Chapter 16

Design/ Drawings/Specifications

Establishing the goals and objectives of the EMS which matches a specific environment is a difficult task. The problems involved are related not so much to unreliable equipment as to failures in human communication. From the owner's point of view, it is essential to define exactly what is required in a system and who is responsible for providing it.

A **kickoff meeting** should be held with all persons involved who will eventually have some part in the process. It is advisable to create a checklist at this meeting. The checklist will serve to define the overall needs as well as delegating responsibilities. A set of building plans should be available to assist in ensuing discussions.

A **walk-through** of the facility usually takes place immediately after the kickoff meeting. In the walk-through, outside consultants become familiar with the facility and the location of all major energy using equipment.

The building's energy envelope must be defined and specific energy using equipment within that envelope identified.

Data-collection may take place over a period of several days or weeks. This process includes: monthly energy consumption data from the previous year (three years is preferable, to establish trends which may be occurring); the skin of the building—which is influenced by weather and the environment; lighting; people; and other variables such as opening/closing doors, traffic patterns, and general/specific building

©2002 by The Fairmont Press

use. Specific equipment such as fan and pump motors, chillers and other energy users must also be taken into account.

During the **field survey**, on a small-scale set of floor plans, all major equipment should be located. Then, with the assistance of operating/maintenance personnel, all those items which are thought to need repair and/or replacement, should be identified. It should also be determined which of the many energy-consuming devices can be controlled. Some processes simply cannot be remotely and automatically controlled. Equipment capacities, (measured-not specified), hours of operation, maintenance, and operating procedures should all be recorded.

The connected load and maximum electrical demand must be carefully studied. A building may have 100 kW of connected load, but this total is rarely, if ever, used. Generally 70 percent or less, and sometimes as low as 25 percent, of the connected load, may be used at any one time. Over the period of a year, the electrical demand will vary depending on the weather, the building's function and the processes involved.

Existing control systems in a building must be carefully analyzed and defined. The basic energy conservation controller—the time clock—will no doubt appear in this audit.

Air conditioning equipment is controlled in several ways, including hot and cold decks, mixing dampers, outside air cycles and economizer control cycles.

If modulating outside-air/return-air dampers are already part of the system, it will be less expensive to convert to a DDC-EMS. However, if there is only a minimum or fixed outside-air system, it may be costly to add an outside-air cycle. Duct openings would have to be cut into the walls, existing ductwork may have to be rebuilt, powered exhaust and recirculating air system may have to be added, and so on. A number of energy (or media) control possibilities exist: a modulating valve, an open-and-close valve, a 3-way bypass, primary/secondary pumping loops, etc.

The building may already be equipped with compressed-air-actuated pneumatic controls, or voltage-actuated electric controls that cause control apparatus to modulate, or electronic controls that operate valves or dampers. The problem then is integrating already existing control devices with a new EMS. Major changes may be required for compatibility.

The prices for EMSs vary in order of system magnitude. The specifying engineer must know exactly what is needed before deciding on such a system. If a $50 remote clock can do the job, there is no reason

©2002 by The Fairmont Press

to spend $5,000 to have a microprocessor turn a system on and off.

The analysis of HVAC systems and controls will indicate both what can be done and what control interface will be required.

DDC/EMS may be installed to upgrade existing controls and/or reduce energy consumption. Is an old system is to be replaced, list problem areas that the new system should solve. Often new control systems are installed with little thought to the objectives. Old systems may be replaced with new systems having the same design problems. Define what needs to be controlled and how.

The **field survey** should also include the following: potential locations of field panels and available power, possible locations for instruments and controls, type and location of motor starters, location of utility metering, and the number and location of building zones.

The next step in the process is to select energy conservation programs that are applicable to the project. Even though many software programs include the basic programs as a standard feature, it doesn't pay to invest time in items which do not apply. Hot water heating reset from outside air temperature would not be considered if there was no fintube radiation system.

After the programs have been selected, a points list must be provided to enable the vendor to determine the number of panels, type of points, relays, sensors and other field hardware requirements. An input/output summary form can be used which will eventually be included in the project specifications. The point schedule allows a logical presentation of input and output analog and digital signaling associated with the system along with alarm points and application programs to be applied. (See Figures 16-1 and 16-2 for use of tables).

Contract documentation will include drawings and specifications.

In general **contract drawings** will not have to be presented at great detail. Block diagrams, suggested layout, and suggested locations of field panels and equipment will be required. Precise details are not required because each vendor will bid the project based on their configuration of hardware.

The location of the **operator's console** should be clarified as to room number and general location. Figure 16-3 shows a typical layout of an EMS central control room which may have been required in the early 1980's. However, with the advent of distributed DDC EMSs, the only desk-top hardware required for the operators station is shown in Figure 16-4.

©2002 by The Fairmont Press

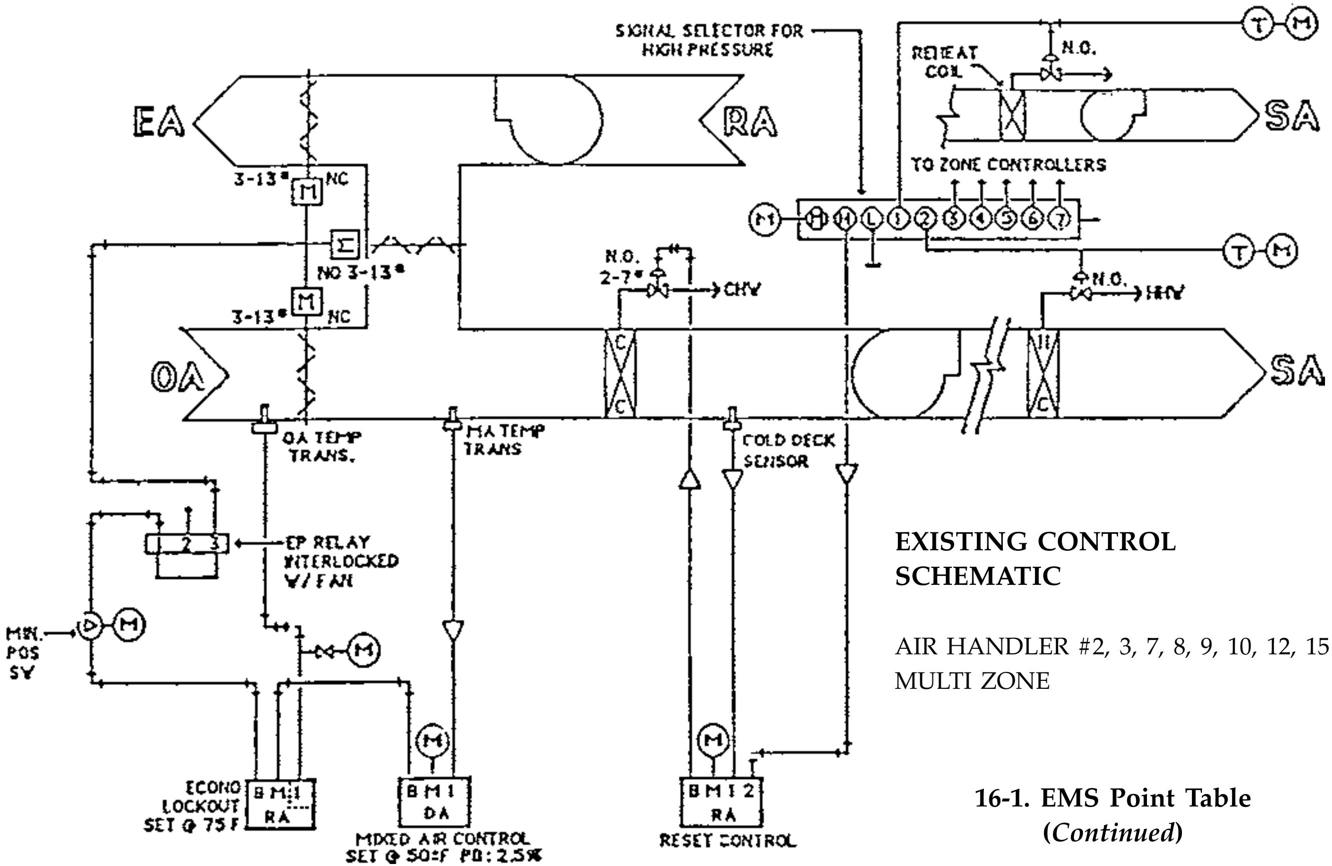
PAGE: ____________ REVISION: ____________

INPUT/OUTPUT SUMMARY TABLE

CUSTOMER:	HARDWARE																				SOFTWARE																											
	OUTPUT (O)								INPUT (T,D,V,C)												ALARMS							EMCS FUNCTIONS																				
LOCATION:	DIGITAL				ANALOG				DIGITAL						ANALOG						DIGITAL			ANALOG																								
SYSTEM: POINT DESCRIPTION:	Control Relay	Solenoid	Contactor		Pneumatic Transducer	Electrical Transducer	4-20MA Module		Pressure Switch	Flow Switch	Switch Closure	Auxiliary Contact	KW		Temperature	Relative Humidity	PSIg, PSIa, PSId	Position	Flow		Equipment Status	Maintenance		High Limit	Low Limit	Run Time		Scheduled Start/Stop	Optimum Start/Stop	Duty Cycling	Demand Limiting	Day/Night Setback	Economizer	Ventilation/Recirculation	Temperature Control	Enthalpy	Hot/Cold Deck Reset	Reheat Coil Reset	Steam Boiler Optim.	Hot Water Boiler Opt.	HW OA Reset	Chiller Optimization	Chilled Water Reset	Condenser Water Reset	Chiller Demand Limit	VAV Control	Lighting Control	

16-1. EMS Point Table

©2002 by The Fairmont Press

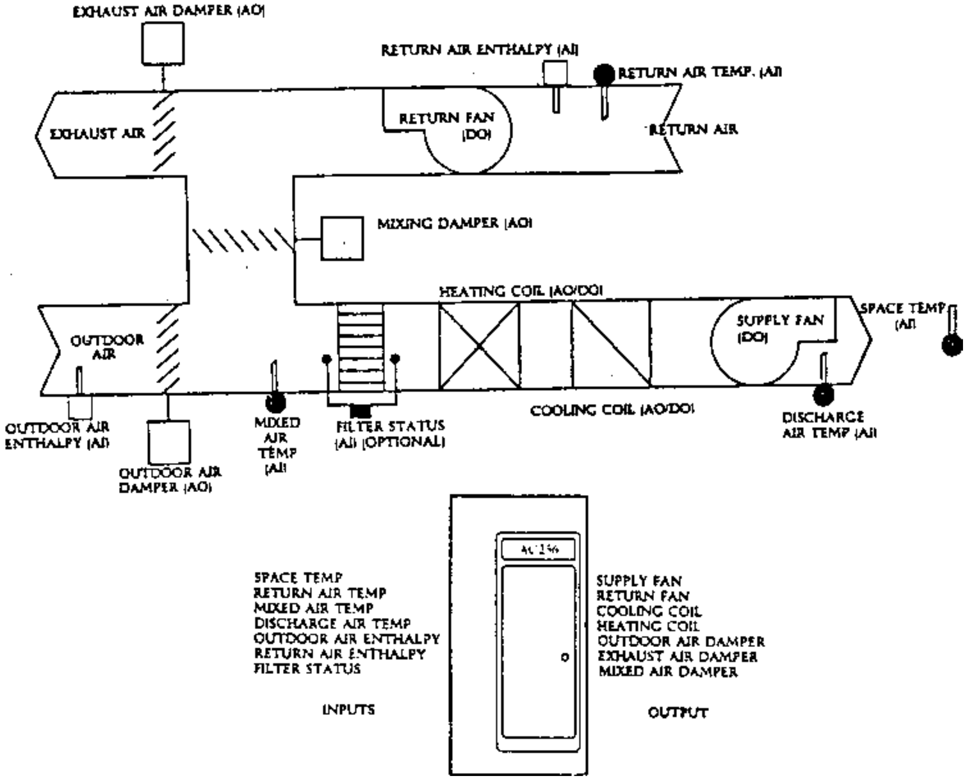


EXISTING CONTROL SCHEMATIC

AIR HANDLER #2, 3, 7, 8, 9, 10, 12, 15
MULTI ZONE

16-1. EMS Point Table (*Continued*)

©2002 by The Fairmont Press



16-2. ANDOVER HVAC Schematic and Point Table

©2002 by The Fairmont Press

PAGE: ______________ REVISION: ______________

INPUT/OUTPUT SUMMARY TABLE

CUSTOMER:

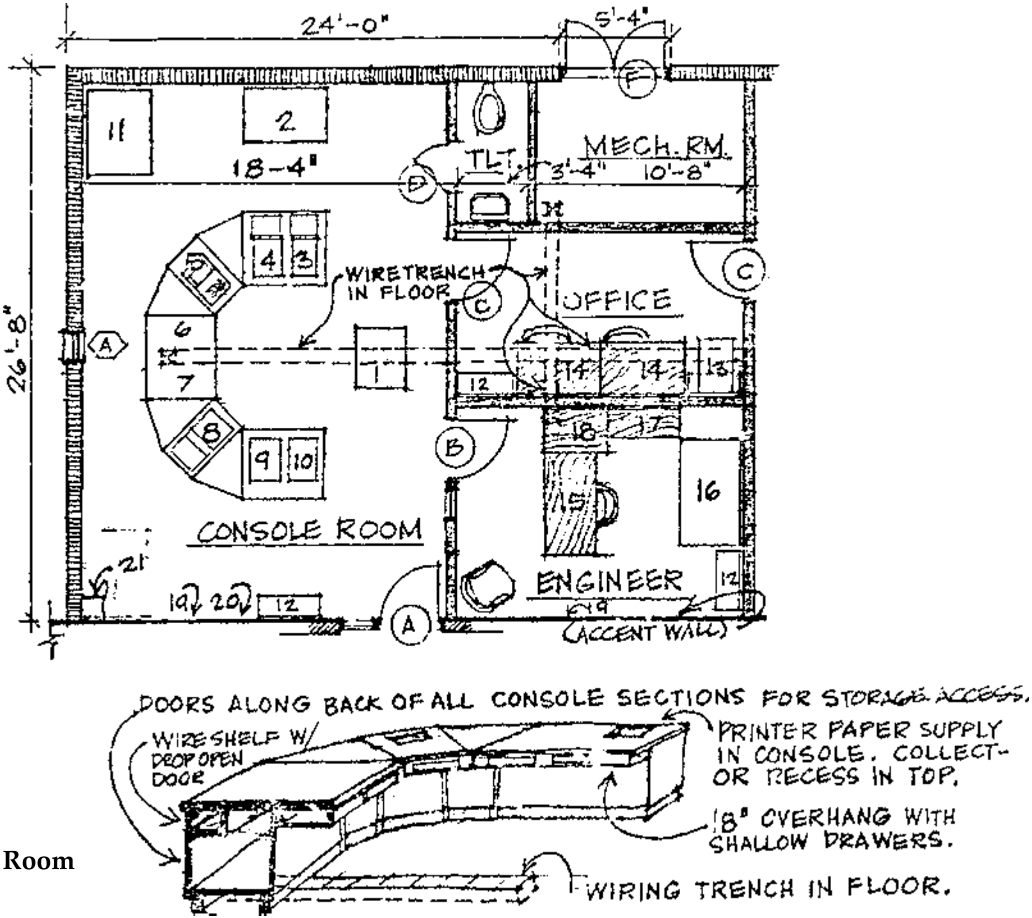
LOCATION: SAMPLE

SYSTEM: SINGLE ZONE AIR HANDLER

POINT DESCRIPTION	HARDWARE: OUTPUT (O) DIGITAL			HARDWARE: OUTPUT (O) ANALOG			HARDWARE: INPUT (T,D,V,C) DIGITAL					HARDWARE: INPUT (T,D,V,C) ANALOG					SOFTWARE: ALARMS DIGITAL		SOFTWARE: ALARMS ANALOG			SOFTWARE: EMCS FUNCTIONS																			
	Control Relay	Solenoid	Contactor	Pneumatic Transducer	Electrical Transducer	4-20MA Module	Pressure Switch	Flow Switch	Switch Closure	Auxiliary Contact	KW	Temperature	Relative Humidity	PSIg, PSIa, PSId	Position	Flow	Equipment Status	Maintenance	High Limit	Low Limit	Run Time	Scheduled Start/Stop	Optimum Start/Stop	Duty Cycling	Demand Limiting	Day/Night Setback	Economizer	Ventilation/Recirculation	Temperature Control	Enthalpy	Hot/Cold Deck Reset	Reheat Coil Reset	Steam Boiler Optim.	Hot Water Boiler Opt.	HW OA Reset	Chiller Optimization	Chilled Water Reset	Condenser Water Reset	Chiller Demand Limit	VAV Control	Lighting Control
SPACE TEMP												X							X	X																					
RETURN AIR TEMP												X							X	X																					
MIXED AIR TEMP												X							X	X																					
DISCHARGE AIR TEMP												X							X	X																					
OUTDOOR AIR ENTHALPY												X																		X											
RETURN AIR ENTHALPY												X							X	X										X											
FILTER STATUS							X																																		
SUPPLY FAN ON/OFF	X																					X	X	X																	
RETURN FAN ON/OFF	X																					X	X	X																	
COOLING COIL				X	X	X																			X	X			X		X										
HEATING COIL				X	X	X																			X	X			X		X										
OUTDOOR AIR DAMPER				X	X	X																					X	X													
EXHAUST AIR DAMPER				X	X	X																					X	X													
MIXED AIR DAMPER				X	X	X																					X	X													

16-2. ANDOVER HVAC Schematic and Point Table (*Continued*)

©2002 by The Fairmont Press



16-3. EMS Control Room

©2002 by The Fairmont Press

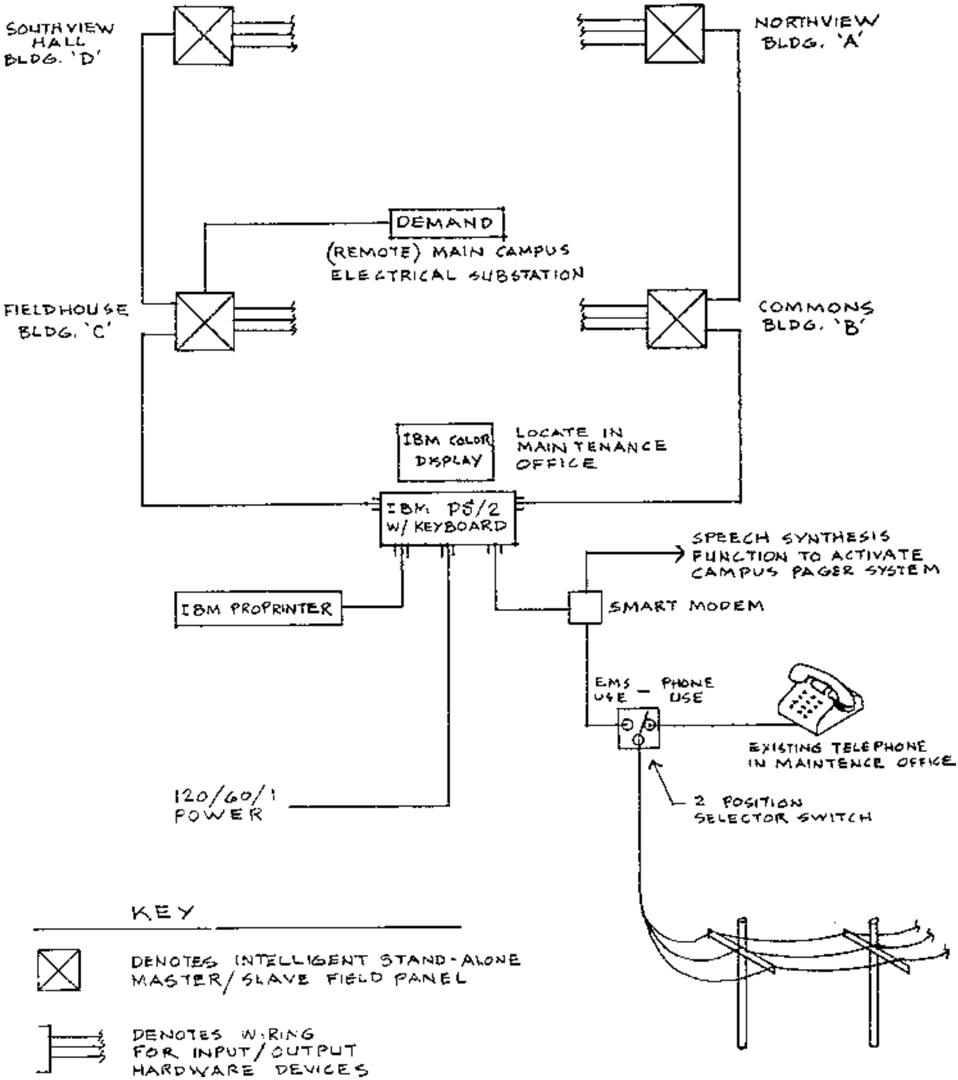
16-4. DDC-EMS Operator Work Station

A **system block diagram** should be provided (as you perceive it) which shows the general system layout and basic architecture including the central operator station, field panels, power available, and connecting transmission cables. If telecommunication capabilities are desired, show same and indicate if each DDC panel is to have this same type of interface. Individual input/output devices are not shown on this diagram since they are specified in the point tables. Quantities of hardware are not to be included. (See Figure 16-5 for a four-building DDC-EMS System Block Diagram).

In addition to **floor plans**, a site plan must be included to show building orientation and the location of remote electric substations, telephone lines, underground utility tunnels or conduits (especially important where multiple buildings are involved) and the major pieces of equipment that will be connected to the EMS in some way even though it might be a simple lighting timer switch. (See Figure 16-6 Site Plan/Equipment Layout).

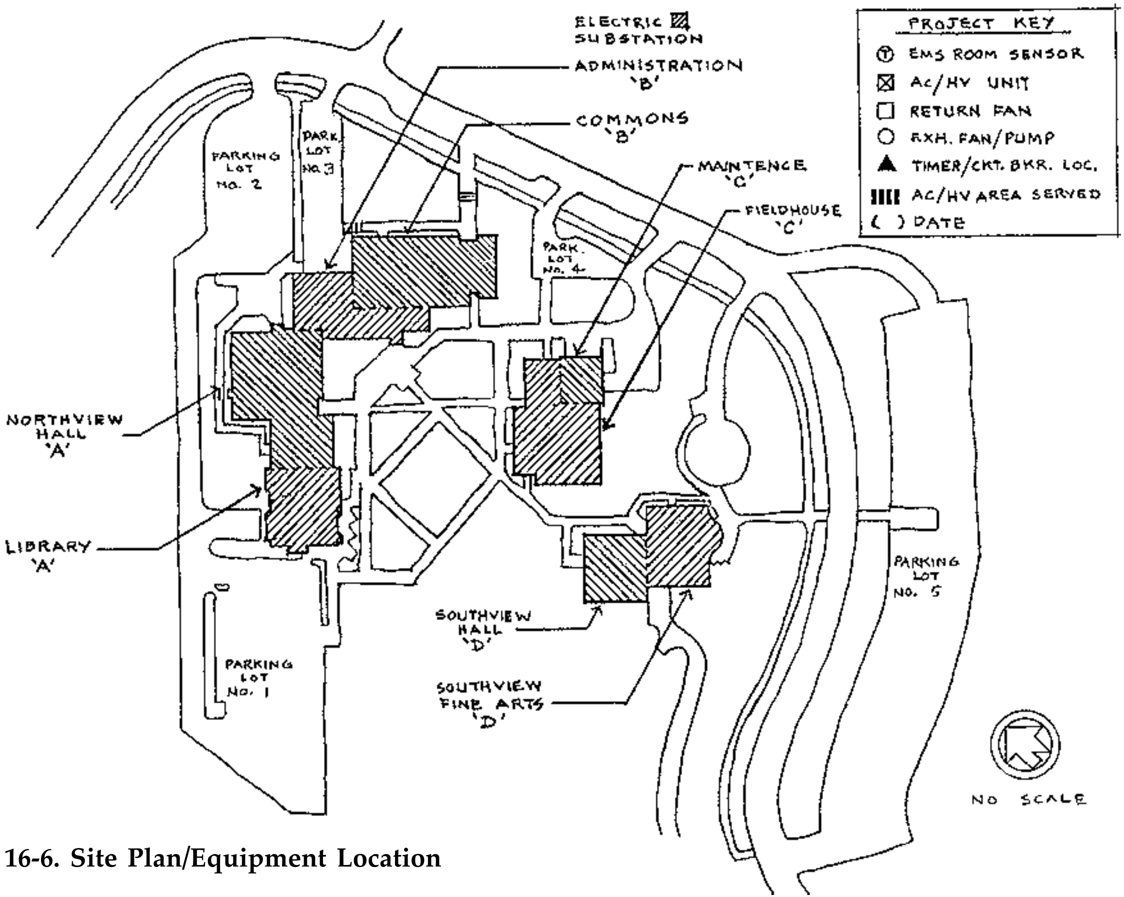
Floor plans should include the location of existing equipment such as fans, pumps, temperature control panels, time-clocks, air compressor, lighting timers/switches, room sensors and all other items that will be connected to the EMS. Actual room numbers and names should be shown as well as all pertinent information and any notes that may assist the installers performing their work. The finished product should include everything you would want on the drawings if you were the installer. Well-presented documents will result in a clear understanding by all parties involved. (See Figure 16-7).

©2002 by The Fairmont Press



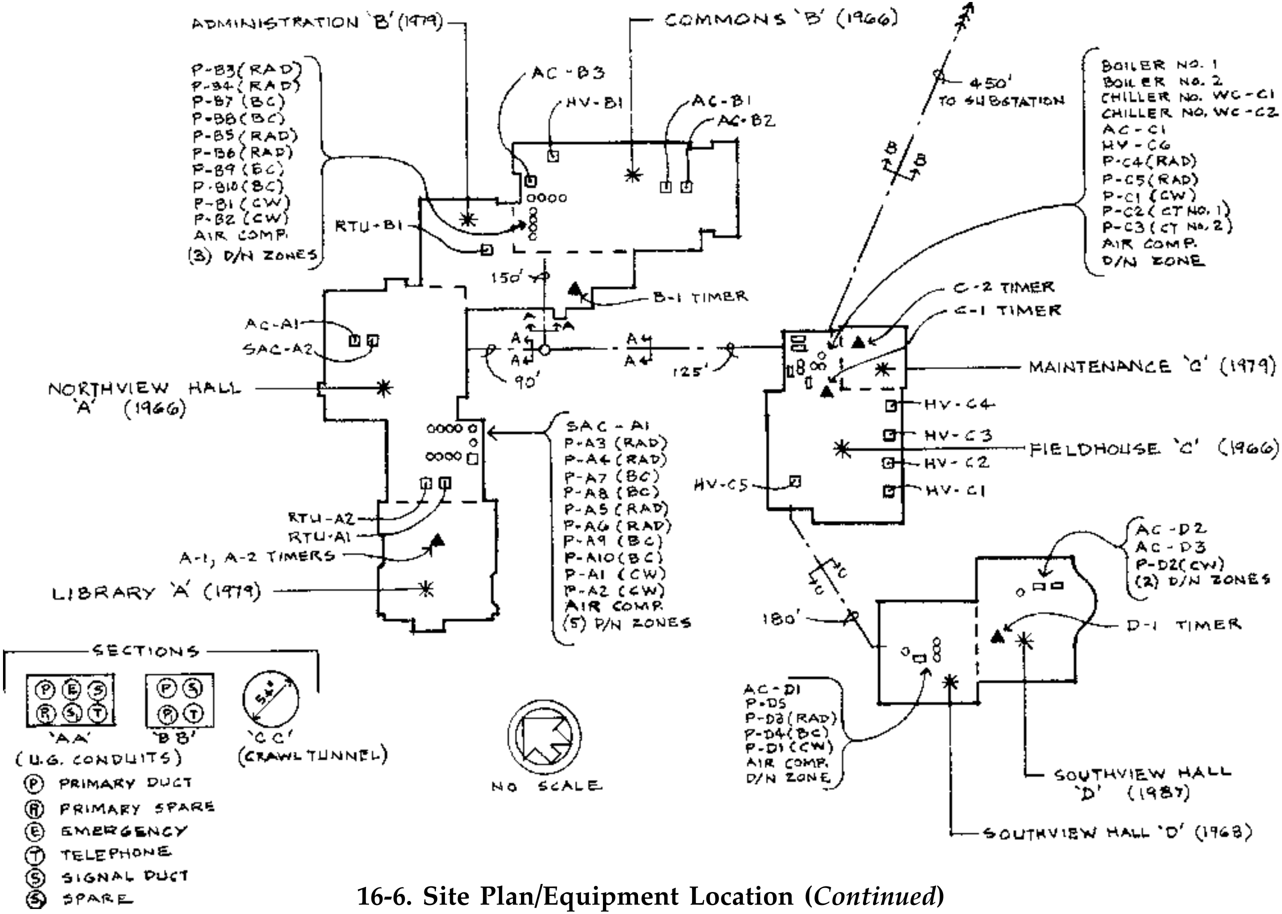
16-5. DDC-EMS System Block Diagram

©2002 by The Fairmont Press



16-6. Site Plan/Equipment Location

©2002 by The Fairmont Press



16-6. Site Plan/Equipment Location (*Continued*)

©2002 by The Fairmont Press

PROJECT No. 8709-03

E.M.S. POINT TABLE

DATE: ________ PAGE: 7 OF 10

CUSTOMER:

LOCATION: FIELDHOUSE/MAINTENANCE BLDG. "C"

SYSTEM: AC UNIT-EXH. FANS-DAY/NITE ZONE-MISC.

HARDWARE

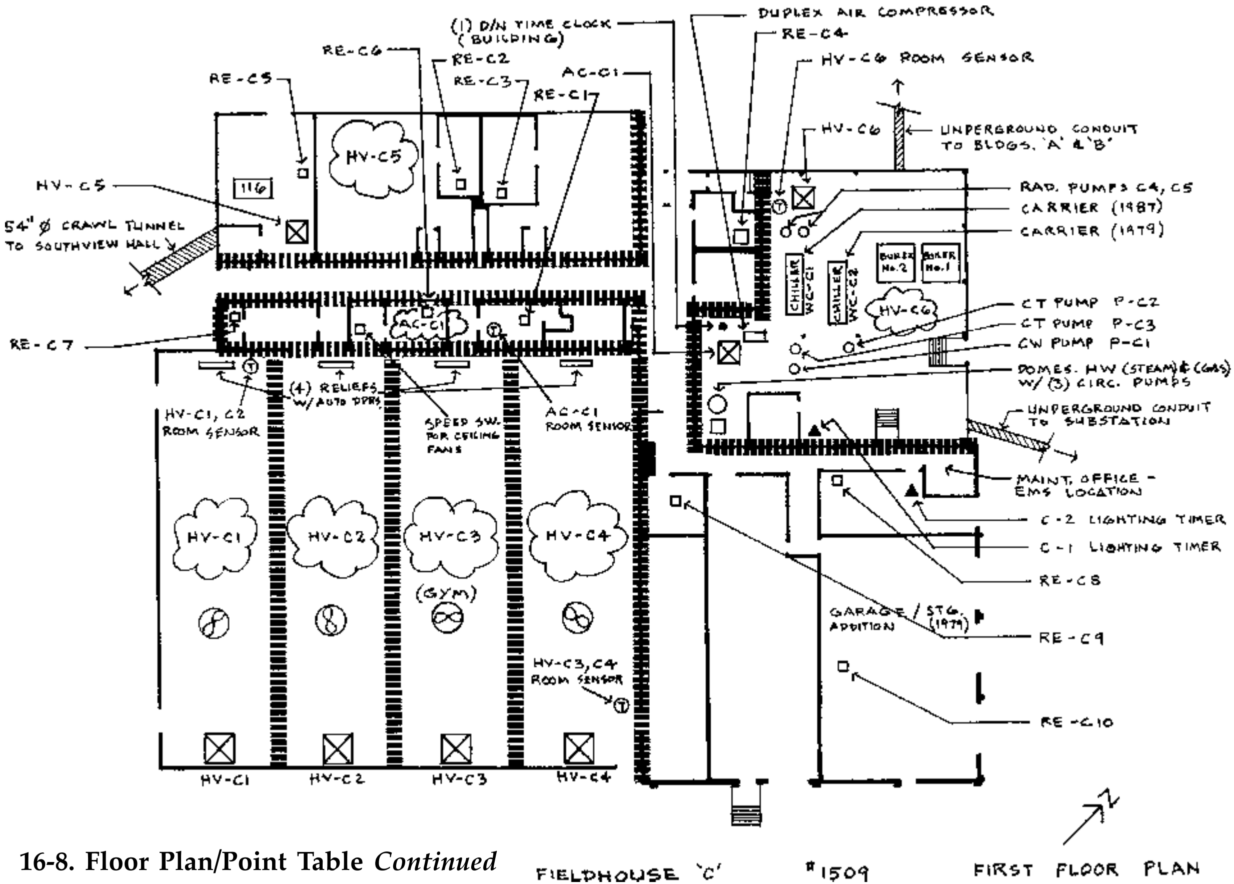
POINT DESCRIPTION	Output Digital: Control Relay	Solenoid	Contactor		Output Analog: Pneumatic Transducer	Electrical Transducer	4-20MA Module		Input Digital: Pressure Switch	Flow Switch	Switch Closure	Auxiliary Contact	KW		Input Analog: Temperature	Relative Humidity	PSIg. PSId	Position	Flow	Current Xfmr. (Optional)
AC-C1 FAN MOTOR (OFFICES)		/								/										
O.A. DAMPER		E/S																		
DISCH. AIR															/					
ROOM															/					
EF-C2 & C3 (SHOWERS)		/																		
EF-C4 (TOILETS		/																		
EF-C5 (WT. ROOM)		/																		
RE-C8 (CARPEN. SHOP)		/																		
RE-C9 (STORAGE)		/																		
RE-C10 (VEHICLE STOR.)		/																		
DAY/NITE ZONE (FIELDHOUSE)		/																		
DUPLEX AIR COMP.									/											
C1 LIGHTS TIMER (LOTS 2,3,4 & EAST WALKS)	/																			
C2 LIGHTS TIMER (LOTS 5 & MAINT. PARK)	/																			
GYM CEILING FANS	/																			
OUTSIDE AIR															/	/				
OUTSIDE PHOTOCELL												/								
ELECT. DEMAND METER													/							

SOFTWARE

POINT DESCRIPTION	Alarms Digital: Equipment Status	Maintenance		Alarms Analog: High Limit	Low Limit	Run Time		EMS Functions: Scheduled Start/Stop	Optimum Start/Stop	Duty Cycling	Demand Limiting	Day/Night Setback	Economizer	Ventilation/Recirculation	Temperature Control	Holiday	Hot/Cold Deck Reset	Discharge Reset	Scheduled Auto/close	Hot Water Boiler Opt.	HW OA Reset	Chiller Optimization	Chilled Water Reset	Condenser Water Reset	Chiller Demand Limit	VAV Control	Lighting Control
AC-C1 FAN MOTOR (OFFICES)	/					/		/		/	/					/											
O.A. DAMPER													E						S								
DISCH. AIR				/	/																						
ROOM					/																						
EF-C2 & C3 (SHOWERS)								/								/											
EF-C4 (TOILETS								/								/											
EF-C5 (WT. ROOM)								/								/											
RE-C8 (CARPEN. SHOP)								/								/											
RE-C9 (STORAGE)								/								/											
RE-C10 (VEHICLE STOR.)								/								/											
DAY/NITE ZONE (FIELDHOUSE)								/								/											
DUPLEX AIR COMP.	/				/																						
C1 LIGHTS TIMER (LOTS 2,3,4 & EAST WALKS)								/								/											/
C2 LIGHTS TIMER (LOTS 5 & MAINT. PARK)								/								/											/
GYM CEILING FANS								/								/											
OUTSIDE AIR													/														
OUTSIDE PHOTOCELL								/								/											/
ELECT. DEMAND METER											/																

16-7. Floor Plan/Point Table

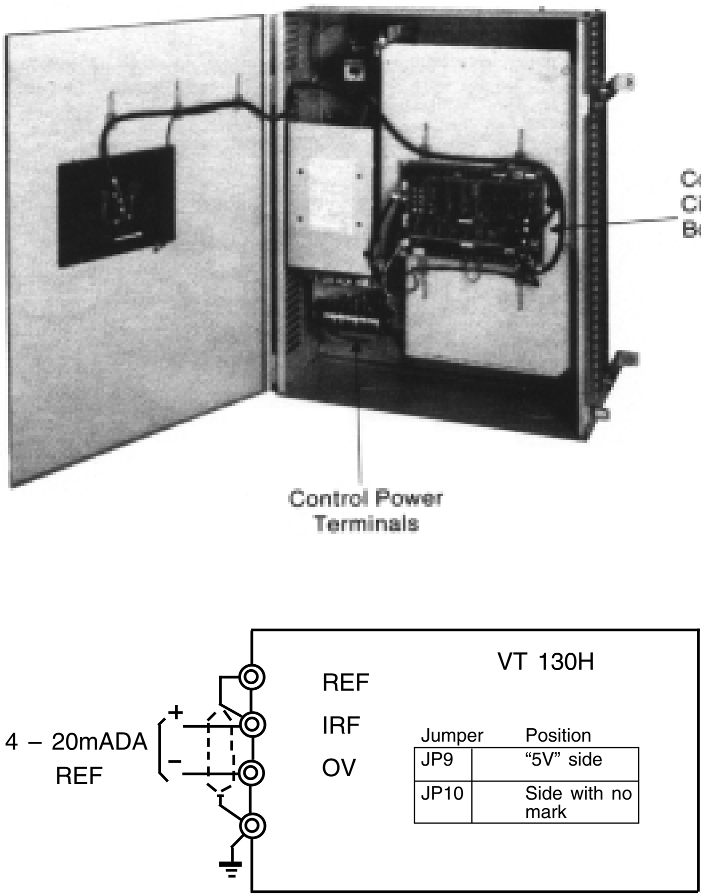
©2002 by The Fairmont Press



16-8. Floor Plan/Point Table ***Continued***

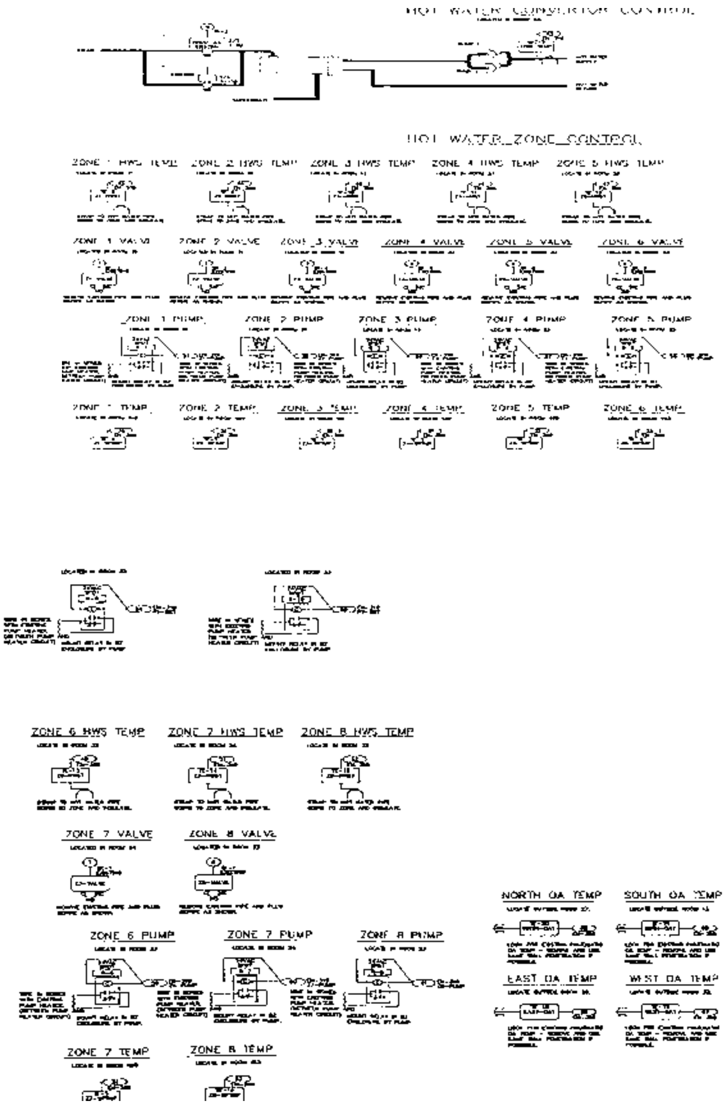
©2002 by The Fairmont Press

Installation details are sometimes required for interfacing connects to special equipment or as a guide for the proper hook-up of equipment. Figure 16-8 shows how an existing variable speed drive is wired and which terminals you desire the installer to connect to for the 4-20 mA control signal. Figure 16-9 shows the correct and incorrect methods of wiring a fan status point.



16-8. VSD Wiring Connections

©2002 by The Fairmont Press



16-9. Fan Status Wiring

©2002 by The Fairmont Press

There are two basic methods of developing a final document for an EMS: 1) **Specification** and 2) performance-based request for proposal. With the request for proposal, a very general and sometimes vague performance specification is written and vendors submit a detailed description and quotation of the EMS (as they interpret the specs) and all of its components, both hardware and software, on which the proposal is based. This process requires a panel of EMS experts to evaluate each proposal to assure they are in compliance.

Developing a specification for a DDC EMS should result in:

1. State-of-the-art DDC system at a reasonable cost.
2. A user friendly and simple to operate system.
3. Reasonable time schedule for installation and start-up.
4. Adequate training for operators and maintenance personnel.
5. A smooth acceptance with both parties understanding conditions for acceptance.
6. A good payback in energy and labor savings.
7. Improvement in comfort conditions for building occupants.
8. Easily serviced and maintained system.
9. A dependable and reliable system.
10. A system that is expandable.

The remainder of this section will address the DDC-EMS specification.

The following is a sample table of contents of an EMS specification with a brief comment on each section:

1. General (Scope of Work)

Briefly describe the project, reference existing conditions (items to remove/remain), contractor to provide all material and labor, contractor to visit site. (No additional compensation will be granted because of lack of knowledge of existing conditions). Include on-site supervision, weekly status report, and coordination with other traders.

©2002 by The Fairmont Press

2. Supporting Documents/Technical Proposal

Low bidder shall submit (1) copy within 5 days after bid: number of similar EMSs in operation; (3) EMS owner names to contact; information on local installers; detailed description of all EMS hardware and software; UL evidence; describe future expansion capability; list prices of all components; procedure to add/delete points; cost and breakdown of (1) year service/maintenance contract; remote monitoring capability; actual print-outs of summaries, logs and trend reports.

3. Codes and Permits

All work shall conform to local and national codes. Contractor shall secure and pay for all permits, licenses, and certificates.

4. System Listing

EMS to conform to UL 916 (EMS) and fire ratings (if applicable).

5. Continuity of Service

Contractor shall maintain continuous services. (3) days notice if an interruption is necessary. Existing controls and time clocks are not to be disconnected until EMS is 100% operational.

6. Equipment Access

Install equipment for access to maintain and service.

7. Submittals and Shop Drawings

(4) copies of submittals required within (3) weeks of contract award and are to include technical information, catalog cut sheets, installation drawings, wiring diagrams, and proposed layout. Submit a construction schedule. Software programs to be reviewed before installing same. Refer to Figures 16-10, 16-11, 16-12 for typical submittal.

8. Delivery and Storage of Equipment

Indicate where and how all equipment is to be received and stored.

9. EMS Requirements

Describe in detail EMS central operator station, field panels, software, input/output devices (sensors, relays, transducers), transmission system, LANs, phone connections, portable devices.

©2002 by The Fairmont Press

10. Energy Management and Control Programs

Describe each application software program plus any special control strategy sequences.

11. Signal Protection

Describe method and ratings for lightning production, power spikes, and brown-outs.

12. Wiring

Describe how and where wiring is to be performed including wiring size, conduit requirements, wire molding, and any special circumstances.

13. Control Piping

Specific type of tubing (copper or fire-retardant polyethylene) and how to install.

14. Manuals and Training

(4) sets of as-built control/wiring diagrams including connections to existing equipment. Description narrative of sequence of control. Installation drawings. Catalog data sheets on all hardware. Complete operating instructions for entire EMS. Software manual and software flow diagrams. Point list. Separate section on training to specify when, where, who an how long training sessions are to be held. Include EMS start-up, programming of software, how to add/delete a point, and system maintenance requirements.

15. Contract Completion and Guarantee

Describe all that is to be included in the warranty (adjustments, programming, commissioning, and a written report of EMS status).

16. Compliance

If bidder is not in full compliance, a written document is to be submitted with bid showing non-compliance items.

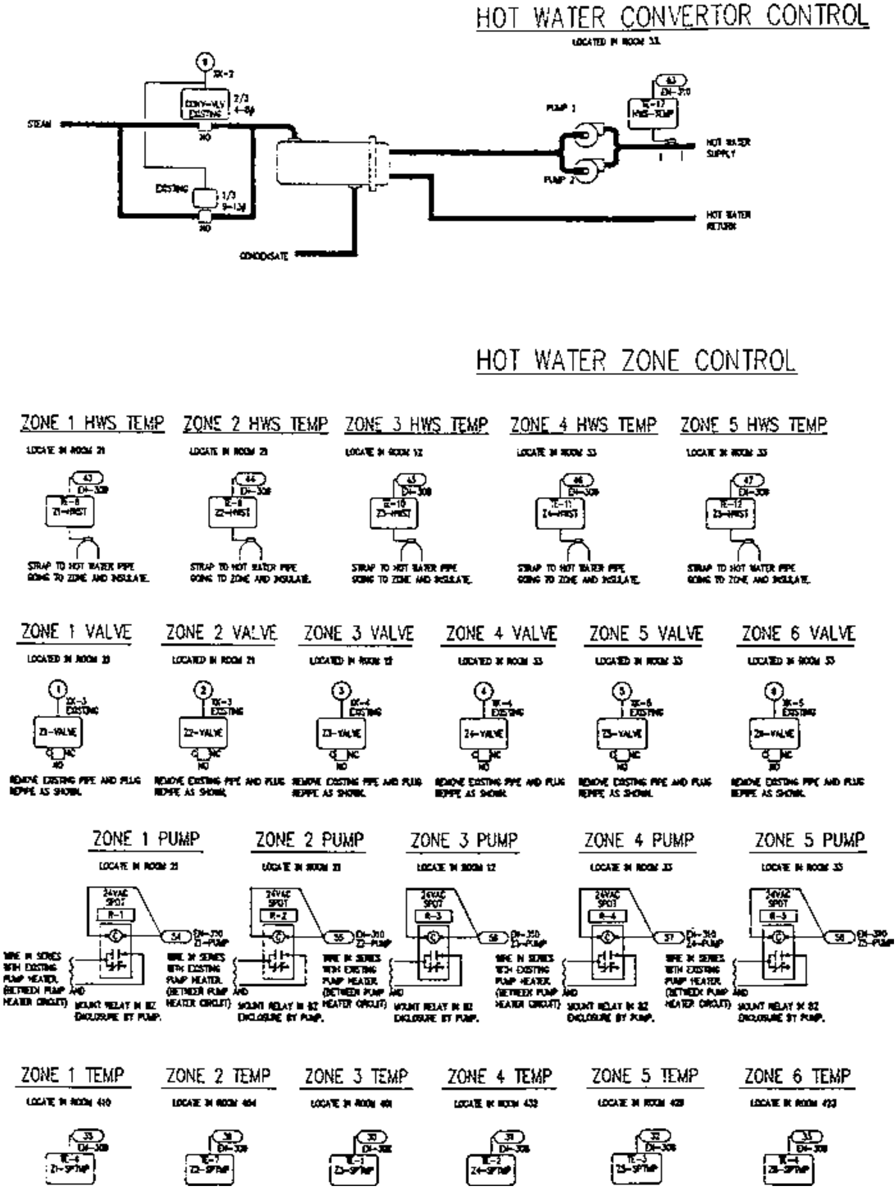
17. Drawings

EMS block diagram, site plan, floor plans with equipment locations, HVAC flow diagram.

18. Point Lists

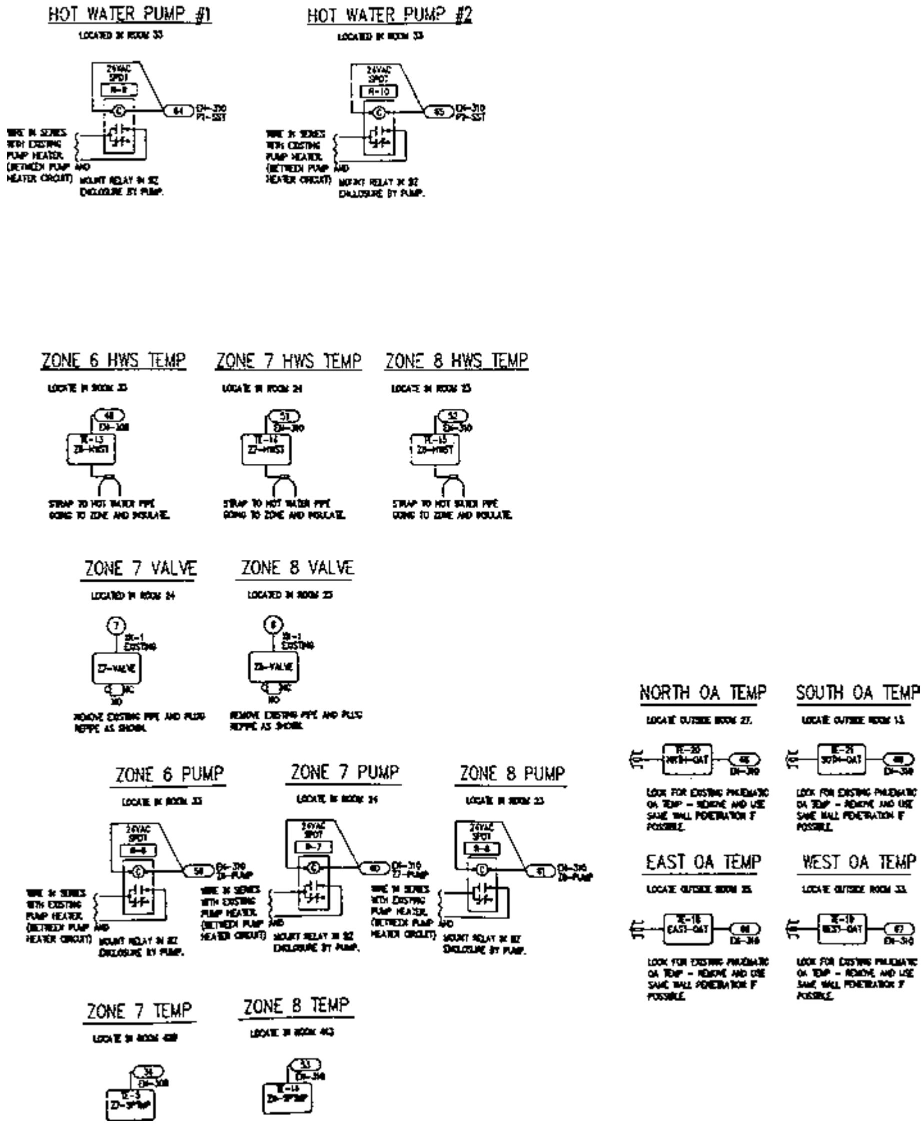
Complete listing of input/output points with reference to special circumstances (see Figure 16-13 for table).

©2002 by The Fairmont Press

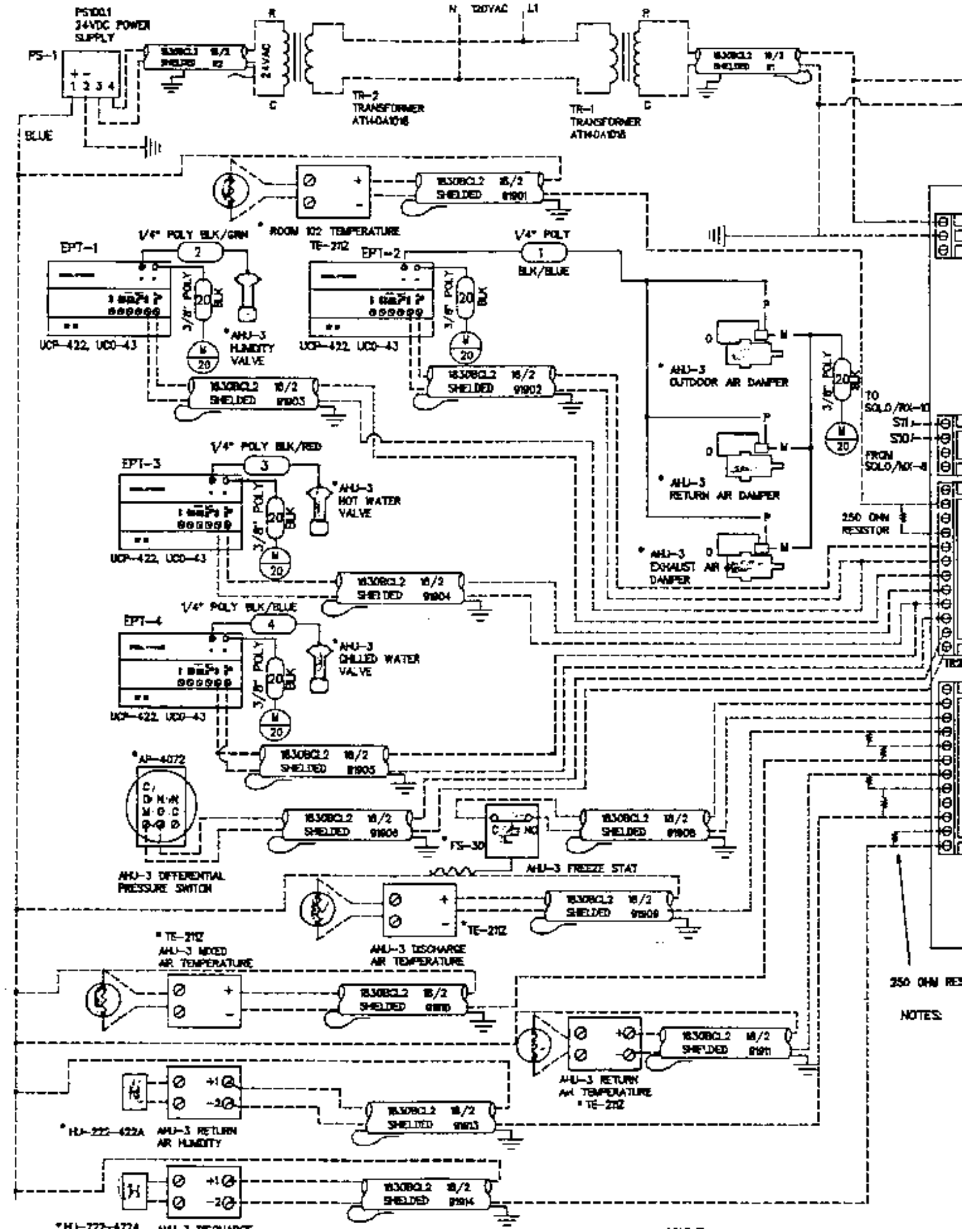


16-10. Zone Controls/Hardware

©2002 by The Fairmont Press

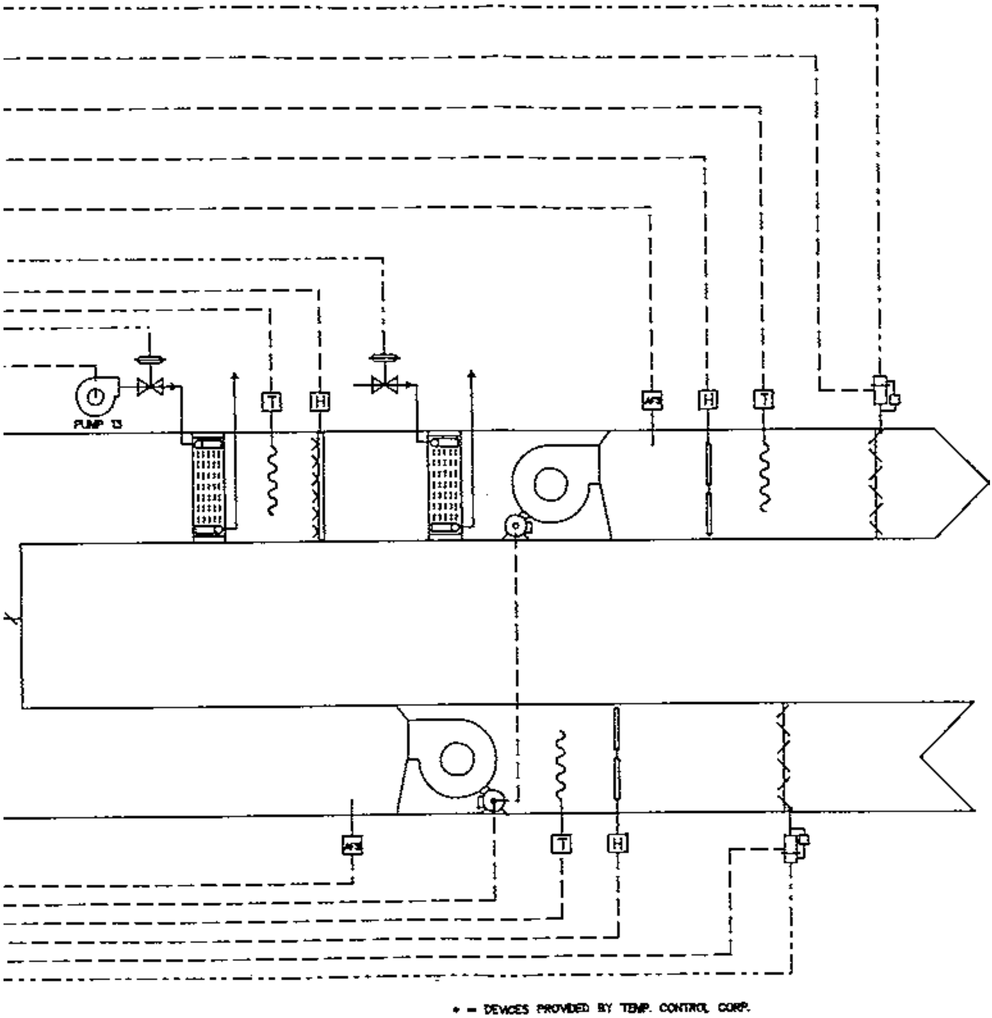


©2002 by The Fairmont Press



16-11. AH Unit/Wiring

©2002 by The Fairmont Press



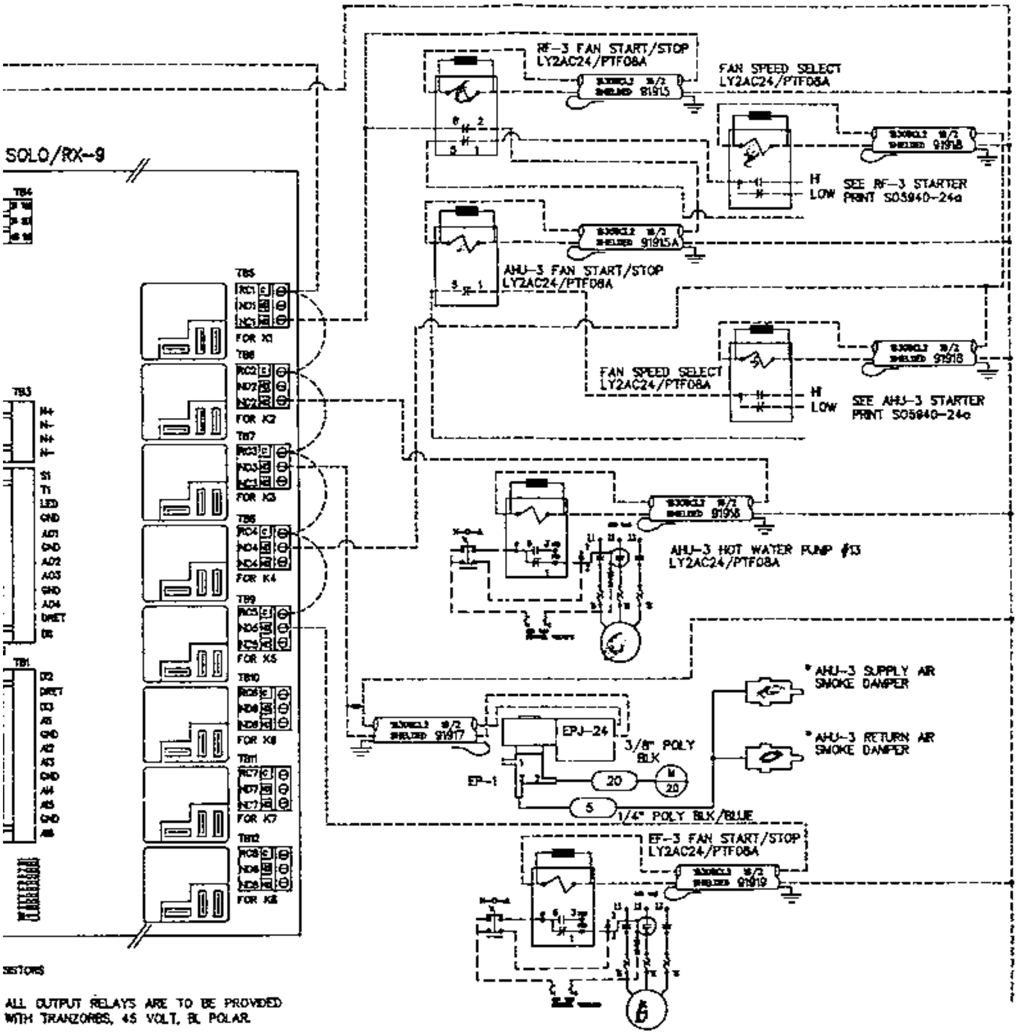
AHU-3

©2002 by The Fairmont Press

	HARDWARE																			
	INPUTS												OUTPUTS							
	ANALOG						BINARY						ANALOG				BINARY			
PROJECT NO.:																				
PROJECT:																				
LOCATION:																				
SYSTEM:																				
POINT DESCRIPTION:	TEMPERATURE	RELATIVE HUMIDITY	PRESSURE	FLOW	POSITION INDICATION		PRESSURE SWITCH	FLOW SWITCH	SWITCH CLOSURE	AUXILIARY CONTACT	DIFF. PRESS. SW.		P/E TRANSDUCER	E/P TRANSDUCER	4-20mA MODULE		CONTROL RELAY	SOLENOID	CONTACTOR	
1.																				
2.																				
3.																				
4.																				
5.																				
6.																				
7.																				
8.																				
9.																				
10.																				
11.																				
12.																				
13.																				
14.																				
15.																				
16.																				
17.																				
18.																				
19.																				
20.																				

16-12. AH Unit/Hardware

©2002 by The Fairmont Press



AHU-3

©2002 by The Fairmont Press

PROJECT NO.:

PROJECT:

LOCATION:

SYSTEM:

	HARDWARE																			
	INPUTS												OUTPUTS							
	ANALOG						BINARY						ANALOG				BINARY			
POINT DESCRIPTION:	TEMPERATURE	RELATIVE HUMIDITY	PRESSURE	FLOW	POSITION INDICATION		PRESSURE SWITCH	FLOW SWITCH	SWITCH CLOSURE	AUXILIARY CONTACT	DIFF. PRESS. SW.		P/E TRANSDUCER	E/P TRANSDUCER	4-20mA MODULE		CONTROL RELAY	SOLENOID	CONTACTOR	
1.																				
2.																				
3.																				
4.																				
5.																				
6.																				
7.																				
8.																				
9.																				
10.																				
11.																				
12.																				
13.																				
14.																				
15.																				
16.																				
17.																				
18.																				
19.																				
20.																				

16-13. Point Table

©2002 by The Fairmont Press

PAGE: ________ OF: ________
DATE: ________
REV.: ________
BY: ________

SOFTWARE																			COMMENTS
ALARMS							FUNCTIONS												
ANALOG			BINARY																
HIGH LIMIT	LOW LIMIT	RUN TIME	EQUIPMENT STATUS	MAINTENANCE	LOW PRESSURE		SCHEDULED START/STOP	HOLIDAY SCHEDULE	OPTIMUM START/STOP	DAY/NIGHT SETBACK	SCHEDULED AUTO/CLOSE	DEMAND LIMITING	ECONOMIZER (D.B.)	TEMPERATURE CONTROL	DISCHARGE RESET	VAV CONTROL			

©2002 by The Fairmont Press