closed. The unit shall cycle to the Unoccupied Off mode when the space temperature is 3°F degrees above the unoccupied space temperature heating setpoint.

3. Unoccupied Setup Cooling: The supply fan shall cycle on when the space temperature is above the unoccupied space temperature cooling setpoint of 85°F (adjustable). When the fan is energized, the economizer and cooling valves shall be sequenced to maintain space temperature. The heating valves shall be closed. The fan shall unit shall cycle to the Unoccupied Off mode when the space temperature is 3°F degrees below the unoccupied space temperature cooling setpoint.

4. Optimum Start. The unit shall use an optimal start algorithm to minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

C. Safety Shutdowns

1. Duct smoke detection, and low temperature limit trips shall de-energize the supply fan and close the outside air dampers. Manual reset of the tripped device shall be required to restart the system

2. The cooling valve shall open 50% when ever the low temperature limit is on.

3. The heating valve shall open 100% whenever the supply air temperature is less than 35ºF (adj.).

D. Alarms

1. Alarm the following conditions

   a. High Zone Temp: If the zone temperature is 5°F greater than the cooling setpoint.
   b. Low Zone Temp: If the zone temperature is 5°F less than the heating setpoint.
   c. Supply Fan Failure: Commanded on, but the status is off.
   d. Supply Fan in Hand: Commanded off, but the status is on.
   e. Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit.
   f. High Mixed air temp: Mixed air temperature greater than 90ºF.
   g. Low mixed air temperature: mixed air temperature less than 45ºF.
   h. High Discharge Air Temp: If the discharge air temperature is greater than setpoint by 5°F (adj.) after the unit has been operating for a minimum of 15 minutes.
   i. Low Discharge Air Temp: If the discharge air temperature is less than setpoint by 5°F (adj.) after the unit has been operating for a minimum of 15 minutes.
   j. Filter Alarm: If the filter differential pressure switch exceeds its setpoint.
   k. Smoke detection.
   l. Low temperature limit.

Figure 4b Example Sequence of Operation - Mode Style.

Delete Figure 5 sample object list and replace with new list.

~~Tag~~	~~Object Name~~	~~Type~~	~~Alarm~~	~~Graphic~~	~~Trend~~	~~Notes~~
~~A-1~~	~~AHU 1 Discharge Air Temp.~~	~~AI~~	~~60 /~~	~~AHU1~~	~~DAT~~	
~~A-2~~	~~AHU 1 Mixed Air Temp.~~	~~AI~~	~~/ 40~~	~~AHU1~~		
~~A-3~~	~~AHU 1 Low Limit~~	~~BI~~	~~Yes~~			
~~A-4~~	~~AHU 1 Fan Status~~	~~BI~~	~~Yes~~			
~~A-5~~	~~AHU 1 RunTime~~	~~AV~~	~~10,000~~			
~~A-6~~	~~AHU 1 Discharge Air Setpoint~~	~~AV~~		~~AHU1~~		
~~A-7~~	~~AHU 1 Duct Static~~	~~AI~~	~~0.5 / 4.5~~	~~AHU1~~		
~~A-8~~	~~AHU 1 Duct Static Setpoint.~~	~~AV~~		~~AHU1~~		
~~A-9~~	~~AHU 1 CHW Valve Pos.~~	~~AO~~				
~~A-10~~	~~AHU 1 Economizer Pos.~~	~~AO~~				
~~A-11~~	~~AHU 1 Outdoor Air Flow~~	~~AI~~				~~Report #1~~
~~**Notes**: Report number 1 (IAQ) shall list the OA introduced by each AHU every 15 minutes.~~						

POINT NAME	HARDWARE POINTS				SOFTWARE POINTS			TREND	SHOW ON GRAPHIC
	AI	AO	BI	BO	AV	BV	SCHED		
ZONE TEMP	X							15 MIN	X
ZONE SETPOINT ADJUST	X								X
RETURN AIR TEMP	X							15 MIN	X
OUTSIDE AIR TEMP	X							15 MIN	X
MIXED AIR TEMP	X							15 MIN	X
OA FLOW CFM	X							15 MIN	X
DISCHARGE AIR TEMP	X							15 MIN	X
COOLING VALVE		X						15 MIN	X
HEATING VALVE		X						15 MIN	X
ECONOMIZER DAMPERS		X						15 MIN	X
LOW TEMPERARURE LIMIT			X					COV	X
SMOKE DETECTOR			X					COV	X
SUPPLY FAN STATUS			X					COV	X
FILTER STATUS			X						X
SUPPLY FAN START/STOP				X				COV	X
OA FLOW MIN SETPOINT					X				X
SCHEDULE							X		
HEATING SETPOINT					X			±1°F	X
COOLING SETPOINT					X			±1°F	X
HIGH ZONE TEMP						X			
LOW ZONE TEMP						X			
SUPPLY FAN FAILURE						X			
SUPPLY FAN IN HAND						X			
SUPPLY FAN RUNTIME EXCEEDED						X			
HIGH MIXED AIR TEMP						X			
LOW MIXED AIR TEMPERATURE						X			
HIGH DISCHARGE AIR TEMP						X			
LOW DISCHARGE AIR TEMP						X			

Figure 5 Sample DDC control system object list for AHU described in Figures 3, 4a and 4b.

Several features associated with the objects are defined in the object list, including:

- ~~*Alarms*—The alarm limits can be listed if known.~~
- ~~*Object*~~ *Hardware Point type*—The type of ~~object~~ point ~~should~~ must be noted (analog or binary, input or output).
- *Software Point type*–Listing software points is optional but doing so will ensure proper graphical displays and trending. The type of point should be noted (analog value, binary value, or schedule).
- *Trend*—If the object is to be sampled ~~at regular intervals~~ in a trend log, then this should be noted. List either the desired trending time interval (for analog points), change of value (COV, for binary points), or a differential value change (for analog points).
- *Graphic assignment*—If the object is to appear on a graphic, then this should be indicated.
- ~~*Reports—If the object is to be shown on a report, then select this column.*~~
- ~~*Notes—The final column can be used to note any special requirements for an object.*~~

Add the following reference above ASHRAE in Section 12, References:

"Sequences of Operation for Common HVAC Systems"

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

FOREWORD

This addendum modifies sample specification Section 1.6 (Section 7.6.2 of Guideline) to remove the listing of specific contractors from the specifications. The local contractors are not always known to the specifier and limiting the bid to specific contractors may not be allowed by clients who are constrained by open competition laws.

Addendum d to ASHRAE Guideline 13-2000

Note: In this addendum, changes to the current guideline are indicated in the text by underlining and blue type (for additions) and ~~strikethrough~~ and red type (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Revise sample specification Section 1.6 (in Section 7.6.3 of guideline) as shown

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Revise section 7 specification section as shown.

1.0 SECTION INCLUDES

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

Revise section 7.6.3 as shown.

7.6.3 Listing Control System Contractors or Manufacturers in the Specification

While it is desirable to specify approved contractors in a specification, it is not always practical and it is sometimes not allowed by clients, particularly government or institutional bodies where doing so can be considered anti-competitive. In the sample specification language below, it is assumed that only the primary control system manufacturer can be listed in the specification but that specific local dealers or contractors cannot be specified. ~~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~~ PRIMARY MANUFACTURERS

A. The following are ~~the~~ approved c~~C~~ontrol s~~S~~ystem ~~Contractors and~~ manufacturers and product lines:

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

Manufacturer	Product Line
Manufacturer A	
Manufacturer B	
Manufacturer C	

Note:

1. The order of the above list of ~~Contractors~~manufacturers ~~is alphabetical and~~ does not indicate~~display a~~ preference. Inclusion on this list does not guarantee acceptance of products or installation. Control systems shall comply with the terms of this specification.
2. ~~The Contractor shall u~~Use ~~only products~~ operator workstation software, controller software, custom application programming language, building controllers, custom application controllers, and application specific controllers from only one of the ~~corresponding~~ manufacturers and product lines 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 o~~Other products specified herein (~~e.g.,~~such as sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

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

FOREWORD

This addendum adds a discussion on the merits of using an existing enterprise LAN in lieu of a dedicated DDC system LAN.

Addendum L to ASHRAE Guideline 13-2000

Note: In this addendum, changes to the current guideline are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Make the following changes to Section 8.2.1.

~~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.~~

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 has the option of specifying a dedicated LAN for the DDC system or allowing the DDC system to share the facility LAN with other systems. Consideration should be given to the pros and cons of sharing the facility LAN versus. using a dedicated LAN:

Pros: The major benefit of using the facility LAN is that the network infrastructure, including routers and interconnecting cabling, is already in place. This eliminates a significant material and installation expense. There is typically a network administrator or IT department responsible for managing and maintaining the network. Because the network is already extended to all users in the facility, any connected computer will have access to the DDC data (depending on the format of the data, proprietary software may be required to view it).

Cons: There are security concerns involved with deploying the DDC system over a network shared by other users. Since many systems use Windows-based technology, they are susceptible to viruses, worms, or hacking over the network. Educational facilities are notorious for having connected users with the time and ability to improperly use the network. Fortunately, most IT departments are savvy to these risks, but for smaller facilities this could be a concern. Also, when the facility LAN is down for maintenance, there is no access to DDC data. In some cases, remote access to the facility LAN may not be possible or allowed; this eliminates the possibility for remote monitoring and troubleshooting. For new construction projects, the installation and startup of the facility LAN may be on a schedule that does not allow for timely installation and startup of the DDC system. Another concern is that of available bandwidth. Excessive network traffic can reduce the available bandwidth, resulting in slower communication, delayed alarm reporting, or possibly lost data. Although security issues imposed by the DDC system on the network are unlikely and bandwidth use be DDC systems is typically very low, some IT managers are hesitant to allow DDC systems to share the LAN.

The designer should weigh these pros and cons based on the project-specific parameters. If the choice is made to utilize the facility LAN, early coordination with IT management personnel is critical.

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

FOREWORD

This addendum adds a definition section to the basic specification.

Addendum m to ASHRAE Guideline 13-2000

Note: In this addendum, changes to the current guideline are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Modify Section 7 as indicated:

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 but Not Installed under This Section
.2 Products Installed but Not Furnished under This Section
.3 Products Not Furnished or Installed under but Integrated 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
.13 Definitions

Add new Section 7.13:

7.13 Definitions

This paragraph includes definitions unique to DDC systems. To ensure effective communication, it is important that the same definitions of commonly used terms be employed.

1.13 DEFINITIONS

Term	Definition
BACnet Interoperability Building Blocks (BIBB)	A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification.
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ANSI/ASHRAE Standard 135 and approved addenda.
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.
Direct Digital Control	Microprocessor-based control, including Analog/Digital conversion and program logic.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token Passing	Data link protocol as defined by the BACnet standard.
Point-to-Point	Serial communication as defined in the BACnet standard.
Primary Controlling LAN	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
Protocol Implementation Conformance Statement	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Router	A device that connects two or more networks at the network layer.
Wiring	Raceways, fittings, wire, boxes and related items.

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

FOREWORD

This addendum adds a web-based interface to the system architecture.

Addendum n to ASHRAE Guideline 13-2000

Note: In this addendum, changes to the current guideline are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Modify Section 7.5 as follows:

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.

Included in this section is a description of the architecture with respect to internet accessibility. Many vendors have developed DDC systems that allow communications via internet protocol. This allows users to access DDC data using a standard web browser. The implementation of internet technology chosen by the various vendors typically falls into one of two categories: web-based systems or web-compatible systems. Understanding the differences between the two types will aid the designer in the specification process.

Web-based DDC systems are developed as true web applications. These systems are designed to be interfaced using only a standard web browser. The DDC system files are typically housed on a dedicated server (loaded with the vendor's web-based system software) that is not used as an operator interface. The operator interface can be any computer using a standard web browser that is able to communicate to the server over the internet/intranet. Since the DDC system is designed to operate as a web application, all system data is web-accessible.

Web-compatible systems serve up data from the DDC system to the web. These systems can be accessed using a standard web browser, but still require the use of the vendor's proprietary software on dedicated computers to access advanced functions or to view all system data. In many cases additional software must be used in conjunction with a standard web browser for users to interrogate the system over the internet. DDC system files typically reside on a dedicated server and/or operator workstation(s) running the vendor's proprietary software. A gateway or web-enabled controller is used to convert specific data to internet format. Therefore the DDC system as a whole is not web-accessible (only the data that has been designated for conversion). Because only data that is specifically designated for web accessibility can be served up via the web, the designer must carefully specify the system functionality that will be available to web users.

For applications where the internet users will simply be viewing DDC data or making setpoint changes, the web-compatible system may be a good fit. It may also be a good alternative for projects where there is an existing DDC system that offers a web-compatible product. For facilities where multiple users need to access all aspects of the DDC system (scheduling, trend analysis, loop tuning, etc.), web-based systems may be a better fit. A web-based system may be more attractive for larger projects or facilities with multiple buildings, since the system files and web interface reside in a single server (or group of servers) as opposed to being distributed between multiple gateways, web-enabled controllers, and/or servers and workstations. IT departments are often very protective of allowing internet access, and the fewer ports open to the internet the better.

Specifying the performance required by the internet user will define the type of system that can be used for the project. If the user is only required to view system data and have the ability to change setpoints, either web-accessible system type will be acceptable. If the user is required to have access to all system data including the manipulation of adjustable parameters, scheduling, trend data, tuning parameters, etc., then a web-based system is required. The designer should also consider how many different users will be accessing the DDC system and how often. Some vendors (web-based and web-compatible) restrict the number of simultaneous web users, or charge extra for additional users above a preset minimum.

It is not enough to specify that the DDC system be web-accessible. The designer must determine what level of web interface is required for the specific project and define it clearly in the specifications.

Project Considerations: ~~This section should be edited to describe the project.~~This first example is generic and may or may not result in a web-based interface.

1.5 DESCRIPTION

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

~~B. Provide for future system expansion to include monitoring of occupant card access, fire alarm, and lighting control systems.~~

This second example is for a full web-based interface.

1.5 DESCRIPTION

A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and an operator workstation.

B. System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. The control system server shall be accessed using a web browser over the control system network, the Owner's local area network, and remotely over the Internet (through the Owner's LAN).

C. The intent of the thin-client architecture is to provide operators complete access to the control system via a web browser. No special software other than a web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to edit programming.

This third example is for a web-compatible interface.

1.5 DESCRIPTION

A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and/or an operator workstation.

B. The control system server and/or operator workstation shall provide for overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.

C. The system shall support web browser access to the building data. A remote user using a standard web browser shall be able to access the control system graphics and change adjustable setpoints with the proper password.

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

FOREWORD

This addendum modifies the how time synchronization is presented. Currently there are comments about time synchronization in Specification Paragraph 2.2.E, Guide Paragraph 8.3.4.7 and Specification Paragraph 2.3.E.13 with slight differences. This addendum consolidates this topic in one place.

Time Synchronization is a communication function affecting hardware performance. Wording about it should occur in one place, namely in Specification Paragraph 2.2, Communication.

Addendum p to ASHRAE Guideline 13-2000

Note: In this addendum, changes to the current guideline (as modified by any addenda published on the ASHRAE website) are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Delete 2.2 E, to be relocated to item F of 2.2 and rewritten.

2.2 COMMUNICATION

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to *ASHRAE/ANSI Standard 135-2001, BACnet*.

B. Each controller shall have a communication port for connection to an operator interface.

C. Project drawings indicate remote buildings or sites to be connected by a nominal 56,000 baud modem over voice-grade telephone lines. In each remote location, a modem and field device connection shall allow communication with each controller on the internetwork as specified in Paragraph D.

D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.

1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, reports, system software, and custom programs shall be viewable and editable from each internetwork controller.

2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified control system operation. An authorized operator shall be able to edit cross-controller links by typing a standard object address.

~~E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.~~

E~~F~~. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.

Relocate text from Guide Paragraph 8.3.4.7 to a newly inserted Guide Paragraph 8.3. Rewrite Specification Paragraph 2.2.E to incorporate nuances lost from 2.3.E.13 and renumber 2.2F. Renumber 8.3 Operator Interface to 8.4.

8.3 Clock Synchronization

Since most systems will have multiple devices with real-time clocks, a method of coordinating the clocks should be provided. This ensures that when a time-of-day schedule is to start a chiller at 7:00 a.m., that it starts at 7:00 and not at 7:10.

Project Considerations: The example specification uses the BACnet Time Synchronization service to accomplish this function. When specifying a project that does not use BACnet, use the services available in either the proprietary network or through whatever open protocol (e.g., LonTalk) is being used in that particular instance.

F. Workstations, Building Control Panels and Controllers with real-time clocks shall use the BACnet Time Synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight savings and standard time as applicable.

8.4~~3~~ Operator Interface

Delete 8.3.4.7 (moved into new 8.3 above) and Specification Paragraph 2.3.E.13.

~~8.3.4.7 Clock Synchronization~~

~~Since most systems will have multiple devices with real-time clocks, a method of coordinating the clocks should be provided. This ensures that when a time-of-day schedule is to start a chiller at 7:00 a.m., that it starts at 7:00 and not at 7:10.~~

~~Project Considerations: The example specification uses the BACnet Time Synchronization service to accomplish this function. When specifying a project that does not use BACnet, use the services available in either the proprietary network or through whatever open protocol (e.g., LonMark or CAB) is being used in that particular instance.~~

~~13. Clock Synchronization. The real-time clocks in all building control panels and workstations shall use the BACnet Time Synchronization service. The system also shall be able to automatically synchronize all system clocks daily from any operator-designated device in the system. The system shall automatically adjust for daylight savings and standard time, if applicable.~~

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

FOREWORD

This addendum updates the operator workstation hardware section of the guideline and also addresses the problem of keeping this section up to date given the rapid changes in the PC industry.

Addendum q to ASHRAE Guideline 13-2000

Note: In this addendum, changes to the current guideline (as modified by any addenda published on the ASHRAE website) are indicated in the text by underlining and blue type (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

8.3.3 System Hardware

~~For most projects~~Depending on the project, the operator may ~~interface~~ access the DDC system~~will be~~ directly via an operator ~~personal~~workstation ~~computer (PC)~~ or across a network by connecting to a web server. In either case, the designer must specify a personal computer (PC). PCs~~This is an economical,~~ are commonly available devices that can be used for other functions by the owner, including word-processing, maintenance management, and other common functions; however, for larger projects or where recommended by the DDC system manufacturer, the workstation/server should be dedicated to DDC functions only.

Specifying computers can be difficult due to rapid technology changes in that industry. ~~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~~ most subject to change are ~~the~~ processor type and speed, as well as both memory and hard drive capacit~~y~~ies. By specifying that the hardware meet the DDC manufacturer's recommendations along with the specified system performance requirements, the designer may avoid calling out such specifics as minimum processor speed, hard drive size, etc. Of course, if there are specific computer requirements, then this is the place to define them; just remember that these will need to be edited periodically to keep up with changes in technology (paragraph C.1.c in the example specification below illustrates specific requirements that may be added by the designer).

Any ~~A~~accessories required with the ~~PC~~ workstation ~~also~~ should also be specified in this section. This ~~will typically~~ may include ~~the printer and~~a modem for remote communication or an alarm printer.

Project Considerations:

Buildings that will have on-site ~~operations~~ operators should include at least one ~~PC workstation~~operator interface if a web server configuration is not used. Larger facilities may ~~have~~require several ~~PCs~~ operator workstations to be ~~that are conveniently~~ located throughout the building, but more than likely will utilize a web server arrangement. Consult with the owner to verify the need and location ~~of these~~ for all operator interfaces~~workstations~~.

Smaller buildings, those that are part of a connected campus or enterprise, and those that do not have on-site operators may not require an on-site ~~PC~~operator workstation. For those buildings that are part of a connected campus or enterprise utilizing an existing web server, a local PC with network access may suffice. For the~~se projects~~ other cases, several options are available. ~~The most basic~~One option is to use ~~a simple LCD~~some type of local display. This ~~typically~~ may consist~~s~~ of an LCD or LED display panel and a keypad, which allows operators to see objects' status, view alarms, and change set points and schedules. A~~second~~nother option ~~is not to have~~would be to eschew any local operator interface ~~but to~~and ~~rely on remote communication and~~utilize a portable operator's terminal or hand-held interface device to interrogate the system. ~~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~~The last two options are less common and will require the designer to become familiar with the capabilities of each DDC manufacturer to be considered.~~. 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 th~~is~~ere ~~project justifies~~is the need for BACnet 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~~or web server shall consist of the following:

1. Computer: Hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The following hardware requirements also apply:
   a. The hard disk shall have sufficient memory to store:
      1) All required operator workstation software
      2) A DDC database at least twice the size of the delivered system database
      3) One year of trend data based on the points specified to be trended at their specified trend intervals.~~Personal Computer. Furnish, install, and configure IBM compatible PCs with a minimum of:~~
   b. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.
   c. Minimum hardware configuration shall include the following:
      ~~a.~~1) Intel ~~Pentium 2~~3.0 GHz processor
      ~~b.~~2) ~~500 M~~1 GB of RAM
      ~~c.~~3) 1.44 MB 3.5-inch diskette drive
      ~~d.~~4) 48x CD-RW/DVD optical drive
      ~~e.~~5) ~~40~~ 80 GB hard disk drive providing data at 1~~00 M~~ GB/sec
      ~~j. Mouse~~
      ~~k. Keyboard~~
      ~~h.~~6) 17-in ~~color~~ LCD monitor with at least 1024 x 768 resolution
      ~~m. Serial, parallel, and network communication ports and cables required for proper operation~~
2. Modem~~s.~~: Auto-dial modem and associated cables shall transmit over voice-grade telephone lines at a nominal 56,000 baud and shall provide communication between workstation or web server and remote buildings and workstations.
3. Alarm Printer~~.~~: Alarm printer shall have tractor feed and associated cables and shall be capable of a minimum 160 characters per second operation.
4. BACnet~~.~~: ~~w~~Workstation/server shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Operator Workstation (B-OWS) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L.

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.