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UNIFIED FACILITIES CRITERIA (UFC)

UTILITY MONITORING AND CONTROL SYSTEMS

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UNIFIED FACILITIES CRITERIA (UFC)

UTILITY MONITORING AND CONTROL SYSTEMS

U.S. ARMY CORPS OF ENGINEERS (Preparing Activity)

NAVAL FACILITIES ENGINEERING COMMAND

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes are indicated by **1**\ ... /**1**/)

Change No.	Date	Location

This UFC supersedes TI 811-12, dated 18 August 1998. The format of this UFC does not conform to UFC 1-300-01; however, the format will be adjusted to conform at the next revision. The body of this UFC is a document of a different number.

FOREWORD

\1\
The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD(AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

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TI 811-12
18 August 1998

US Army Corps of Engineers®

Technical Instructions

Utility Monitoring And Control Systems

Headquarters
U.S. Army Corps of Engineers
Engineering and Construction Division
Directorate of Military Programs

TECHNICAL INSTRUCTIONS

UTILITY MONITORING AND CONTROL SYSTEMS (UMCS)

Approved for public release; distribution is unlimited.

Record of Changes (changes indicated \1\... /1/)

No.	Date	Location

This Technical Instruction supersedes EI 16E010, dated 15 April 1997

FOREWORD

These technical instructions (TI) provide design and construction criteria and apply to all U.S. Army Corps of Engineers (USACE) commands having military construction responsibilities. TI will be used for all Army projects and for projects executed for other military services or work for other customers where appropriate.

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FOR THE COMMANDER:

/S/
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UTILITY MONITORING AND CONTROL SYSTEMS

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CHAPTER 1

INTRODUCTION

1. PURPOSE. This manual provides a methodology and standards for the design of Utility Monitoring and Control Systems (UMCS) and for other computer automation systems which sense the physical environment and control equipment. The methodology described will be used for design of each system.

2. SCOPE. This manual provides design guidance for new UMCS, expansion of existing UMCS, upgrade of existing Energy Monitoring and Control Systems (EMCS) to UMCS, and expansion of existing EMCS. This manual includes guidance for both direct digital control and supervisory control implementations of UMCS and EMCS.

3. REFERENCES. Appendix A contains a list of references used in this document.

4. UMCS. A UMCS is a utility management system which may be used to achieve utility cost, energy, and manpower savings for electrical systems, heating, ventilating, and air conditioning, water and sanitary sewer systems, process equipment, lighting, chillers, boilers and other utility systems and equipment. The UMCS may also be used to assist in building and maintenance management. The UMCS employs personal computers or workstations, associated peripherals, microprocessor-based field equipment panels, instrumentation, control equipment, and applications programs written in high level computer languages like FORTRAN, C, or PASCAL. The UMCS is configured as a network with control functions at multiple locations and one or more central points of operator control and supervision. The UMCS, depending on its configuration, may include a central station, one or more island stations, and various combinations of peripherals, data transmission systems, field equipment panels, necessary interfacing controls, and instruments. Field equipment panels include smart field panels, remote terminal units, universal programmable controllers and unitary controllers which perform field input/output (I/O) functions. The smart field panel contains a microprocessor and other supporting electronics, and performs local control functions and applications programs without requiring communications with the central station or island stations.

5. EXISTING EMCS. An EMCS is an energy management system similar to a UMCS. In the past, many EMCS have been installed primarily to save energy and reduce electrical demand. The new terminology, UMCS, reflects the broader use of the system to improve the operation of utility systems and equipment. Existing EMCS which are operating satisfactorily may be expanded provided that the required equipment is commercially available and the Government has the necessary documentation and technical data and computer software licenses. Existing EMCS which are not operating satisfactorily or for which the Government does not have the necessary documentation and technical data and computer software licenses can be upgraded to or replaced by UMCS. The EMCS, depending on its configuration, consists of a central control unit with various combinations of peripherals, data communication systems, field equipment panels, necessary interfacing controls, and instruments. Field equipment panels, referred to as field interface devices, contain a microprocessor and other supporting electronics. Field I/O functions are performed by a multiplexer which is functionally part of the field interface device, although it may be remotely located. In the non-communicating or "stand-alone" mode, the field interface device performs certain local control functions and applications programs (utilizing default values for global information) without requiring communications with the central control unit.

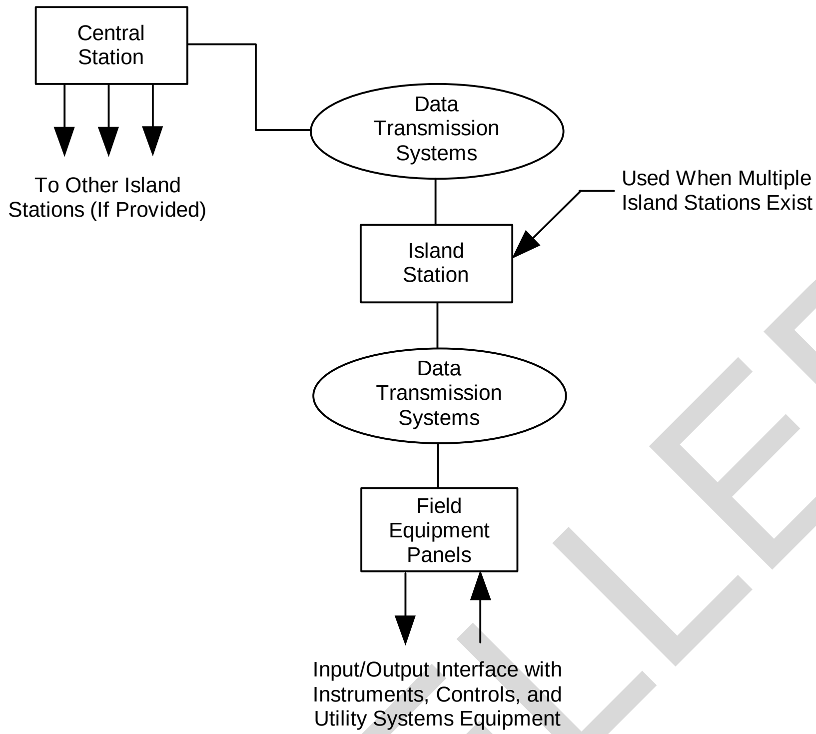


Figure 1-1. Typical UMCS Configuration.

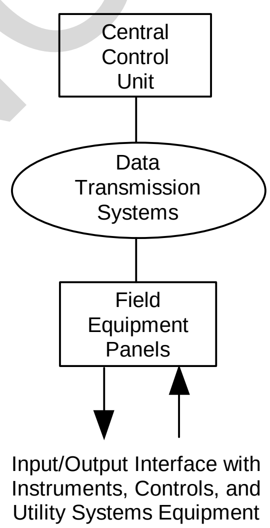


Figure 1-2. Typical EMCS Configuration.

CHAPTER 2

GENERAL CONSIDERATIONS

1. RELIABILITY. The independent (stand-alone) operation of the smart field panel ensures that equipment under its control will continue to operate in the absence of communications with the central station or island station. In this stand-alone mode, each smart field panel will continue to perform most functions, including data collection, time scheduled operations, space temperature adjustments, complex control algorithms and sequences of operation, and self-diagnosis. Failure of any smart field panel must not adversely affect performance of the rest of the UMCS. The only exception allowed is the condition where another smart field panel, the central station or island station require data from the failed smart field panel. An example is peak demand prediction calculations used in electrical demand management, which cannot be performed if the smart field panel which collects the electric metering data is not operating and/or communicating with the central station or island station and other smart field panels.

2. EXPANDABILITY. A UMCS is installed under contracts that provide the Government with legal rights in technical data and computer software, and specific site license agreements allowing for system expandability. Additional hardware and/or software may be required for incorporating new buildings, control points or other systems into the UMCS. The expansion of systems must be developed with great care. Particular care must be exercised in evaluating the feasibility of expanding existing EMCS, since expansion may be a cost-effective solution.

3. BENEFITS. Application of UMCS design features required by this manual, such as distributed processing, results in efficient use of the central station and island station computers, since many time-consuming operations take place in the smart field panel. The central computer systems utilize their processing time performing central alarm reporting, trend logging, electric demand limiting, global energy optimization functions, and supporting operator interface functions such as graphic displays.

4. APPLICATIONS. UMCS may perform many utility management functions, including maintenance management, monitoring of water treatment plants/ industrial facilities, and other utility related tasks, provided that agency guidelines on funding and applications are satisfied. In buildings having life safety systems utilizing UMCS controlled devices, coordination of priorities for control of the final device, such as a damper, will be determined and specified. Life safety functions and equipment will have priority over UMCS control functions. Utility system applications of UMCS include monitoring and limited control of electrical distribution systems; emergency generators and fuel storage; exterior and interior lighting systems; water treatment and distribution systems including storage tanks, distribution piping, booster pumps, and treatment plants; sanitary sewer systems including sewage lift stations; irrigation systems; hot water and steam boiler plants and heating distribution systems; chiller plants including chillers, pumps, cooling towers and chilled water distribution systems; building systems such as heating, ventilating and air conditioning systems; electric power systems; thermal storage systems; domestic water systems; cold storage and refrigeration systems; and specialty systems such as compressed air and medical gas systems. In general, the UMCS is not used for fire alarm or security systems.

5. CODES AND STANDARDS. Design of the UMCS will incorporate all applicable codes and standards. Regulations which are in effect for the specific site at the time the drawing & specifications are prepared will be incorporated.

6. FUNCTIONAL EQUIVALENCY. This manual defines the minimum needs of the Government. Some manufacturers offer systems in response to the Government's need which vary in system architecture and physical arrangements. The procuring activity must determine whether or not the system offered in response to the Government's requirements does, in fact, meet or exceed the specified arrangement. One example of functional equivalency is the use of network-compatible smart field panels which communicate directly with the island station local area network (LAN). In this system configuration all data communication management functions are handled by the network devices and the island station

computer, eliminating the need for the separate communication processor described in this manual for systems with multiple communication channels.

7. POWER LINE CONDITIONER. Power line conditioners protect UMCS equipment from power line fluctuation and noise which can result in computation error, erratic operation, loss of data, overheating, circuit burnout, and in some cases, system shutdown. The power line conditioner provides attenuation of the power line noise by using isolation transformers. It provides a regulated voltage source by using solid state devices that provide fast response to changes in incoming voltage or load conditions; however, they do not protect the UMCS from power outages. Power line conditioners will be provided for all central station equipment, island station equipment, smart field panels and remote terminal units except equipment for which the design includes an uninterruptible power system (UPS). Each power line conditioner will be sized for 125 percent of the required load for the connected equipment.

8. UNINTERRUPTIBLE POWER SYSTEM. An uninterruptible power system will be provided for UMCS equipment which must operate continuously under all conditions including loss of commercial power. Static uninterruptible power systems provide continuous, conditioned, single-phase AC power while operating either from an AC line power source or from DC storage batteries. The batteries will be sized for a minimum backup time of 15 minutes or as required by the installation and application. The UPS also protects UMCS equipment from power line fluctuation and noise similar to the power line conditioner. Uninterruptible power systems will be sized for 125 percent of the required load for the connected equipment.

9. INTERCOMMUNICATIONS SYSTEMS. An intercom system can be used to communicate with field personnel while performing checkout, maintenance, and trouble shooting tasks for UMCS. The intercom system can also facilitate the checkout and acceptance of the UMCS by providing communication between field equipment panel locations and the central station or island station. Implementation of an intercom system will require dedicated circuits between the central station or island station intercom and each intercom station, or the encoding of voice communications on the data communication systems. Hand held FM radio units are an alternative to intercommunications systems.

10. INTERFACE AND FUTURE EXPANSION. When specifying the central station or island station, provision must be made for additional peripherals such as workstations which may be required in the future when expanding or modifying the UMCS. In addition, provision may be necessary for a central station to communicate with additional island stations which may be required in the future. Hardware and software communication protocol documentation, required to implement a system expansion, must be provided by the original system manufacturer via appropriate license agreements. If future planning at the facility indicates an expansion and the potential need for both a central station and one or more island stations, costs for the system can be deferred to the future project by installing the field equipment with only a single island station; or, depending on agency criteria and cost tradeoffs, it may be more prudent to initially procure the central station and one or more island stations.

11. CONSOLE AND ACCESSORIES. The central station and each island station will contain necessary accessory equipment to support operation of the system, including a desk type console, swivel chairs with casters, paper trays for printers, and storage enclosures for test equipment, magnetic cartridge tapes, printer paper and other supplies. The console will contain sufficient surface area for the operator's workstations and work area. Equipment cabinets and accessories will be color coordinated. Figure 2-1 is typical for a central station or island station equipment room.

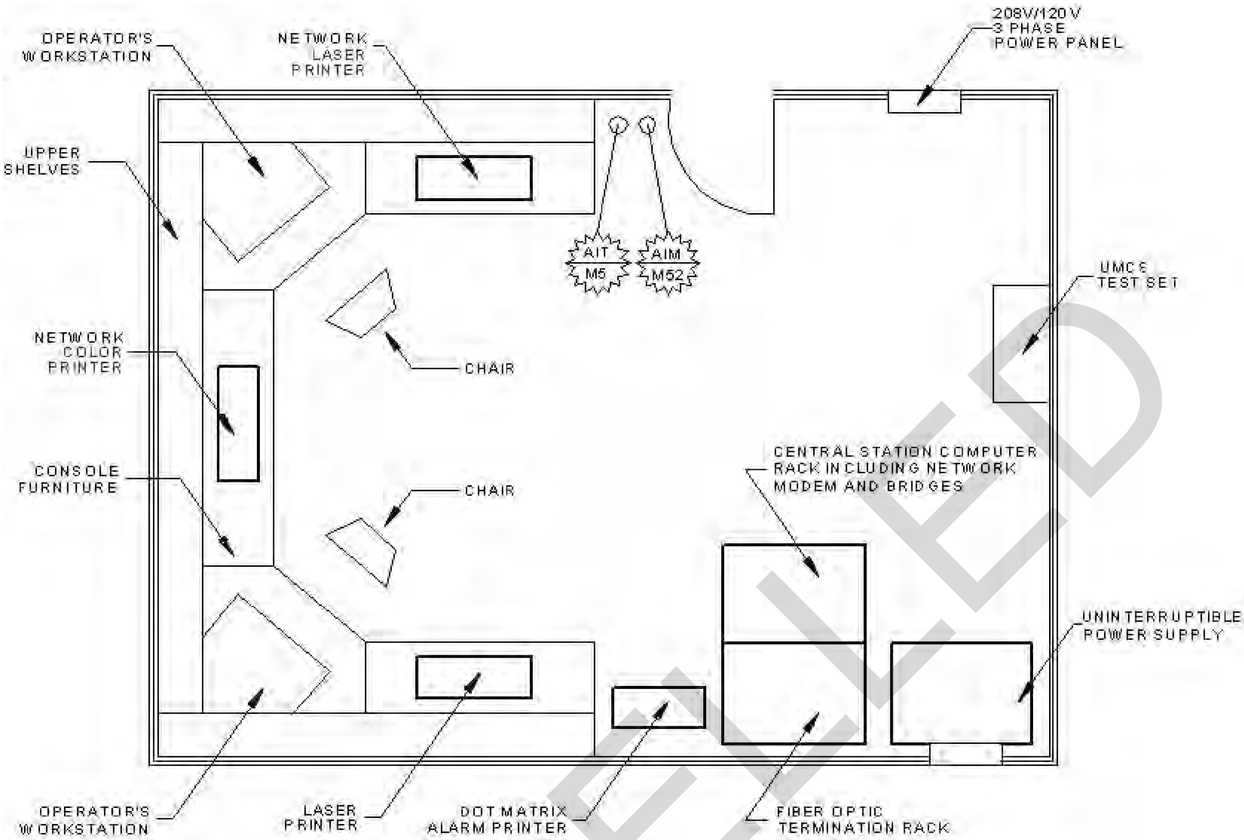


Figure 2-1. Typical Central Station or Island Station Equipment Room.

12. SUPPORT EQUIPMENT.

a. A UMCS test set, consisting of a smart field panel and input/output simulator, is part of the system that enables the operator to simulate and display the operation of a smart field panel. Analog and digital sensor input conditions are adjustable from the simulator's control panel. The simulator receives a control signal from the smart field panel and returns a feedback signal, simulating the performance of various analog sensors or digital monitors. By use of this device, the operator will be able to study system response when new control algorithms are implemented, and verify the performance of programs.

b. A UMCS portable tester provides diagnostics, programming, and database entry functions through connection to a field equipment panel. The tester will include a keyboard, display, and mass storage device sufficient to perform all required diagnostics and exercise all points.

13. TRANSIENT PROTECTION REQUIREMENTS.

a. UMCS equipment is susceptible to interference from two types of transients: functional and damaging upsets.

(1) Functional upsets are transients which may be caused by inductive or capacitive coupling between data lines, control lines, and monitor lines that result in loss of data or improper control actions.

(2) Damaging upsets are transients which may be caused by voltage surges and indirect lightning strikes that physically damage the equipment.

b. Power lines serving the system, nearby electrical and electro-mechanical devices, and lightning strikes are sources of transients.

c. Power line variations, due to transients from large starting loads or other disturbances, may cause temporary low voltage conditions to exist. Power line conditioners or uninterruptible power systems protect UMCS equipment from the effects of powerline variations.

d. Communication links except fiber optic cables, between the central station and island station, between the island station and smart field panels, and between smart field panels and remote terminal units or unitary controllers must have surge protection circuits installed at each end. Triple electrode gas surge arrestors must be installed within 3 feet of the building cable entrance and connected to the building grounding system.

e. Power circuits serving UMCS equipment must be surge protected.

f. Control and sensor lines connected to UMCS equipment must be surge protected.

14. TRANSIENT PROTECTION DEVICES. Surge arresters provide low impedance paths to ground for surge voltage and near-lightning strikes which exceed threshold voltages ranging from 6.8 volts to 100,000 volts. A variety of different devices are available to protect against lightning and other transients in power supplies, data transmission lines, digital hardware, controllers, and instruments. Fuses and circuit breakers will be used to limit current in power supplies from overcurrent and short circuits. Transient protection devices will be used to protect electronic circuits. Types of transient protection are enumerated below.

a. Spark gap surge protection devices, such as gas filled tubes, are generally used to handle surges due to lightning or other transients. Gas filled tubes are available for a range of threshold voltages to meet various applications, such as power or signal lines. Gas filled tubes are relatively slow to react when compared to semiconductor devices, thus requiring that they be used in conjunction with other faster acting protection devices, such as zener diodes. These faster acting devices protect the circuit until the overvoltage is shunted to ground by the gas filled tube.

b. Solid state surge protection devices, such as varistors, silicon avalanche diodes, zener diodes and double anode zeners are semiconductor devices that provide low voltage clamping for high speed transients. Double anode zeners are also used across relay coils to eliminate coil generated electromagnetic interference (EMI). Solid state surge protection devices are used in conjunction with spark gap surge protection devices, to provide protection against overvoltage in excess of the solid state device ratings.

c. Crowbars consist of an electronic circuit that rapidly senses an overvoltage and provides a low impedance path to ground. The overvoltage setpoint of crowbar circuits is adjustable to suit the application. One use of crowbars is to limit the voltage output of DC power supplies.

d. Optical isolators provide DC isolation between interconnecting wiring and input circuits by the use of LEDs and photocells. These circuits are used primarily to isolate control and sensor wiring circuits from the UMCS input circuits. Optical isolators prevent damaging transients from passing through them, but are still subject to failure when large surges occur. Optical isolators typically provide up to 2500 volts RMS isolation.

e. Inductor-capacitor-resistor passive filter networks are used in input/output circuits to attenuate high frequencies associated with fast rise times in voltage transients.

15. GROUNDING. The ideal grounding system is one which provides a zero impedance path for currents at all frequencies the system is expected to encounter. The most common type of grounding system consists of a grounding circuit that is terminated by rods or pipes driven into the ground. Use of

underground well casings and building structural steel members in accordance with the National Fire Protection Association No. 70 are other acceptable means of grounding. To meet grounding resistance requirements, it may be necessary to combine several grounding techniques. Instrumentation systems typically require a single point signal ground in addition to a power ground. The signal ground will be connected to the power ground only at the building entrance. Signal grounding conductors which run parallel to primary power or lightning conductors must be avoided. Floating signal grounding systems are not acceptable because of lack of operating stability and shock hazard. All enclosures will be tied to an equipment ground, which will be separate from communications and instrumentation grounds. Grounding will be in accordance with IEEE Standard 142 and IEEE Standard 1100. Additional grounding and power requirements exist for use in computer equipment areas such as the central station or island station. These additional requirements, defined in FIPS-94, "Guidelines for Electrical Power for ADP Installations", will be incorporated in the central station and island station design in addition to other stated requirements.

16. SHIELDING. Electronic circuits sensitive to EMI will be protected by electrical shielding. Shielding is used in telephone lines, twisted pairs, and other circuits to reduce the strength of interfering electric or magnetic fields. Shielding will be grounded only at one end to preclude ground loops.

CHAPTER 3

CENTRAL STATION AND ISLAND STATION HARDWARE

1. HARDWARE CONFIGURATION.

a. The central station and island stations are arrangements of personal computers (PCs), peripherals, and PC based operator workstations communicating together on a local area network (LAN). The central station and island station provide human operator interface, centralized utility optimization routines, and archival data storage for the UMCS. For UMCS extended to multiple geographical and functional areas, each island station provides human operator interface with field equipment panels within a geographical and functional area, while the central station provides supervisory interface with multiple island stations. For UMCS installed at a single installation, the central station provides human operator interface, centralized optimization and archival data storage, and there are no island stations. Depending on the utility monitoring and control needs of the installation, a UMCS may include only a central station or may include a central station and a number of island stations.

b. A UMCS for a single installation requires a central station interfaced with field equipment through data transmission systems. This configuration is illustrated in Figure 3-1.

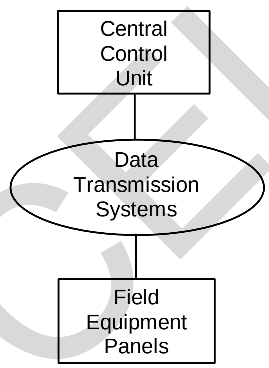


Figure 3-1. Single-Site UMCS with Central Station.

c. A UMCS for multiple installations requires a central station interfaced through data transmission systems to island stations at each remote geographical area. Field equipment at each installation is interfaced through data transmission systems to that installation's island station. Field equipment at the installation containing the central station will be interfaced to the central station. This configuration is illustrated in Figure 3-2.

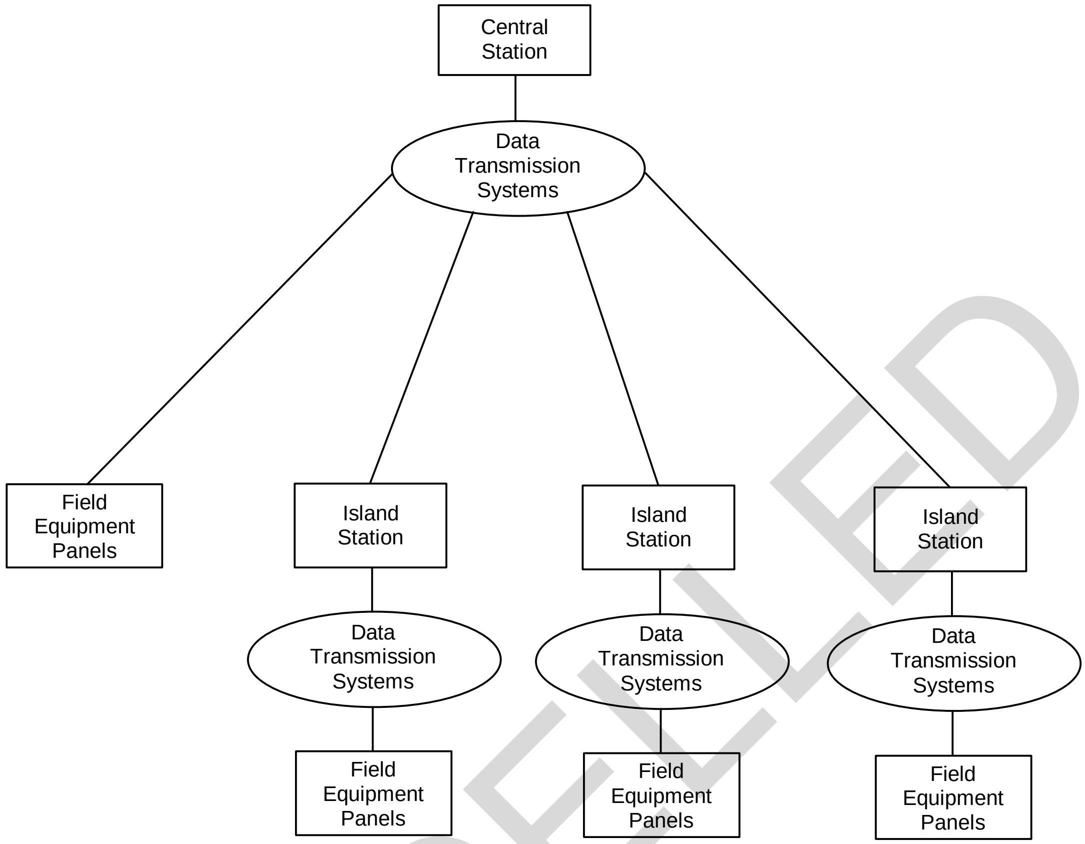


Figure 3-2. Multi-Site UMCS with Central Station and Island Stations.

d. The central station or island station may include the following equipment:

(1) Central station or island station computer.

(2) Communication processor.

(3) Network interface adapter.

(4) Printers.

(5) Workstations.

(6) Local Area Network (LAN)

(7) Modems

(8) UMCS test set with I/O simulator

A typical island station arrangement is shown in Figure 3-3 for an island configuration using multiple data transmission channels to field equipment.

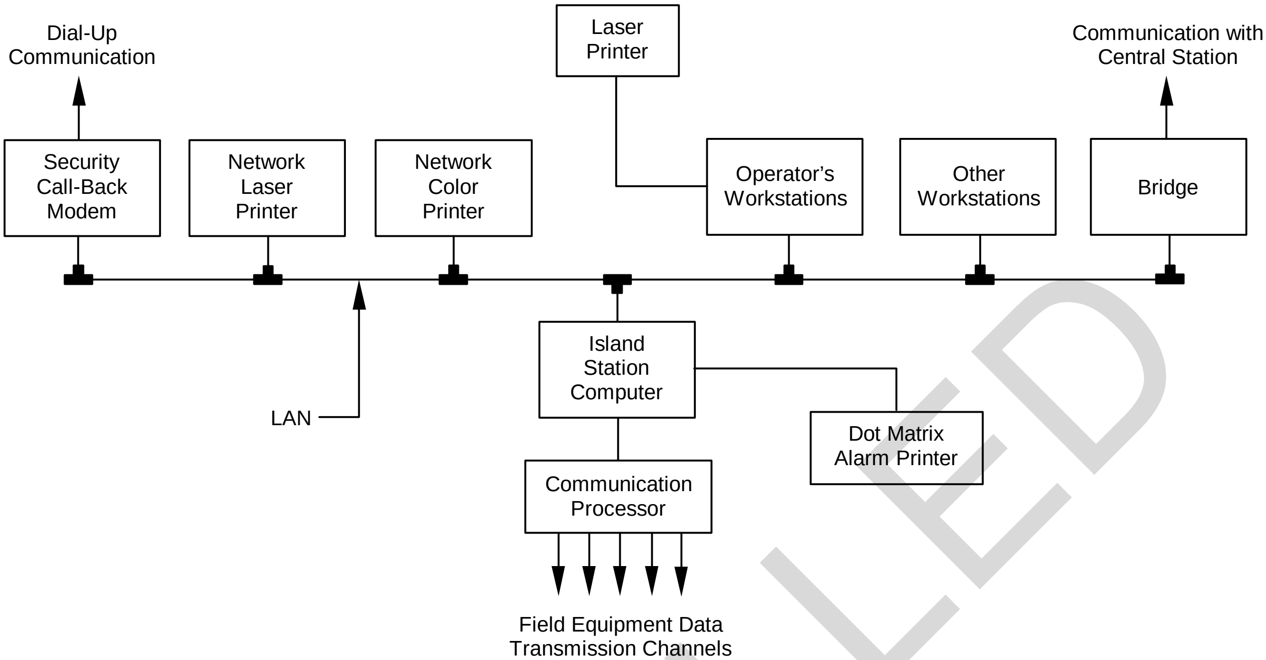


Figure 3-3. Typical Island Station Arrangement (Multiple Data Transmission Channels).

A typical island station arrangement is shown in Figure 3-4 for an island configuration using LAN-based field equipment.

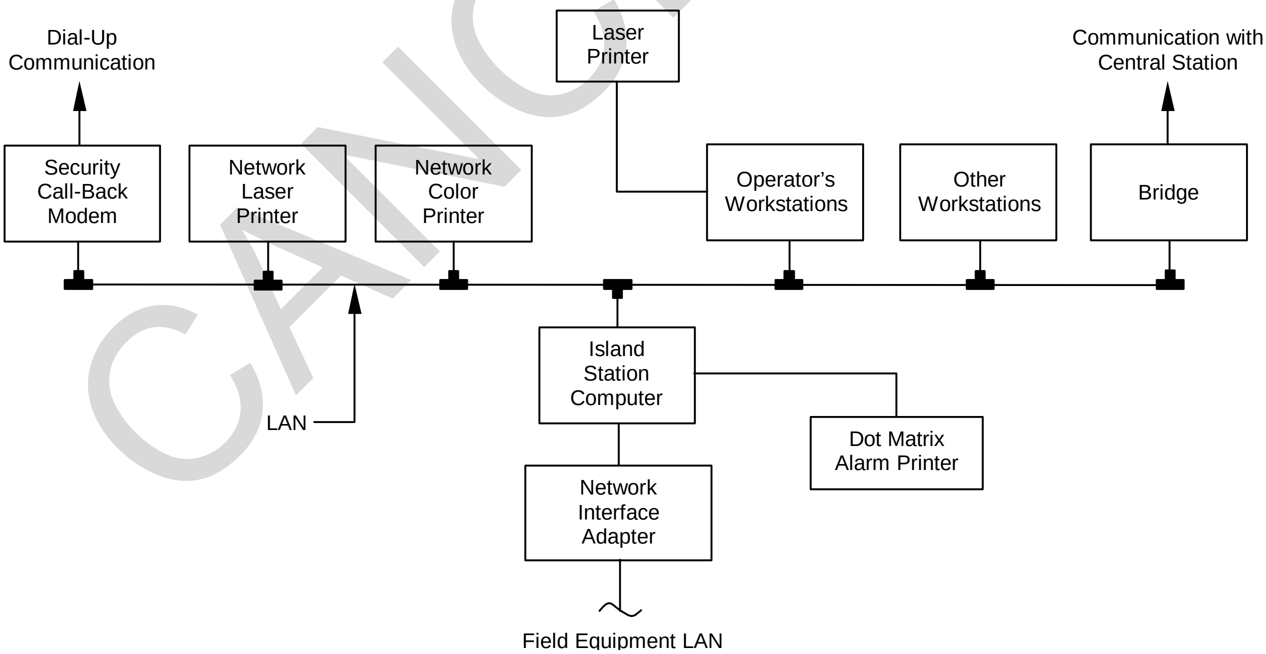


Figure 3-4. Typical Island Station Arrangement (LAN-based Field Equipment).

A typical central station arrangement is shown in Figure 3-5.

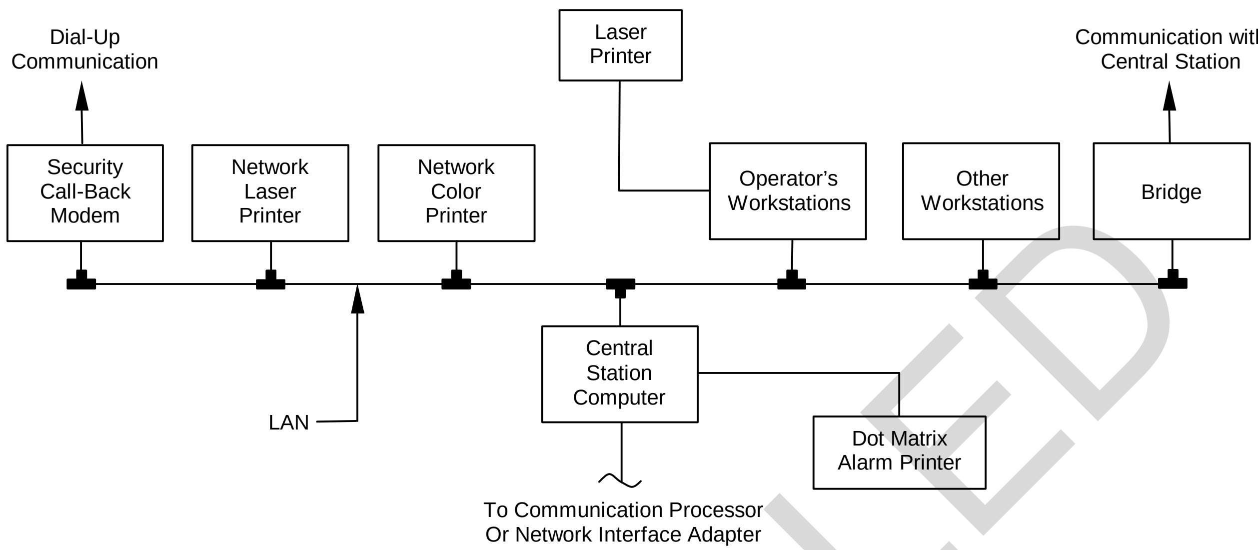


Figure 3-5. Typical Central Station Arrangement.

2. CENTRAL/ISLAND STATION COMPUTER.

a. The central station computer or island station computer functions as the overall system coordinator, performing centralized utility management functions, complex calculations, control of peripheral devices, alarm management and reports management.

b. The central station computer or island station computer is a complete computer system consisting of a system unit with central processing unit, memory, input-output interfaces, keyboard, mouse, monitor, hard disk drives, floppy disk drives, CD ROM drive, cartridge tape drive and WORM drive, and a dedicated dot matrix alarm printer. A block diagram of a central station computer or island station computer is provided in Figure 3-6.

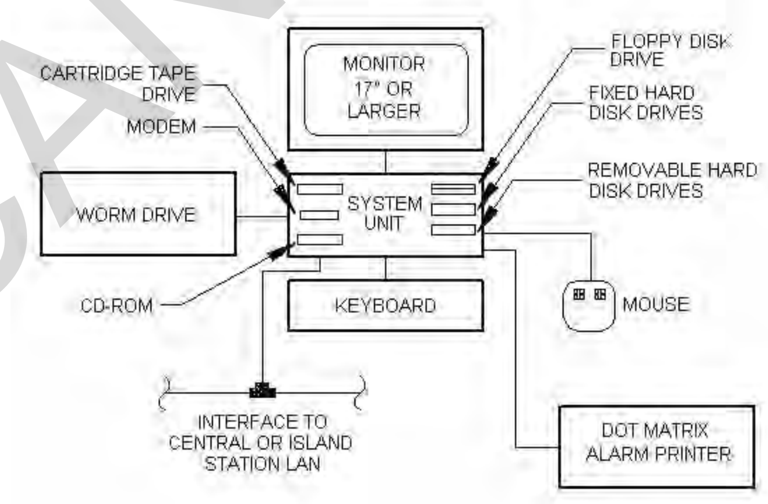


Figure 3-6. Central/Island Station Computer.

3. COMMUNICATION PROCESSOR.

a. The communication processor is provided on systems with multiple dedicated data transmission channels (as opposed to a LAN) between the central/island station and the field equipment. The communication processor functions as the overall communication manager, directing operator commands, alarm messages, status information and other data between the central/island station computer and the field equipment. On systems with LAN-compatible smart field panels, the communication processor is not required because data transmission between the central/island station and the field equipment is managed by the LAN using the network interface adapter.

b. The communication processor is a special purpose, dedicated processor with a single connection to the central/island station computer and multiple interfaces for communication with field equipment, typically 16 EIA 232 serial ports.

4. NETWORK INTERFACE ADAPTER.

a. The network interface adapter is provided on systems with LAN-based field equipment. The network interface adapter provides a physical media interface and a communication protocol interface between the central/island station computer and the field equipment LAN.

b. The network interface adapter is a special purpose, dedicated processor which is mounted internal to the central/island station computer or interfaced to it through a communication port, with interfaces for one or more field equipment LANs.

5. HARD DRIVES. Hard drives are sealed rotating magnetic storage media integrated with the read/write drive mechanism and controller, and mounted internal to the computer system unit. Advances in equipment technology have resulted in the availability of hard drives with storage capacities in excess of 1 gigabyte. Hard drives are used to store the computer's operating system software, applications software program files, and data files requiring frequent access. Hard drives provide faster file access than other mass memory storage devices such as floppy drives, cartridge tape drives and optical disk drives. Hard drives will not be used as the only file archival mechanism because failure of the hard drive requires replacement of the drive and may result in loss of all files on the drive. Mirrored hard drives or redundant arrays of hard drives should be considered for UMCS with critical data acquisition and storage requirements, where loss of data gathered between archival backups is undesirable. These arrangements will provide for access to all data, even if one hard drive fails. Removable hard drives, which are installed in PCMCIA slots, provide portability of data and can be installed in laptop PCs.

6. FLOPPY DRIVES. Floppy drives are mounted internal to the computer system unit and use removable magnetic media (floppy disks or diskettes). Three and one-half inch floppy disks typically store up to 1.44 megabytes of information. Floppy drives are suitable for small program file updates or for storage and transfer of small data files between computers which are not networked together. Floppy drives are not suitable for most file archival applications because of the low storage capacity.

7. MAGNETIC TAPE SYSTEMS. Magnetic cartridge tape systems are mounted internal to the computer system unit and use removable magnetic tape cartridges for data storage. They can typically store 40 to 250 megabytes of data. Magnetic tape systems are used for file archival/backup.

8. OPTICAL DRIVES.

a. Optical drives are mounted internally to the computer system unit or provided in a separate enclosure with an interface to the computer system unit. Optical drives are used for large file archival applications. Optical drives utilize lasers to read data encoded as discrete variations in reflectivity on optical media (disks). There are several types of optical drive systems which are classified based on the type of disk used.

b. Write-once-read-many (WORM) disks use an organic dye thin film optical recording technique and have typical storage capacities starting at 650 megabytes. Data can only be written to a WORM disk until the disk capacity is filled one time, so there is no risk of accidentally destroying archived data on the WORM disk by overwriting. WORM disks provide very secure archival of large files, such as the static database of a UMCS island, a snapshot of the dynamic database, trend values or graphic display diagrams, and have a life of more than fifteen years.

c. Compact disk read only memory (CD ROM) disks have a typical storage capacity of 650 megabytes. CD ROM disks can only be read from, not written to by an optical drive. A special purpose CD ROM recorder is required to write files to the CD ROM disks. Because of this feature, CD ROM disks are often used for software distribution (such as delivery of a complete system software update from the UMCS manufacturer) instead of archiving. An important advantage of CD-ROM is standardization of the recording format according to ISO guidelines.

d. The rewriteable (or erasable) optical drives have the advantage of high volume data storage capacity (650 Mbytes or 1.3 Gbytes) coupled with the ability to erase and write again. Some manufacturers offer multifunctional drives that will support both the write-once (archival) and erasable (working storage) function. This removable media has a long shelf life of 30 years and is easy to handle and store.

e. Specific optical drives are required for each type and size of disk. Multiple disk changers (jukeboxes) can be provided for installations requiring greater storage capacity.

9. PRINTERS.

a. Dot Matrix alarm printers will be provided for all island stations and central stations, connected to the island/central station computer printer port. Dot matrix alarm printers utilize sprocket-fed fanfold paper up to 11 inches wide, providing hard-copy record of all alarm activity including acknowledgment and return-to-normal. Printing speed and character spacing will be specified for all dot matrix alarm printers.

b. Laser printers with both automatic and manual feed of single sheets will be provided for all island stations and central stations. The system will include dedicated laser printers connected to printer ports on workstations as well as network laser printers. Network compatible laser printers which can be accessed by the central/island station computer or any workstation on the LAN are used to provide economy in cost and in required console areas. Laser printers provide letter quality (high resolution) output suitable for reports. The laser printer resolution, random access memory capacity and printing speeds will be specified for all UMCS.

c. Network Color printers will be included in the design, if required by the installation. Thermal ink jet color printers which allow the use of standard laser printer paper will be used. Although color printers can be used for text printing, they should not be used in place of dot matrix or laser printers because of their slower speed and higher cost per page. Color printers will be connected to the LAN.

10. WORKSTATIONS.

a. A full color, microcomputer based graphic workstation is the primary operator-machine interface. The workstation displays equipment schematics, system status, operating parameters, and equipment operating data. The workstation includes a dedicated keyboard and mouse for entry of operator commands. Graphic displays may be brought up automatically when an alarm is activated, or upon operator command. Operator workstations are located in the central station or island station equipment room. Additional workstations may be located in other areas of the installation based on the installation's requirements. Location of workstations in maintenance shops, such as an HVAC shop, is encouraged. The workstation software permits partitioning of alarms and other information so that, for example, an operator workstation located in the electrical maintenance facility will only display alarms associated with electrical utility systems. The central station or island station LAN may be extended to the additional workstations or they may communicate with the LAN using a network modem.

b. The workstation is a complete microcomputer system consisting of a system unit with central processing unit, memory, input-output interfaces, keyboard, monitor, mouse or trackball, hard disk drive, floppy disk drives, cartridge tape drive and CD ROM drive. Since the UMCS operator requires clear graphic displays which are easily viewed and recognized, the operator workstation monitor will not be smaller than 17 inches (nominal diagonal screen measurement). A block diagram of an operator workstation is provided in Figure 3-7.

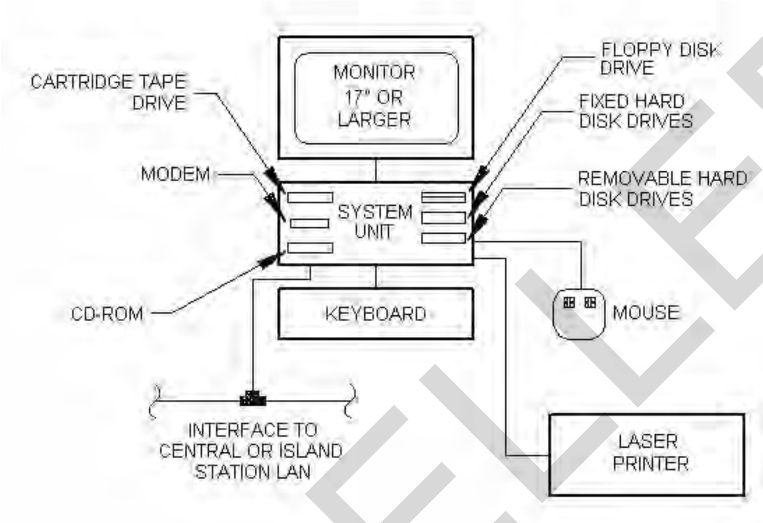


Figure 3-7. Workstation with Laser Printer.

11. LOCAL AREA NETWORK.

a. A LAN is a system composed of hardware, media (cabling) and software which allows computers to share information and resources. The central station or island station LAN will be configured in a bus or star topology as shown in Figures 3-8 and 3-9. In a star topology, cables from network devices are connected to a hub which passes data signals between connected ports. The LAN will utilize fiber optics, twisted pairs, coaxial cable, or radio frequency (RF).

b. Two or more LANs may be interfaced together using dedicated communication circuits, switched circuits, or a packet RF data transmission system to form a wide area network (WAN). Connection of the WAN requires network devices such as network modems or remote bridges at each connected LAN.

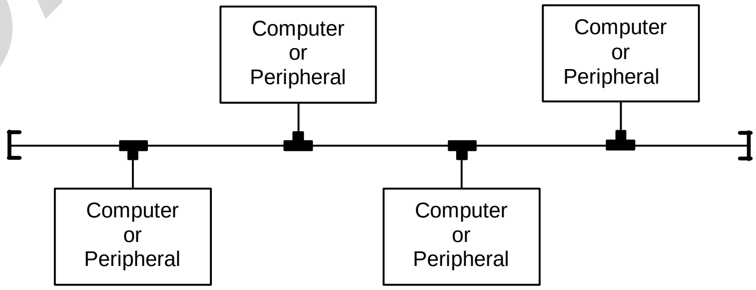


Figure 3-8. Central or Island Station LAN using a Bus Topology.

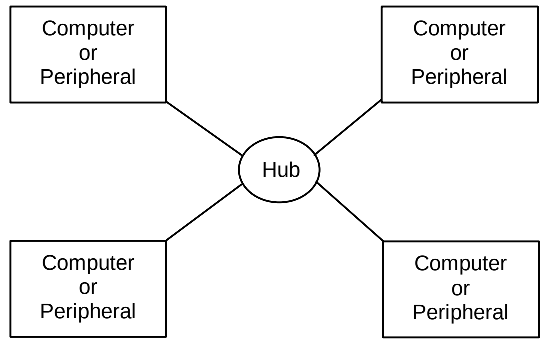


Figure 3-9. Central or Island Station LAN using a Star Topology.

12. MODEMS.

a. A dial-up modem with auto answer security callback and manual originate capabilities will be used for remote interface between the central or island station and a remote location, such as the UMCS supplier's diagnostics facility. The modem allows the supplier's personnel to perform system diagnostic checks and programming from their facilities. However, the security callback feature terminates the connection after auto answer, and then automatically dials a previously established and programmed number, preventing dial-in access to the system from unauthorized locations. The modem's manual originate capabilities allow on-site maintenance personnel to communicate with the supplier's home office to transmit data as required to resolve field problems. The manual originate capabilities are also used by utilities/UMCS operations personnel to establish communication between a central station and an island station in the event that the normal network communication circuits fail.

b. Network modems provide communication between geographically separated LANs or between a remote processor, such as an operator workstation, and a LAN. In some systems, this function is provided by LAN devices referred to as remote bridges.

CHAPTER 4

FIELD EQUIPMENT PANEL HARDWARE

1. HARDWARE CONFIGURATION. The field hardware consists of smart field panels, remote terminal units, universal programmable controllers, and unitary controllers, referred to collectively as field equipment panels. These panels are located in the vicinity of the utility systems monitored and controlled by the UMCS, and communicate with the central station or island station.

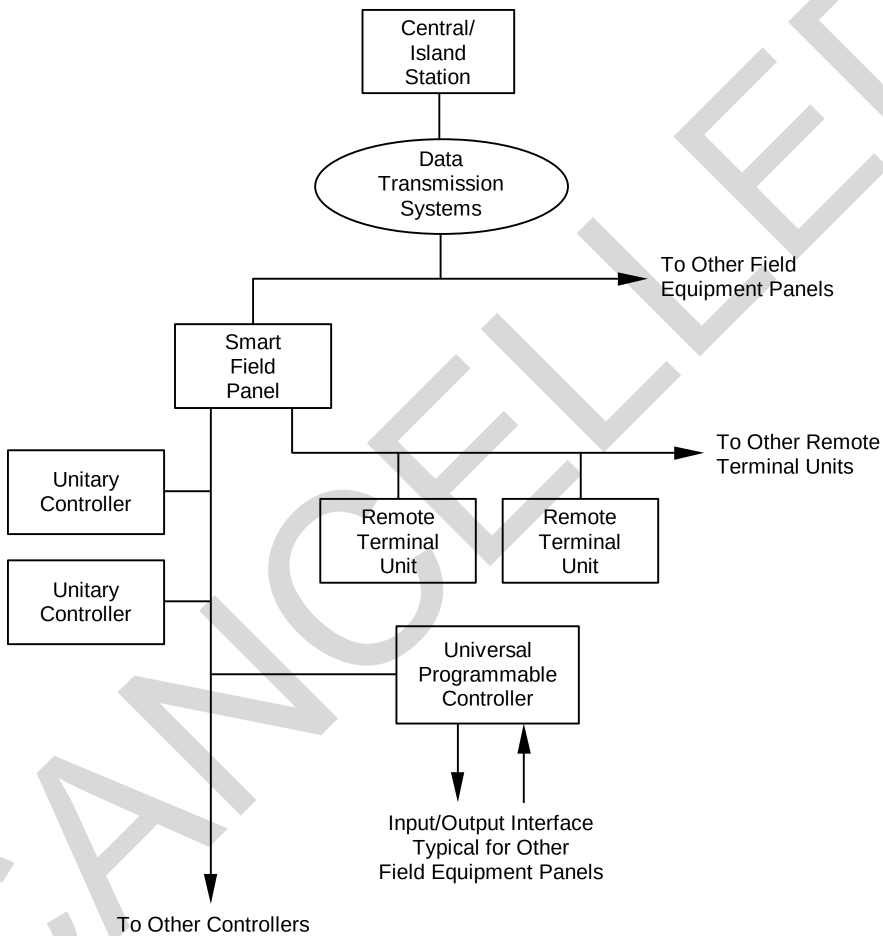


Figure 4-1. Field Hardware.

2. SMART FIELD PANEL.

a. A smart field panel contains a microprocessor, memory, real time clock, communication interface, digital and analog I/O, controls, indicators, and power supply. The smart field panel communicates with the central/island station, where the central/island station provides for operator interaction, global parameter updates, and information requests and accepts information for alarm reporting, logging of events, generation of reports, and display. The smart field panel must function in an independent (stand-alone) mode performing the monitoring and control routines using applications software programs and operating parameters stored in the smart field panel's memory.

b. The smart field panel collects data from instruments interfaced to the utility systems and generates commands to control operating devices such as valves, dampers, motors, and relays. The smart field panel's capabilities include control of all physical parameters such as space temperature, space humidity, and supply water temperature without requiring data or operating parameters from the central/island station. The smart field panel also responds to central/island station requests for equipment operating data and status. The smart field panel transmits alarms to the central/island station for conditions such as high and low temperatures, pressures, flows, unauthorized equipment operation, and field hardware malfunction. Commands from the operator's workstation can result in the downloading of new or revised parameters to adjust setpoints or change operating parameters of equipment.

c. The smart field panel must include sufficient memory to contain the operating system, applications software, database and control sequences for all required operation. Volatile memory is required to be backed up in event of power loss. Software stored in non-volatile memory does not have to be downloaded from the central/island station after an interruption of power occurs.

d. The smart field panel must be equipped with a battery backed internal real time clock function to provide a time base for implementing time dependent programs. The smart field panel's real time clock must be updated by the central/island station at least once a day and upon resumption of communications with the central/island station after any data transmission system interruption.

e. A communication interface in the smart field panel converts the data output of the smart field panel to a signal compatible with the site specific data transmission system for communications with the central/island station. The communication interface must transmit and receive data at rates sufficient to support system response requirements.

f. Resumption of power after an outage will cause the smart field panel to automatically restart and establish communications with the central/island station. If the smart field panel is unable to establish communications, it must still perform all required functions while saving certain data for later uplink to the central/island station. Smart field panel shutdown based on a self-diagnosed failure in the power supply, hardware, or software must set each piece of controlled equipment to a predetermined failure mode.

g. In the situation where the smart field panel will be required to continuously collect data to be transmitted to the central/island station, it will be necessary to provide an uninterruptible power system (in lieu of the power line conditioner) for the entire smart field panel as well as any sensor and controller power required.

h. The smart field panel functionally includes the remote terminal units associated with it whether in the same enclosure or remotely located. The relationship between the central/island station, smart field panels and remote terminal units is shown in Figures 4-2 and 4-3.

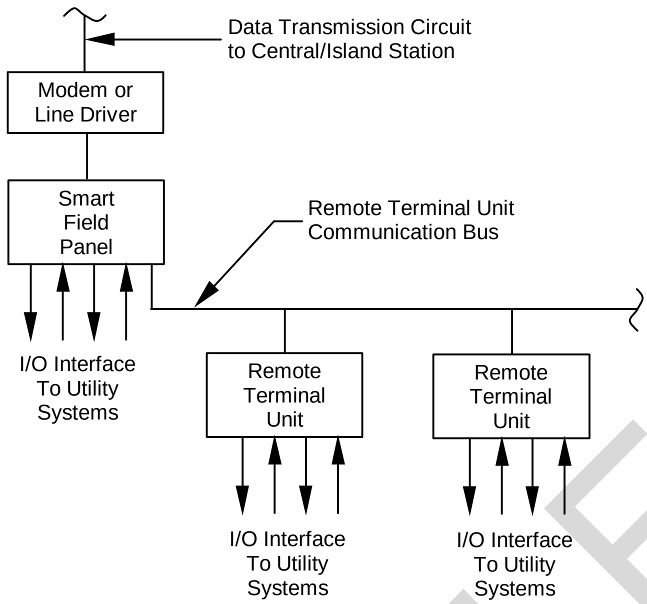


Figure 4-2. Smart Field Panel and Remote Terminal Units (System with Multiple Data Transmission Channels).

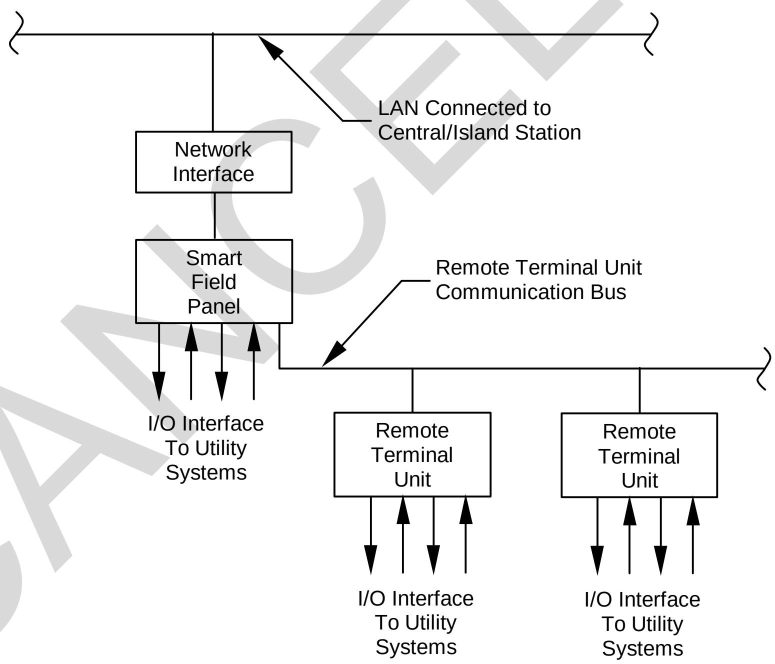


Figure 4-3. Smart Field Panel and Remote Terminal Units (System with LAN-based Smart Field Panel).

3. REMOTE TERMINAL UNIT. Remote terminal units serve as I/O devices for smart field panels and functionally are an extension of the smart field panel. The number of remote terminal units connected to a single smart field panel is limited only by the maximum number of points addressable by a smart field panel, the number of points allowed on a single communication circuit, or by alarm response time. Remote terminal units transmit their data to the smart field panel over a data transmission circuit via

modems, line drivers or LAN. The remote terminal unit contains I/O functions to handle digital and analog data, digital data error detection, and message transmission. Failure of a remote terminal unit must set each piece of controlled equipment to a predetermined failure mode. Remote terminal units will have an uninterruptible power system to sustain operation during a power failure in those situations where their associated smart field panels also require an uninterruptible power system.

4. UNIVERSAL PROGRAMMABLE CONTROLLER. Universal programmable controllers are field programmable stand-alone controllers which are used to control HVAC systems, central plant equipment, or entire small buildings. The universal programmable controller contains a seven-day calendar and a real-time clock so that building, equipment, and system operations are maintained independent of communication with the smart field panel and island or central station. Universal programmable controllers are less costly than smart field panels, but have limited I/O point capacities. Because of the potential cost benefits of universal programmable controllers, the designer will consider their use in stand-alone buildings requiring only a few points. The relationships between smart field panels and universal programmable controllers are shown in Figures 4-4 and 4-5.

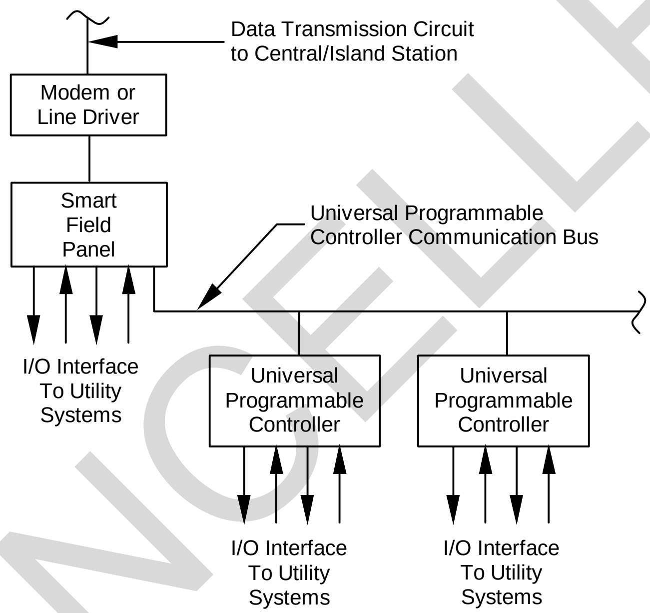


Figure 4-4. Smart Field Panel and Universal Programmable Controllers (System with Multiple Data Transmission Channels)

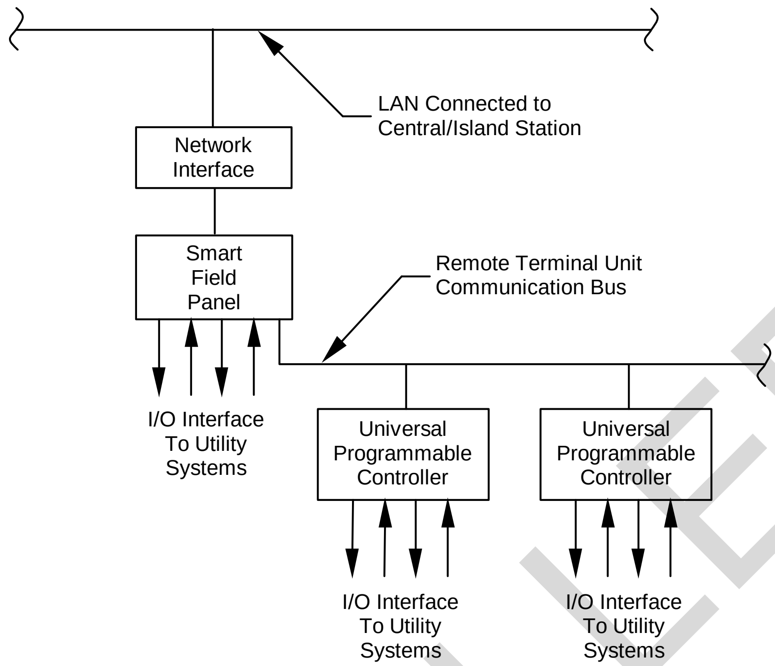


Figure 4-5. Smart Field Panel and Universal Programmable Controllers (System with LAN-based Smart Field Panels)

5. UNITARY CONTROLLERS. Unitary controllers serve as I/O devices and special purpose controllers. Unitary controllers contain application software for the control of individual utility system equipment, such as fan coil units, variable air volume terminal boxes and dual duct mixing boxes. Unlike smart field panels, which are field programmable, unitary controllers have a fixed complement of I/O functions and fixed (or minimally configurable) applications programs. Their program accommodates specific operating requirements of utility system equipment by the selection of a small number of setpoints and operating parameters. In addition, the unitary controller does not maintain a seven-day calendar to accommodate varying daily schedules without communicating with the smart field panel. Some UMCS manufacturers allow the unitary controllers to share a common communication circuit with remote terminal units while others provide a separate communication circuit. Some manufacturers of UMCS using LAN-based field equipment allow the unitary controllers to interface directly to the LAN which connects smart field panels to the central/island station. Unitary controllers will be required to communicate with smart field panels, and a separate data transmission circuit will be shown between the smart field panel and connected unitary controllers. The relationships between smart field panels and unitary controllers are shown in Figures 4-6 and 4-7.

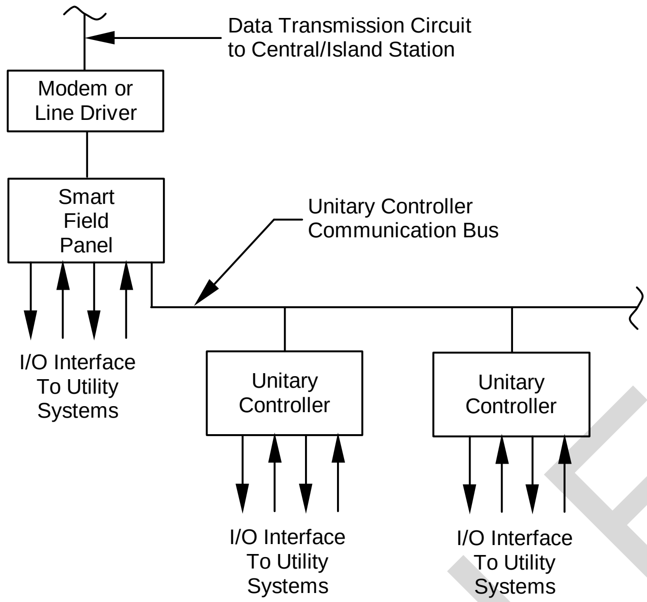


Figure 4-6. Smart Field Panel and Unitary Controllers (System with Multiple Data Transmission Channels).

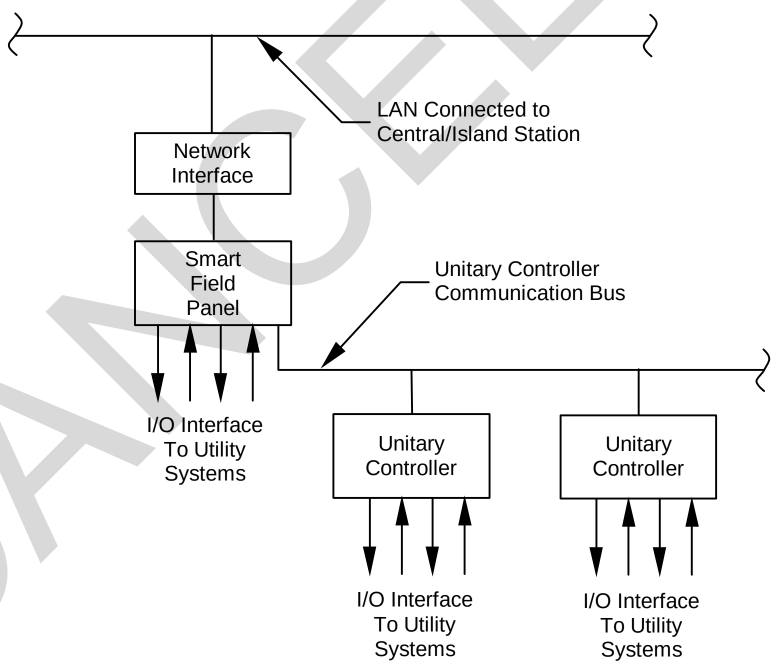


Figure 4-7. Smart Field Panel and Unitary Controllers (System with LAN-based Smart Field Panels).

6. I/O FUNCTIONS. Electronic circuits enable the UMCS to interface with the utility system instrumentation and controls. Instrumentation signals from utility systems to field equipment panels are either digital or analog signals. Control signals to the utility systems from the field equipment panels are converted into digital or analog commands. Analog data to and from utility systems must be conditioned to ensure signal level and type compatibility between the I/O functions and utility systems instrumentation

and controls. Digital inputs include contact closures of limit switches, flow switches, temperature switches, and pressure switches. Digital outputs include on/off commands to relays, motor starters, or solenoid valves. Analog outputs include commands such as valve or damper positioning or remote reset of analog controllers. Analog inputs include measurements from temperature, humidity, pressure, flow and other specialized sensors.

a. Analog input (AI) functions. The AI function is the interface between analog (continuously variable) field measurements and the field equipment panel. Instruments monitoring physical properties such as temperature, flow, and pressure, require circuitry to convert the analog measurement to digital data. The AI function is designed to accept analog signals when measuring parameters such as temperature, flow, and pressure, and to convert each to a digital quantity usable by the system.

b. Analog output (AO) functions. The AO function is the interface between commands generated by the field equipment panel and controlled equipment. The field equipment panel commands are converted to an analog value which is compatible with individual controllers or local loop controls.

c. Digital input (DI) functions. The DI function provides interfacing between field equipment on/off or two-state indicators and the field equipment panel. DIs monitor both momentary and maintained contacts and serial digital pulses from electrical power meters, gas flow meters, water meters and other utility meters.

d. Digital output (DO) functions. The DO function interfaces output signals between the field equipment panel and field controls that require digital commands. DOs are capable of performing momentary or maintained switching. This allows incremental control of setpoints, and momentary contact closures for devices such as motor starters, or maintained contact closures for devices such as electric heaters, solenoid valves , and lighting.

e. Pulse accumulator functions. The pulse accumulator (PA) function interfaces pulse initiator signals from electric or natural gas meters to the field equipment panel. The PA function is provided through Dis with buffer memory to totalize pulses. The field equipment panel microprocessor periodically interrogates the buffer and resets the pulse count.

f. Binary coded decimal function. The binary corded decimal (BCD) function interfaces specialized instruments, utilizing BCD format singals, to the field equipment panel. The BCD format utilizes four-bit groups to represent the units, tens, hundreds and higher decimal positions of an analog value (for example, the analog value 6,144 is represented in BCD format as 0110 0001 0100 0100). The binary signals representing individual bits are interfaced to the field equipment panel as DIs.

7. CHILLER CONTROL PANEL. Existing electronic, pneumatic, or relay logic chiller control panels may be replaced with microprocessor chiller control panels providing the same safety and operating fnctions as the original panels. These chiller control panels have communication ports which allows them to be interfaced to a smart field panel, similar to the way a unitary controller is interfaced. This communiation interface provides two-way data transfer, allowing the UMCS to access real-time chiller status and operational data and to command the operation of the chiller. Chiller control panels will be considered in UMCS design when existing chiller controls are in poor condition or replacement is economically feasible. Chiller control panels will also be considered when the specific installation requires many UMCS input/output interfaces with the chiller. In this situation, the use of a chiller control pnael may be more cost-effective than installing the required chiller instrumentation of interface to the UMCS.

8. BOILER CONTROL PANEL. Existing electronic, pneumatic, or relay logic boiler control panels may be replaced with microprocessor boiler control panels providing the same safety and operatingfunctions as the original panels. These boiler control panels have communication ports which allows them to be interfaced to a smart field panel, similar to the way a unitary controller is interfaced. This communication interface provides two-way data transfer, allowing the UMCS to access real-time boiler status and

operational data and to command the operation to the boiler. Boiler control panels will be considered in UMCS design when existing boiler controls are in poor condition or replacement is economically feasible. Boiler control panels will also be considered when the specific installation requires many UMCS input/output interfaces with the boiler. In this situation, the use of a boiler control panel may be more cost-effective than installing the required boiler instrumentation to interface to the UMCS.

CHAPTER 5

INSTRUMENTATION AND CONTROLS

1. SENSING DEVICES.

a. General. The following sensor descriptions include the majority of instrument types used to interface the UMCS to utility systems for monitoring of system conditions and operation. Transmitters providing a DC signal proportional to the required analog measurement will be included as a part of each instrument to provide a linear conditioned signal for input to field equipment panels. The designer will refer to TM 5-815-3, HVAC Control Systems, for additional information regarding the application of sensing devices to HVAC systems.

b. Temperature instruments.

(1) Temperature instruments include various configurations of platinum resistance temperature detectors (RTDs) and require proper housing for temperature measurement in rooms, ducts, piping, and outside air (OA). The selection of a platinum RTD for the specific application depends upon the required range and accuracy. Thermistors will not be used in UMCS applications. Thermocouples will not be used in UMCS applications except in the specific case when the measured temperature might exceed the maximum recommended temperature for platinum RTDs (about 1,800 degrees F) or when the thermocouples are provided by the manufacturer of rotating machinery for bearing or coil temperature measurement. Conditioning circuitry is required, and will be integral to the sensor.

(2) Continuous averaging RTDs have long, flexible sensing elements. They are installed in a serpentine fashion in the cross-section of a duct to reduce measurement errors due to air stratification. The continuous averaging RTD transmitter output signal represents the average temperature along the sensing element.

(3) Temperature switches are bimetallic or filled elements affected by temperature changes that cause contacts to open (or close) at a selected temperature setting. Temperature switches must be adjustable over the operating temperature range.

(4) Temperature instruments on pipes or boiler stacks will be installed in thermowells. The thermowell material will be selected based on the piping material and properties of the fluid in which the thermowell is immersed.

(5) Outside air temperature instruments will be installed in instrument shelters to prevent the sun from directly striking the sensors, and will be located and mounted to minimize direct solar radiation and conductive heat transfer to the building.

c. Relative humidity instruments are used to measure percent relative humidity in spaces, ducts, and OA. Where OA measurements are required, shielding will be provided to neutralize the effects of solar heating and rain.

d. Pressure instruments.

(1) Pressure transducers are pressure measurement devices which use the deformation of an elastic membrane as the primary measuring device. The various pressure transducers include bellows, diaphragm, bourdon tube, and strain gage types. Pressure transducers are subdivided into a number of categories including those for measuring gauge pressure, absolute pressure, and differential pressure.

(2) Pressure switches are operated by an input pressure to open or close contacts at a selected pressure setting. Pressure switches may be gauge, absolute, or differential type with adjustable settings, and may be manual or automatic reset.

e. Flow instruments.

(1) Flow of liquids and gases is directly or indirectly measured in the flow path. A direct metering device measures fluid flow by measuring volume or weight for a given period of time. An indirect metering device uses an intermediate parameter, such as pressure drop across a constricted flow area, to measure flow.

(2) Concentric orifice plates will be used for measuring steady flow of clean liquids, vapor, or gas in the normal turbulent flow region with a Reynolds number of 2000 or greater.

(3) Eccentric orifice plates are used to measure fluids which carry a small amount of non-abrasive solids, since the solids will flow through the bottom of the orifice rather than accumulate behind it. They are also useful for measuring the flow of vapors or gases which carry small amounts of liquid. Eccentric plates will also be used to measure the flow of liquids carrying small amounts of gas, in which case the orifice opening must be located at the top of the pipe.

(4) Flow nozzles will be used where the Reynolds number is in excess of 50,000. Flow nozzles will handle approximately 60 percent more flow with the same pressure drop, compared to an orifice plate. At higher Reynolds numbers, the amount of straight pipe required prior to the flow nozzle is reduced.

(5) Venturi tubes, like flow nozzles, will handle approximately 60 percent more flow than an orifice plate, but with the same pressure drop as the orifice plate. For equal flows, the pressure drop of a venturi tube will be only 10 to 20 percent of the pressure drop of an orifice plate. The venturi tube is capable of measuring any fluid flow which an orifice plate or flow nozzle can measure. Venturi tubes will be used for gas flow measurement when suspended particles are in the stream.

(6) Annular pitot tubes are a variation of the pitot tube. Pitot tubes have a single sensing point and have poor accuracy, particularly at low velocities. The annular pitot tube senses dynamic pressure at multiple ports distributed along the sensing tube to provide a single output of the average flow. Static pressure is measured by a port which faces downstream at the centerline of the pipe. The sensor requires approximately five pipe diameters of straight pipe upstream of the device. A major advantage of this sensor is the ability to install an annular pitot tube into an existing line under pressure with "hot tap" methods.

(7) Turbine flow meters use the moving fluid to turn a turbine rotor. Turbine flow meters supply flow quantity information via a precisely known number of pulses for a given volume of fluid displaced. The relationship is linear for a given flow rate and viscosity. The turbine flow meter is designed on flanged ends to be mounted in-line. Recently, reduced size turbine meters have been developed for mounting into existing piping by hot-tap methods, allowing the units to be removed and reinserted without system shutdown.

(8) Vortex shedding flowmeters use a non-streamlined obstruction inserted in the pipe centerline to create eddies or vortices which grow. The detachment of the vortex from the obstruction is termed shedding. A sensor located downstream of the obstruction measures the frequency of shedding, which is proportional to the flow velocity, the output being linear with flow.

(9) Air flow measurement stations may be of the pitot-tube or electronic type. For applications where the minimum required flow measurement corresponds to an air velocity of less than 1,000 feet per minute, the electronic type air flow measurement station will be used. Both types have sensing elements distributed throughout the cross-section of the duct.

(10) Gas utility flow meters are diaphragm or bellows type (gas positive displacement meters) for flows up to 2,500 standard cubic feet per hour (SCFH) and axial-flow turbine type for flows above 2,500 SCFH. These meters, which are designed specifically for natural gas supply metering, have electrical impulse dry contact outputs for input to UMCS.

(11) Flow switches are operated by input flow to open or close contacts at a selected flow setting. Flow switches must be adjustable over the operating flow range.

f. Level instruments.

(1) For vented tanks with accessible bottom taps, a pressure transducer connected to a bottom tap will be used for level measurement. The pressure measurement is converted to a level measurement by the UMCS based on the density of the liquid in the tank. In certain cases, where temperature is expected to vary widely and the density of the liquid varies significantly with temperature, a temperature measurement is required for compensation of the engineering units conversion. If the tank is pressurized and both bottom and top taps are accessible, level will be measured using a differential pressure transducer and engineering units conversion based on density.

(2) For sumps or tanks without accessible taps, capacitive liquid level sensors will be used. For measurement of non-conductive liquids or where sloshing of the liquid is expected, the liquid level sensor will be installed in a perforated steel stilling well.

(3) Bubbler type liquid level sensors will be used for level measurement of fuel oil or extremely caustic or corrosive liquids. Compatibility of the wetted tubing with the liquid will be assured by the designer.

(4) Liquid level switches are combinations of displacer floats suspended from a stainless steel cable attached to the switch housing. Changes in liquid level near the elevation of the displacers results in varying downward force on the stainless steel cable, which actuates the switch mechanism. Liquid level switches will be used where the UMCS is required to actuate specific alarms or controls at defined liquid levels, but continuous monitoring of liquid level is not required.

(5) Float switches will be utilized for sewage lift station pits or similar applications with corrosive liquids and floating solids. Float switches are mercury-free tilt switches rigidly mounted in bouyant polypropylene (or other corrosion-resistant material) floats. The floats are secured at the elevation where switch actuation is desired, and the tilt switches actuate when the liquid level tilts the float.

g. Electrical power instruments.

(1) Electrical energy consumption measurements require the use of voltage and current transformers whose proportional outputs are connected to a dedicated watt-hour meter or transducer, or to a field equipment panel where the watt-hour consumption calculations are performed. Where dedicated watt-hour meters are used, a dry contact pulse output is required from the meter for input to the field equipment panel. Where watt-hour transducers are used, an analog output is required for input to the field equipment panel.

(2) Electrical peak demand is calculated from the output of potential (voltage) and current transformers used for the electrical energy measurements or by the use of dedicated electrical peak demand transducers with an analog output to a field equipment panel.

(3) Voltage and current measurements for ranges which do not match field equipment panel input requirements will require the application of voltage and current transformers.

(4) Some electrical utility management applications require measurement of reactive power (volt-amperes reactive or VAR) in addition to real power. VAR transducers will be used for measurements of reactive power in three phase electrical power systems.

(5) Power factor transducers provide an analog output proportional to the cosine of the phase angle difference between the voltage and current of three phase electrical power systems.

h. Position sensors.

(1) Position sensors measure the position of devices such as valves and dampers which move from one position to another. Typical position instruments include end (limit) switches and potentiometers.

(2) End (limit) switches provide a contact closure at or near the limit of the moving object's travel.

(3) Potentiometers are resistors with a continuously adjustable sliding contact. Depending on the application, these devices may be either rotary or linear. They will indicate position on a percent open basis.

i. Key-operated switches including hand-off-automatic (HOA), and off-automatic, must be keyed alike. Key-operated switches will be provided with status feedback auxiliary contacts connected to a field equipment panel for UMCS alarming of abnormal switch positions, such as an HOA switch not in the automatic position.

j. Additional sensing devices used in UMCS may include water analysis sensors for water system characteristics such as pH, conductivity, turbidity and total dissolved solids; flue gas analysis sensors such as carbon monoxide, oxygen, and nitrous oxide monitors; ambient environmental sensors such as carbon monoxide detectors, chlorine gas detectors, oxygen depletion monitors and refrigerant leakage monitors; and specialty system sensing devices such as compressed air dewpoint sensors.

2. CONTROL DEVICES.

a. It is necessary to add output devices of various types to allow the UMCS to control utility system operations. The following control device descriptions include the majority of controller interfaces required between the UMCS and utility systems. The designer will refer to TM 5-815-3, HVAC Control Systems, for additional information regarding the application of control devices, valves and dampers to HVAC systems. Output devices include the following types:

b. Electrical relays are operated in a maintained, momentary, magnetically held, or latching configuration by an output from a DO in the smart field panel to operate equipment directly or through contactors. The most common types of relays for UMCS applications are time delay relays, latching relays, and solid state relays.

(1) Time delay relays operate so that there is a time lag between energizing and deenergizing a circuit. These relays may be used when there is a need to delay start-up, recycling, and/or shutdown of equipment and during failure mode application.

(2) Latching relays physically "lock" themselves in the energized or deenergized position until they are manually or electrically reset.

(3) Contactors are single coil, electrically operated, magnetically held devices that are used by relays to operate equipment.

(4) Solid state relays are semiconductor based switches with sufficient rating to replace electromagnetic relays.

c. Electric solenoid operated pneumatic (EP) relays are operated in an on-off manner electrically by a digital output. EP relays are placed in a pneumatic local loop control circuit to apply air pressure to a device, exhaust air pressure from a device, or transfer control from one device to another. Control air is obtained from the existing compressed instrument air system.

d. Controllers continuously measure changes in controlled variables and automatically send appropriate signals to adjust equipment or devices to correct any deviation from the desired setpoint.

(1) Single input Control Point Adjustment (CPA) controllers are used when reset control is required. The setpoint of the controller must be adjustable over a range of plus or minus ten percent of the primary sensor span.

(2) Dual input controllers can be used instead of single input CPA controllers when the adjustable control range needs to exceed more than plus or minus 10 percent of the primary sensor span.

(3) Some electric and electronic controllers have CPA or remote setpoint inputs, which may require a 4 to 20 mA signal or a varying resistance (rheostat) input to adjust the control loop setpoint. An example is a centrifugal chiller capacity controller which permits gradual chiller demand limiting by the UMCS.

e. Current to pneumatic (I/P) transducers are electrically operated by an AO in the smart field panel. The AO signal is converted into a pneumatic output signal compatible with the local control loop or actuator. These proportional signals position valves, dampers, and reset local loop control setpoints.

3. MICROPROCESSOR-BASED CONTROLLERS.

a. Many HVAC, utility and process systems utilize microprocessor-based controllers. One example is the single-loop digital controller utilized in standard control panels for HVAC control systems. Standard control panels include interfaces for connection to UMCS. Another example is an application-specific unitary controller provided as a packaged equipment control system by an equipment or system supplier.

b. Some microprocessor-based controllers may be interfaced with a UMCS smart field panel with a controller communication port which utilizes a standardized communication interface such as EIA 485. In this case, up to 32 microprocessor-based controllers may be interfaced on a single communication circuit to a smart field panel. The designer will investigate existing microprocessor based controllers to determine if they are equipped with the controller communication port.

c. If the existing microprocessor-based controllers do not include controller communication ports, the designer will consider two options for interface of the controllers with the UMCS. The first option is replacement of the existing microprocessor-based controllers with units equipped with the proper controller communication ports. The second option is to provide CPA interface to the microprocessor-based controllers through 4 to 20 mA analog outputs if the controllers are equipped to accept a remote setpoint signal.

CHAPTER 6

SOFTWARE DESCRIPTIONS AND REQUIREMENTS

1. GENERAL. The operation of UMCS is controlled by software at the central station, island station, and field equipment panels. UMCS are distributed processing networks that provide increased operational reliability through the use of distributed software and computing power by executing application programs while processing and storing information at field equipment panels. The distributed processing approach also provides increased operator convenience through the graphical interface available at each workstation.

2. CENTRAL STATION AND ISLAND STATION.

a. Four types of software may be implemented in the central station and island stations:

(1) Operating system software controls operations of the CPU and performs functions such as control of its peripheral devices, file management, service interrupts, diagnostics, and software development.

(2) Command and graphical user interface software enables the operator to monitor, control, and interact with the system via any workstation using a graphical interface or simple English language commands. Command software is designed to generate reports, display alarms, display system graphics, and exchange data between field equipment and island stations and between island stations and central station.

(3) Applications software consists of energy conservation and other support programs affecting equipment operations.

(4) LAN software includes a network operating system which controls communication between network devices, including the central station or island station computer, workstations and shared peripheral devices such as network printers.

b. The operating system software, the command software and the graphical user interface software, and the LAN software are always running at the central station regardless of the type of applications software implemented. Under normal conditions, the command software updates the central station database whenever a change in data is entered into the system.

c. The type of applications software programs resident in the central station and island stations varies according to the type of equipment and utility systems monitored and controlled by the UMCS. A copy of all applications software installed in the field equipment panels will also be maintained at the central station and updated to the island station and field equipment panels whenever changes are made to the programs. Software such as demand limiting applications involving equipment at multiple geographical locations will be executed at the central station. Other demand limiting applications involving equipment monitored and controlled by multiple field equipment panels will be executed at the island station.

3. FIELD EQUIPMENT PANEL.

a. Two types of software are implemented in the field equipment panel.

(1) Operating system software controls and schedules the operation of the microprocessor, interfaces, and diagnostics in real time.

(2) Applications software monitors and controls the utility systems and equipment connected to the field equipment panel and exchanges data with other field equipment panels and with the island station.

b. The field equipment panel uses stored operational data, measurements from local instruments and time of day to execute applications programs. Software generated values must be checked against field equipment panel stored constraints to prevent equipment damage due to improper commands. In the event that software generated values exceed the constraints, the stored constraint values must prevent issuance of that command.

c. Field equipment panel system software must be capable of detecting hardware and software failures and forcing all outputs to a predetermined state, consistent with the failure mode requirements defined on the drawings.

CHAPTER 7

APPLICATIONS SOFTWARE

1. GENERAL DESCRIPTION.

a. Applications software includes programs which monitor and control the operations of various HVAC, mechanical, and electrical utility systems, as well as other site specific programs providing building support functions. Examples of specific applications programs include energy conservation programs, equipment selection programs, and utility demand limiting programs. The designer will select the appropriate instrument inputs and control outputs to be used with selected applications software as defined in the database table.

b. Depending on the requirements of the application, applications programs may use adaptive control techniques that allow the UMCS to monitor its own past performance and automatically adjust its parameters for optimum performance.

c. The applications software programs discussed in this section are not listed in the order of the highest potential energy or cost savings. The determination of cost effective programs for each building or system is made after the savings and economic calculations are completed. The amount of cost savings depends on factors such as existing building type, equipment condition, equipment performance and operating schedules.

d. Most applications software programs apply to both direct digital control (DDC) and supervisory control implementation. Depending on the system sequence of operation, the specific programs selected, the site-specific implementation, and the configuration of the controlled equipment, UMCS outputs based on the operation of applications programs may be binary (or change of state) control signals, analog signals to directly modulate final control elements such as valves or dampers, control point adjustment (CPA) signals or software adjustment to a sequence of operations.

e. For supervisory control implementation, CPA will be implemented by using an AO or a pair of DOs in conjunction with an AI signal from sensors to achieve changes in operating setpoints through the CPA port on a local loop controller.

2. SCHEDULED START/STOP PROGRAM. The scheduled start/stop program consists of starting and stopping equipment based on the time of day and day of week. Scheduled start/stop is the simplest of all UMCS functions to implement. This program provides the best potential for energy conservation by turning off equipment or systems during unoccupied hours. In addition to sending a start/stop command, it is mandatory to have a feedback signal indicating the status (on-off or open-closed) of the controlled equipment. The feedback signal verifies that the command has been carried out and provides the UMCS operator with an alarm when the equipment fails or is locally started or stopped. Design requirements for this applications program will be indicated by the letter X adjacent to the program listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS input from utility system. Equipment status from pressure switch, auxiliary contacts, flow switch or current sensing relay/transducer.

(2) UMCS output to utility system. Start/stop control signal from UMCS to interposing relays (momentary or maintained signal as required by the equipment control circuit configuration and failure mode) - one for each piece of equipment.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Cooling and heating high low alarm limits.

(d) Cooling and heating start/stop schedules.

(e) Equipment status.

(f) Equipment constraints.

(g) Consecutive start time delay.

(2) Program outputs.

(a) Start signal.

(b) Stop signal.

c. Application notes. The scheduled start/stop program operates in conjunction with optimum start/stop, demand limiting, and ventilation-recirculation programs.

3. OPTIMUM START/STOP PROGRAM. The scheduled start/stop program is refined by automatically adjusting the equipment operation schedule in accordance with space temperatures and outside air (OA) temperature. In the scheduled start/stop program, HVAC systems are started prior to occupancy to cool down or heat up the space on a fixed schedule independent of space and OA conditions. The optimum start/stop program automatically starts and stops the system on a sliding schedule. The program will adjust start/stop times by taking into account the thermal inertia of the structure, the capacity of the HVAC system to either increase or reduce space temperatures, OA conditions, and current space temperatures, using prediction techniques. These techniques determine the latest time for starting HVAC equipment to satisfy the space environmental requirements at the beginning of the occupied cycle, and determine the earliest time for stopping equipment at the day's end. Design requirements for this applications program will be indicated by the letter X adjacent to the program listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS inputs from utility system.

(a) Equipment status from pressure switch, auxiliary contact, flow switch or current sensing relay/transducer - one for each piece of equipment

(b) Space dry bulb temperature (minimum of one per zone).

(c) OA dry bulb temperature.

(2) UMCS outputs to utility system. Start/stop control signal from UMCS to interposing relays (momentary or maintained signal as required by the equipment control circuit configuration and failure mode) - one for each piece of equipment.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Cooling and heating operation.

(d) Equipment status.

(e) Cooling and heating building occupancy schedule.

(f) Space temperature(s).

(g) Building heat constant (operator adjustable).

(h) Building cooling constant (operator adjustable).

(i) OA temperature.

(j) Required space temperature at occupancy (heating).

(k) Required space temperature at occupancy (cooling)

(l) Equipment constraints.

(m) Cooling and heating high-low alarm limits.

(2) Program outputs

(a) Start signal.

(b) Stop signal.

c. Application notes. The optimum start/stop program operates in conjunction with the scheduled start/stop, demand limiting, and ventilation-recirculation programs.

4. ECONOMIZER PROGRAM. The use of an economizer cycle in air conditioning systems can be a cost effective conservation measure, depending on climatic conditions and the type of mechanical system. The economizer cycle utilizes OA to reduce the building's cooling requirements when the OA dry bulb temperature is less than the required changeover temperature. At optimum conditions, the space temperature is maintained at setpoint without the addition of mechanical cooling.

a. Changeover Temperature. The changeover temperature is equal to the return air (RA) temperature minus a fixed differential temperature. The fixed differential shall be determined site-to-site depending on local weather conditions, to minimize periods when the OA enthalpy would be greater than the RA enthalpy.

b. Cold Deck Type Systems. For cold deck type systems (such as Reheats, Multizones, Dual Ducts, and Variable Air Volume systems), the UMCS shall modulate the OA, RA, and relief air dampers based on the conditions shown in Table 7-1.

Table 7-1. Damper Modulation for Cold Deck Systems.

Condition No.	Description	Control
1	OA temperature < SA temperature < Changeover temperature	Modulate OA, RA, and relief dampers to maintain mixed air temperature at cold deck supply temperature setpoint minus 2 degrees F.
2	SA temperature < OA temperature < Changeover temperature	Set OA and relief dampers at 100% open; RA dampers closed.
3	SA temperature < Changeover temperature < OA temperature	Set OA and relief dampers at their minimum positions, and set RA damper at its corresponding open position.

c. Single Zone Type Systems. For single zone type systems, the UMCS shall modulate the OA, RA, and relief dampers based on the conditions shown in Table 7-2.

Table 7-2. Damper Modulation for Cold Deck Systems.

Condition No.	Description	Control
1	OA temperature < Changeover temperature	Modulate OA and relief dampers open, and the RA dampers closed to maintain the space temperature cooling setpoint.
2	Changeover temperature < OA temperature	Set OA and relief dampers at their minimum positions, and set RA damper at its corresponding open position.

d. Damper Controls. The OA, return air and relief air dampers are positioned by the UMCS (for direct digital control implementation) or by local loop control (for supervisory control implementation) to maintain the required mixed air temperature. Design requirements for this applications program will be indicated by the letter X adjacent to the program listing on the appropriate database table, as shown in Chapters 8 and 9.

(1) Field hardware requirements. The hardware requirements are:

(a) UMCS inputs from utility system.

1/ OA intake damper position feedback - one per OA damper.

2/ OA dry bulb temperature.

3/ Mixed air temperature.

4/ Return air temperature.

(b) UMCS outputs to utility system.

1/ Proportional control signal to dampers (for direct digital control implementation).

2/ Minimum OA override of local loop mixed air temperature controls (for supervisory control implementation).

(2) Software I/O requirements. The software requirements are:

(a) Program inputs.

1/ Changeover dry bulb temperature.

2/ OA dry bulb temperature.

3/ Return air dry bulb temperature.

4/ Equipment constraints.

(b) Program outputs. Automatic/minimum OA damper control signal.

(3) Application notes. This program cannot be used where humidity control is required.

5. VENTILATION-RECIRCULATION PROGRAM. The ventilation-recirculation program controls the operation of the OA dampers when the introduction of OA would impose an additional thermal load during warm-up or cool down cycles prior to occupancy of the building. This program is particularly useful in those facilities which maintain environmental conditions (such as electronic equipment installations) during building unoccupied periods. During unoccupied periods, the OA dampers remain closed. During building occupied cycles, the OA, return and relief dampers are under normal UMCS control (for direct digital control implementation) or local loop control (for supervisory control implementation). During summer cool-down cycle operation, when the OA temperature is cooler than the space temperature, the OA and exhaust air dampers are opened, and the fans are energized. During winter warm-up cycle operation, when the OA temperature is warmer than space temperature, the OA and exhaust air dampers are opened and the fans are energized. Design requirements for this applications program will be indicated by the letter X adjacent to the program listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS inputs from utility system.

(a) OA dry bulb temperature - one per facility.

(2) UMCS outputs to utility system.

(a) Proportional control signal to dampers (for direct digital control implementation).

(b) Open/close damper override control signal to local loop controls - one per HVAC system (for supervisory control implementation).

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Cooling and heating operation.

(d) Cooling and heating start/stop schedules.

(e) Equipment status.

(f) Cooling and heating occupancy schedules.

(g) OA dry bulb temperature.

(h) Space temperature.

(i) Equipment constraints.

(2) Program outputs. Automatic or open/close override damper control signal.

c. Application notes. This program operates in conjunction with scheduled start/stop and optimum start/stop programs prior to building occupancy.

6. HOT DECK-COLD DECK TEMPERATURE RESET PROGRAM. The hot deck-cold deck temperature reset program is applied to dual duct systems and multizone HVAC systems. These systems utilize a parallel arrangement of heating and cooling surfaces, commonly referred to as hot and cold decks, for providing heating and cooling capabilities simultaneously. The hot and cold air streams are combined in mixing boxes or plenums to satisfy the individual space temperature requirements. In the absence of optimization controls, these systems mix the two air streams to produce the desired temperature. When the space temperature is acceptable, a greater difference between the temperatures of the hot and cold decks results in inefficient system operation. This program selects the areas with the greatest heating and cooling requirements, and establishes the minimum hot and cold deck temperature differentials which will meet the requirements, thus maximizing system efficiency. Zone space temperature sensors are used to determine the greatest cooling and heating space temperature requirements during the building occupied period and reset the corresponding deck temperature proportionately. Where humidity control is required, the program will prevent the cold deck cooling coil discharge temperature from increasing further when the maximum allowable space humidity setpoint is reached. Design requirements for this applications program will be indicated by the letter X adjacent to the program listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS inputs from utility system.

(a) Hot deck heating coil discharge temperature.

(b) Cold deck cooling coil discharge temperature.

(c) Space dry bulb temperature - one sensor per zone.

(d) Space relative humidity - one per zone of humidity control.

(e) Mixing box damper position or proportional control signal feedback - one per zone.

(2) UMCS outputs to utility system.

(a) Hot deck heating coil control valve proportional control signal (for direct digital control implementation).

(b) Hot deck heating coil control valve CPA (for supervisory control implementation).

(c) Cold deck cooling coil control valve proportional control signal (for direct digital control implementation).

(d) Cold deck cooling coil control valve CPA (for supervisory control implementation).

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Zone space temperature set point.

(b) Zone space temperatures.

(c) Space humidity set point (where shown).

(d) Space relative humidities (where shown).

(e) Mixing box damper position or proportional control signal feedback.

(f) Hot deck temperature.

(g) Cold deck temperature.

(h) Minimum space temperature during occupied periods.

(i) Maximum space temperature during occupied periods.

(2) Program outputs.

(a) Hot deck temperature setpoint.

(b) Cold deck temperature setpoint.

c. Application notes. This program operates in conjunction with the chilled water temperature reset program.

7. REHEAT COIL RESET PROGRAM. Terminal reheat systems operate with a constant cold deck cooling coil discharge temperature. Air supplied at temperatures below the individual space temperature requirements is elevated in temperature by reheat coils in response to signals from individual space thermostats. The program then resets the cold deck discharge temperature upward until it equals the discharge temperature of the reheat coil with the lowest demand. Where humidity control is required, the program will prevent the cooling coil discharge temperature from increasing further when the maximum allowable space humidity setpoint is reached. For air conditioning systems, where reheat coils are not used, the program will reset the cold deck discharge temperature upward until the zone or space with the greatest cooling requirement is satisfied. Design requirements for this applications program will be indicated by the letter X adjacent to the program listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS inputs from utility system.

(a) Cold deck cooling coil discharge temperature.

(b) Reheat coil valve position or proportional control signal feedback - one per reheat coil valve.

(c) Space dry bulb temperature - one per zone up to 40 percent of the zones per building exposure.

(d) Space humidity - one per zone of humidity control.

(2) UMCS outputs to utility system.

(a) Cold deck cooling coil control valve proportional control signal (for direct digital control implementation).

(b) Cold deck cooling coil control valve CPA (for supervisory control implementation).

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Zone relative humidity high limit.

(b) Zone temperature.

(c) Zone relative humidity (where shown).

(d) Cold deck cooling coil discharge temperature.

(e) Reheat coil valve positions or proportional control signal feedbacks.

(f) Minimum space temperature during occupied periods.

(g) Maximum space temperature during occupied periods.

(h) Equipment constraints.

(2) Program output. Cold deck temperature setpoint.

c. Application Notes. This program operates in conjunction with the chilled water temperature reset program.

8. BOILER MONITORING AND CONTROL PROGRAM. Steam and hot water boiler monitoring and control will allow for automatic central reporting of alarms, critical operating parameters, boiler selection, remote enabling and disabling permissives for boilers and calculation of boiler efficiency. The UMCS operator will be able to interrogate all monitored parameters for determining satisfactory boiler operation. The operator will be prompted when an alarm condition occurs, allowing corrective action to be taken by appropriate personnel, upon operator notification. Boiler operating data will be obtained from the manufacturer, or developed by monitoring fuel input as a function of the steam output. Determination of boiler efficiency also takes into account the heat content of the condensate return and make-up water. Based on the efficiency curves, fuel inputs vs. steam output, the boilers with the highest efficiency can be selected to satisfy the heating load. Boilers may be started manually by a boiler operator or automatically by UMCS depending on site requirements. Burner operating efficiency is monitored by measuring the oxygen or carbon monoxide and flue gas temperature in each boiler flue. Design requirements for this applications program will be indicated by the letter X adjacent to the program listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS inputs from utility system.

(a) Steam supply pressure - one per boiler.

(b) Hot water supply pressure - one per boiler.

(c) Steam temperature - one per boiler.

(d) Hot water temperature - one per boiler.

(e) Steam flow - one per boiler.

(f) Hot water flow - one per boiler.

(g) Fuel flow - one per boiler.

(h) Fuel pressure - one per boiler (with natural gas).

(i) Fuel temperature - one per boiler (with heated fuel oil).

(j) Feed water or make up flow - one per boiler.

(k) Feed water temperature - one per boiler.

(l) Boiler drum level - one per boiler.

(m) Furnace draft - one per boiler.

(n) Flame status - one per boiler.

(o) Flue gas analyzer - one per boiler (oxygen and carbon monoxide)

(p) Flue gas temperature - one per boiler.

(q) Common steam supply pressure - one per steam plant.

(r) Common steam supply temperature - one per steam plant.

(s) Common condensate return total flow - one per steam plant.

(t) Common condensate return temperature - one per steam plant.

(2) UMCS outputs to utility system. Boiler Enable/Disable control signals or permissives to boiler operator for manual control.

b. Software input requirements.

(1) Program Inputs.

(a) Fuel type.

(b) Fuel flow.

(c) Fuel pressure (for natural gas)

(d) Fuel temperature (for heated fuel oil)

(e) Flame status

(f) Flue gas oxygen

(g) Flue gas carbon monoxide (over 20,000 lb/hr)

(h) Flue gas temperature

(i) Makeup or feed water flow

(j) Furnace draft

(k) Hot water flow (hot water boilers)

(l) Hot water pressure (hot water boilers)

(m) Hot water supply temperature (hot water boilers)

(n) Hot water return temperature (hot water boilers)

(o) Hot water BTUs (hot water boilers)

(p) Steam flow (steam boilers)

(q) Steam pressure (steam boilers)

(r) Steam temperature (steam boilers, superheat only)

(s) Steam BTUs (steam boilers)

(t) Feedwater temperature (steam boilers)

(u) Boiler drum level (steam boilers)

(2) Program Outputs.

(a) Boiler enable/disable control signal

(b) Boiler enable/disable permissive to boiler operator for manual control

(c) Boiler efficiency

c. Application Notes. The hardware and software inputs described are not necessarily required in every case. The designer will study the existing or new system to determine which of the parameters are necessary. Extreme care will be observed when providing automatic start/stop of boilers in lieu of operator supervised startups.

9. CHILLER SELECTION PROGRAM. The chiller selection program is implemented in chilled water plants with multiple chillers. Based on chiller operating data and the energy input requirements obtained from the manufacturer for each chiller, the program will select the chiller or chillers required to meet the load with the minimum energy consumption. When a chiller or chillers are started, chiller capacity must be limited (prevented from going to full load) for a predetermined period to allow the system to stabilize in order to determine the actual cooling load. Comparison of equipment characteristics vs. the actual operating chiller characteristics makes it possible to determine when heat transfer surfaces need cleaning to maintain the highest efficiency. The program must follow the manufacturer's startup and shutdown sequence requirements. Interlocks shown between chilled water pumps, condenser water pumps, and chiller will be in accordance with the chiller manufacturer's requirements. Chillers may be started automatically by the UMCS or manually by the chiller operator depending on the site's operating requirements. Design requirements for this applications program will be indicated by the letter X adjacent to the program listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS inputs from utility system.

(a) Chiller status (auxiliary contacts) - one per chiller.

(b) Chilled water supply temperature - one per chiller.

(c) Chilled water return temperature - one per chiller.

(d) Chilled water flow - one per chiller (for variable flow systems only)

(e) Entering condenser water temperature - one per chiller.

(f) Leaving condenser water temperature - one per chiller.

(g) Condenser water flow - one per chiller (for variable flow systems only).

(h) Instantaneous kW to chiller - one per chiller.

(i) Instantaneous kW to chiller water pump(s) - one per CW pump (if variable).

(j) Instantaneous kW to condenser water pump(s) - one per condenser water pump (if variable).

(k) Instantaneous kW to cooling tower fan(s) - one per cooling tower fan (if variable).

(l) Common chilled water supply temperature - one per chilled water plant.

(m) Common chilled water return temperature - one per chilled water plant

(n) Total chilled water flow - one per chilled water plan.

(o) Chilled water pump status - one per chilled water pump.

(p) Condenser water pump status - one per condenser water pump.

(q) Solution pump status (absorption chillers only).

(r) Steam flow (for absorption chillers only).

(2) UMCS outputs to utility system. Start/stop control signal to interposing relays or start/stop signal to chiller operator for manual control - one for each chiller, chilled water pump, condenser water pump, cooling tower fan.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Efficiency curves.

(b) Chiller water supply temperatures.

(c) Chiller water return temperatures.

(d) Chiller water flows (for variable flow systems only).

(e) Entering condenser water temperatures.

(f) Leaving condenser water temperatures.

(g) Condenser water flows (for variable flow systems only).

(h) Instantaneous kW to chillers.

(i) Instantaneous kW to chilled water pumps (if variable).

(j) Instantaneous kW to condenser water pumps (if variable).

(k) Instantaneous kW to cooling tower fans (if variable).

(l) Common chilled water supply temperatures.

(m) Common chilled water return temperatures.

(n) Total chilled water flow.

(o) Chilled water pumps status.

(p) Equipment constraints.

(2) Program outputs.

(a) Start/stop signals for chillers (manual or automatic).

(b) Start/stop signals for chilled water pumps (manual or automatic).

(c) Start/stop signals for condenser water pumps (manual or automatic).

(d) Start/stop signals for cooling tower fans (manual or automatic).

(e) Chiller efficiency data.

c. Application notes. The hardware and software inputs described may not be required in every case. The designer will study the existing or new system to determine which of the parameters are necessary. Care will be observed when providing automatic start/stop of chillers in lieu of operator supervised startups.

10. CHILLED WATER TEMPERATURE RESET PROGRAM. The energy required to produce chilled water in a reciprocating or centrifugal refrigeration machine is a function of the chilled water supply temperature. The refrigerant suction temperature is also a direct function of the supply water temperature; the higher the suction temperature, the lower the energy input per ton of refrigeration. Chilled water supply temperature is selected for peak design times; therefore, the supply temperature can be reset upward during non-peak design operating hours to the maximum which will still satisfy space cooling requirements. The program resets chilled water temperature upward until the required space temperature or humidity setpoints can no longer be maintained. This determination is made by monitoring positions of the chilled water valves on various cooling systems or by monitoring space temperatures. Design requirements for this applications program will be indicated by the letter X adjacent to the program listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS inputs from utility system.

(a) Chilled water valve position (analog position indicator, or fully open indicator on valve stem) - one per air conditioning chilled water valve.

(b) Space dry bulb temperature - one per zone.

(c) Chiller supply water temperature.

(d) Space relative humidity - one per zone (where required).

(2) UMCS outputs to utility system. Chilled water supply temperature CPA - one per chiller.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Chilled water valve position.

(b) High limit for space dry bulb temperature.

(c) High chilled water operating temperature.

(d) Low chilled water operating temperature.

(e) High limit for space relative humidity.

(f) Equipment constraints.

(2) Program outputs. Chilled water supply temperature setpoint.

c. Application notes. The chilled water temperature reset program will affect any system requiring chilled water.

11. CONDENSER WATER TEMPERATURE RESET PROGRAM. The energy required to operate refrigeration systems is directly related to the temperature of the condenser water entering the machine. Heat rejection systems are designed to produce a specified condenser water temperature such as 85F at peak wet bulb temperatures. Automatic controls are provided at some sites to maintain a specified temperature at conditions other than peak wet bulb temperatures. In order to optimize the performance of refrigeration systems, condenser water temperature is reset downward when OA wet bulb temperature will produce lower condenser water temperature. The reset schedule will incorporate the manufacturer's requirements governing acceptable condenser water temperature range. Design requirements for this applications program will be indicated by the letter X adjacent to the program listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS inputs from utility system.

(a) Condenser water supply temperature - one per condenser.

(b) OA dry bulb temperature.

(2) UMCS outputs to utility system. Condenser water supply temperature CPA - one per condenser.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) High condenser water operating temperature.

(b) Low condenser water operation temperature.

(c) Condenser water supply temperature.

(d) OA dry bulb temperature.

(e) OA relative humidity.

(f) Equipment constraints.

(2) Program output. Condenser water supply temperature setpoint.

c. Application notes. A dedicated local loop controller may be implemented.

12. DEMAND LIMITING PROGRAM. Demand limiting is accomplished by shedding electrical loads or starting sources of auxiliary power such as standby generators to prevent electrical demand from exceeding a peak value (target). This technique is used to reduce electrical costs where electric demand is a cost factor in the utility rate schedules. Peak demand values are established by the utility company using fixed demand intervals, sliding window intervals, and/or time of day schedules. The strategy to be utilized in UMCS is the sliding window interval. Many complex schemes exist for reducing peak demand billings; however, all schemes continuously monitor power demand and calculate the rate of change of the demand value in order to predict future peak demand using prediction techniques. When the predicted peak approaches preset limits, predetermined auxiliary power sources must be started and predetermined scheduled electrical loads within pre-established groups must be shut off or power-limited on a prescheduled priority basis to reduce the connected load before the peak is exceeded. Within a particular group, the order in which a load is shed must be changed by the program so that after a load has been the first to be shed in a group, it is moved to last in the group and another load becomes first. The most commonly shed loads are non-critical HVAC and other utility systems. Design requirements for this applications program will be indicated by the letter X adjacent to the demand limiting step listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS inputs from utility system.

(a) Equipment status (differential pressure switch, auxiliary contact, flow switch, chiller current) - one for each piece of equipment

(b) Instantaneous kilowatts (kW) demand for each metered point.

(2) UMCS outputs to utility system.

(a) Start/stop control signal to each load to be shed.

(b) Analog control signal or set point adjustment.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Equipment status.

(d) Chiller percent capacity.

(e) Minimum cooling capacity.

(f) Peak demand limit target.

(g) Equipment priority schedules.

(h) Length of sliding window interval.

(i) Instantaneous demand.

(j) Maximum space temperature during occupied periods (cooling).

(k) Minimum space temperature during occupied periods (heating).

(l) Space temperatures.

(m) Equipment constraints.

(n) Cooling and heating operation.

(o) Demand limit setpoints

(2) Program outputs.

(a) Calculated percent load point.

(b) Demand signals.

(c) Start signals.

(d) Stop signals.

(e) Setpoint adjustments.

c. Application notes. The demand limiting program is used in conjunction with scheduled start/stop and optimum start/stop programs. Standard demand limiting steps appropriate to summer and winter operation have been established and listed in guide specification CEGS-16935. The designer will assign each sheddable load to electrical demand limiting steps based on installation requirements. The designer will consider the impact of demand limiting on building habitability, occupant comfort and productivity. In general, demand limiting actions having the least impact on operations will be scheduled to occur first. Demand limiting designs which include shutting off ventilation to occupied buildings shall incorporate air quality sensors or other features to prevent or alert occupants to potential discomfort.

13. CHILLER DEMAND LIMITING PROGRAM. One specific application of demand limiting is chiller capacity control. Centrifugal chillers are normally factory equipped with an adjustable control system which limits the maximum available cooling capacity; thus, the power the machine can use. An interface between the UMCS and the chiller controls allows UMCS to reduce the maximum available cooling capacity in a demand limiting situation, thereby reducing the electric demand without completely shutting down the chiller. The method of accomplishing this function varies with the manufacturer of the chiller. The chiller percent capacity is obtained by monitoring the chiller current input. When a chiller is selected for demand limiting, a signal is transmitted, reducing the chiller capacity. The chiller demand limit adjustment is performed by shunting out taps of a transformer in the control circuit or by resetting the control air pressure to the chiller compressor vane operator or by potentiometer adjustment at the chiller control panel. As further need arises, signals are transmitted until the demand limiting situation is corrected. Extreme caution will be exercised when applying this program to chiller demand, since incorrect control can cause the refrigeration machine to operate in a surge condition, potentially causing it

considerable damage. The chiller manufacturer's recommended minimum cooling capacity and temperature limits will be incorporated into the sequence of operation shown. In general, surges occur in chillers at loads below 20% of the rated capacity. Design requirements for this applications program will be indicated by the letter X adjacent to the demand limiting step listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS inputs from utility system. Chiller current - 1 per chiller.

(2) UMCS outputs to utility system.

(a) Step control signal - one per step per chiller.

(b) Or, analog control signal - one per chiller depending on chiller control interface.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Chiller percent capacity.

(b) Minimum cooling capacity.

(c) Equipment priority schedules.

(d) Equipment constraints.

(2) Program output.

(a) Calculated percent load point

c. Application notes. This program is used in conjunction with the demand limiting program.

14. DAY/NIGHT SETBACK PROGRAM. The energy required for heating or cooling during unoccupied hours is reduced by lowering the heating space temperature setpoint or raising the cooling space temperature setpoint. This applies only to facilities that do not operate 24 hours a day. Space temperature can be reduced from the normal winter inside design temperature to a lower space temperature during the unoccupied hours. In spaces that require air conditioning during unoccupied hours, the normal temperature setting is reset upwards to a temperature that is compatible with space requirements. Design requirements for this applications program will be indicated by listing of default occupied and unoccupied cooling and heating space temperature setpoints on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are :

(1) UMCS inputs from utility system.

(a) Equipment status (differential pressure switch, auxiliary contact, flow switch) - one for each HVAC systems.

(b) Space dry bulb temperature (minimum of one per zone)

(2) UMCS outputs to utility system.

(a) Day/night control signal to interposing relays (momentary or maintained signal as required by the equipment control circuit and failure mode) - one for each HVAC system.

(b) Control signal to close OA damper (as required by equipment control circuit) one per OA damper.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Summer or winter operation.

(d) Summer and winter occupancy schedules.

(e) Equipment status.

(f) Space temperature

(g) Maximum space temperature during unoccupied periods (cooling).

(h) Minimum space temperature during unoccupied periods (heating).

(i) Equipment constraints.

(2) Program output.

(a) Day/night control signal.

c. Application notes. The day/night setback program operates in conjunction with the scheduled start/stop and optimum start/stop programs. Space temperature instruments will be located to preclude freezing during the night setback period.

15. HOT WATER OA RESET. Hot water heating systems, whether the hot water is supplied by a boiler or a converter, are designed to supply hot water at a fixed temperature. Depending on the system design, the hot water supply temperature may be reduced as the heating requirements for the facility decrease. A reduction in hot water supply temperature results in reduction of heat loss from equipment and piping. To implement this program, the temperature control setpoint for the hot water supply is reset as a function of OA temperature. Design requirements for this applications program will be indicated by inclusion of an OA temperature reset schedule on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Hot water supply temperature - one per boiler or converter.

(b) OA dry bulb temperature.

(2) UMCS outputs to utility system. Hot water supply temperature CPA - one per boiler or converter.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Reset schedule.

(b) OA dry bulb temperature.

(c) Maximum HW supply temperature.

(d) Equipment constraints.

(2) Program output. HW temperature setpoint.

c. Application notes. A dedicated local loop controller may be implemented, depending on site specific requirements.

16. LIGHTING CONTROL. Time scheduled operation of lighting consists of turning lights off based on the time of day and the day of the week. Additional off commands may be generated at regular intervals to ensure that lights are off (relay operated zoned lighting only). Emergency lighting is not to be controlled by this program. Design requirements for this applications program will be indicated by the letter X adjacent to the scheduled start/stop program listing on the appropriate database table, as shown in Chapters 8 and 9.

a. Field hardware requirements. The hardware requirements are:

(1) UMCS outputs to utility system. Start/stop control signal to interposing relays - typically one for each lighting circuit to be controlled.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Summer and winter start/stop schedules.

(d) Equipment status.

(e) Times of day for additional off commands (where applicable).

c. Application notes. The lighting control program is used in conjunction with the scheduled start/stop program.

17. UNITARY CONTROLLER APPLICATIONS PROGRAMS. A number of application-specific unitary controllers are available with applications programs for specific types of equipment. Examples are heating and ventilating units, air volume control, and air distribution terminal unit control programs. Design requirements for these applications programs will be indicated in the sequence of operations as shown in Chapter 8.

18. UTILITY CONTROL FUNCTIONS AND SEQUENCES OF OPERATION.

a. In addition to the pre-established applications programs listed in this chapter, the UMCS utilizes several basic control functions in combination for control of utility systems. These control functions include event-driven control, two position control, floating point control, and proportional-plus-integral-plus derivative (PID) control. Structured combinations of these basic control functions applied to specific utility systems are referred to as sequence of operation.

b. Event-driven control is a function allowing the UMCS to activate a control output in response to a specific event or state of the monitored utility system. For example, UMCS control of a swimming pool filtration system may provide for backwashing of the filter when the filter DP exceeds a specified limit. Implementation of event-driven control requires that the UMCS monitor the parameters related to the event (in the example, filter DP).

c. Two position control is a function allowing the UMCS to activate a two-state device to control utility system parameters within specified limits. For example, UMCS control of a steam-to-hot water heat exchanger may provide for opening the steam valve when the hot water temperature falls 2 degrees F below the setpoint and closing the valve again when the hot water temperature reaches 2 degrees F above the setpoint.

d. Floating point control is a function allowing the UMCS to change the position of a final control element (such as a valve) by increments in response to deviation of a utility system parameter from its setpoint. As long as the value of the utility system parameter is within a specified deadband around the setpoint, the final control element maintains its current position. Floating point control is normally used when changes in utility system load are gradual.

e. PID control (or proportional-plus-integral or proportional-only control) is a function of feedback controllers allowing the UMCS to continuously modulate a final control element in response to deviations of a utility system parameter from its setpoint. PID control is normally provided for utility system parameters requiring close control or experiencing rapid load swings. Proportional (gain), integral (reset), and derivative (rate) values must be selected for specific control applications and are not all applicable for every control loop.

f. Sequences of operation are combinations of applications programs and these other basic control functions to describe all operational requirements for specific utility systems. Sequences of operation will address different operational modes such as system startup, normal occupied operation, unoccupied operation, heating and cooling modes and failure modes. Typical sequences of operation for utility systems commonly found on Government installations are provided in Chapters 8.

CHAPTER 8

DIRECT DIGITAL CONTROL IMPLEMENTATION

1. GENERAL. The programs described in Chapter 7 can be applied to existing or new systems. Most of these programs may be applied to several types of systems, but others may only be applicable to special types of systems. For example, the boiler monitoring and control program is only applicable to facilities with boiler plants. Due to the interactive nature of the programs, the inputs and/or outputs of one implemented program may provide inputs to other programs.

2. INSTRUMENTS AND INPUTS. Certain instruments and inputs can be common to an entire building or, in some case, the entire UMCS. Electrical consumption and demand instrumentation do not need to be duplicated except in special cases, such as when a UMCS serves an extremely large geographical area, or multiple utility substations. When applications require OA measurement, the minimum requirement is one OA temperature and one RH instrument (when used) for each building. However, the designer may need to increase the minimum requirements to satisfy site specific building and system conditions. For example, separate OA instruments will be specified where intake temperatures of the OA measured on a roof mounted unit may vary significantly from other air intake locations, causing erroneous economizer calculations.

3. DIAGRAMS. Graphic diagrams of typical systems showing UMCS devices and functions for direct control implementation are provided in Figures 8-1 through 8-16. Failure modes will be defined by the designer for each system's controlled devices in the event of a field equipment panel malfunction. Failure modes will be based on climate, type of system, and user requirements. The failure modes shown are for example purposes only.

4. TABLES. Database tables listing UMCS software and settings applied to typical systems are provided in Tables 8-1 through 8-16. The designer will generate a separate database table for each system to be controlled or monitored by the UMCS. Two or more identical systems within the same building, having the same occupancy schedule, may be listed on the same database table. The table's contents and setpoint values will be tailored to the system being controlled for each specific application.

5. SYMBOLS AND ABBREVIATIONS. A listing of symbols and abbreviations used in the system schematics is provided in Appendix B.

6. SEQUENCES OF OPERATION. The design will include a sequence of operations for each system under direct digital control of the UMCS. The sequence of operations will be tailored for the specific site, system and application. Sequences of operation will identify required control loop accuracy when different from default requirements identified in the guide specification CEGS-16935. Sequences of operation for typical HVAC systems are provided in the following paragraphs. These sequences are keyed to the corresponding figures and tables.

a. Steam/Hot Water Converter and Primary/Secondary Heating System Sequence of Operation (Figure 8-1 and Table 8-1).

(1) All Modes. The UMCS will start and stop the primary and secondary pumps in sequence based on the signal from an outside-air temperature sensor as shown. The UMCS will enable control of the steam/hot water converter control valve when the primary pump is operating. The UMCS will control the primary loop hot water supply temperature by modulating the steam control valve in response to a temperature sensor element and transmitter located in the hot water supply line to maintain its setpoint. The UMCS will reset the hot water supply temperature setpoint with respect to the outside air temperature in a linear schedule as shown.

(2) Occupied Mode. The UMCS will modulate the secondary heating control valve when the secondary zone pump is operating) to maintain the heating zone occupied space temperature setpoint.

(3) Unoccupied Mode. The UMCS will modulate the secondary heating control valve (when the secondary zone pump is operating) to maintaining the heating zone unoccupied space temperature.

b. Hot Water Boiler and Primary/Secondary Heating System Sequence of Operation Figure 8-2 and Table 8-2).

(1) All Modes. The UMCS will start and stop the primary and secondary pumps in sequence based on the signal from an outside-air temperature sensor as shown. The UMCS will enable local control of the hot water boiler when the primary pump is operating. The UMCS will control the primary loop hot water supply temperature by modulating the hot water boiler bypass valve in response to a temperature sensor located in the hot water supply line to maintain its setpoint. The UMCS will reset the hot water supply temperature setpoint with respect to outside air temperature in a linear schedule as shown. Reduced-flow control of the hot water bypass valve will be coordinated with the boiler manufacturer's recommendations and boiler safety settings. The UMCS will disable boiler operation when the primary pump is off.

(2) Occupied Mode. The UMCS will modulate the secondary heating control valve (when the secondary zone pump is operating) to maintain the heating zone occupied space temperature setpoint.

(3) Unoccupied Mode. The UMCS will modulate the secondary heating control valve (when the secondary zone pump is operating) to maintaining the heating zone unoccupied space temperature.

c. Hot Water Boiler with Constant Volume Circulating Loop and Primary/Secondary Heating System Sequence of Operation (Figure 8-3 and Table 8-3).

(1) All Modes. The UMCS will start and stop the primary and secondary pumps in sequence based on the signal from an outside-air temperature sensor as shown. The UMCS will enable local control of the hot water boiler and boiler circulating pump when the primary pump is operating. The UMCS will control the primary loop hot water supply temperature by modulating the hot water boiler bypass valve in response to a temperature sensor located in the hot water supply line to maintain its setpoint. The UMCS will reset the hot water supply temperature setpoint with respect to outside air temperature in a linear schedule as shown. Reduced-flow control of the hot water bypass valve will be coordinated with the boiler manufacturer's recommendations and boiler safety settings. The UMCS will disable boiler operation when the primary pump is off. The boiler circulating pump will remain in operation for a preset adjustable time period after the boiler is disabled.

(2) Occupied Mode. The UMCS will modulate the secondary heating control valve when the secondary zone pump is operating) to maintain the heating zone occupied space temperature setpoint.

(3) Unoccupied Mode. The UMCS will modulate the secondary heating control valve when the secondary zone pump is operating) to maintain the heating zone unoccupied space temperature.

d. High-Temperature Hot Water/Hot Water Converter and Primary/Secondary Heating System Sequence of Operation (Figure 8-4 and Table 8-4).

(1) All Modes. The UMCS will start and stop the primary and secondary pumps in sequence based on the signal from an outside-air temperature sensor as shown. The UMCS will enable control of the high temperature hot water/hot water converter control valve when the primary pump is operating. The UMCS will control the primary loop hot water supply temperature by modulating the high temperature hot water control valve in response to a temperature sensor located in the hot water supply line to maintain its setpoint. The UMCS will reset the hot water supply temperature setpoint with respect to the outside air temperature in a linear schedule as shown.

(2) Occupied Mode. The UMCS will modulate the secondary heating control valve when the secondary zone pump is operating) to maintain the heating zone occupied space temperature setpoint.

(3) Unoccupied Mode. The UMCS will modulate the secondary heating control valve when the secondary zone pump is operating) to maintain the heating zone unoccupied space temperature.

e. Steam/Hot Water Converter with Dual Temperature Distribution System Sequence of Operation (Figure 8-5 and Table 8-5).

(1) All Modes. The UMCS will start and stop the distribution pump based on the signal from an outside-air temperature sensor as shown. The UMCS will enable control of the steam/hot water converter control valve when the distribution pump is operating and the system is in heating mode. When the system is not in heating mode, control of the steam valve will be disabled. Heating and cooling modes will be initiated by the UMCS and confirmed by monitoring the position of the changeover valves. UMCS will not make the heating to cooling changeover until the return water temperature drops below 90 degrees F and will not make the cooling to heating changeover until the return water temperature raises above 60 degrees F.

(2) Heating Mode. When the heating mode is selected, the system changeover valves will close to the chilled water flow and will open to flow through the steam/hot water converter. The UMCS will control the hot water supply temperature by modulating the steam control valve in response to a temperature sensor in the hot water supply line to maintain its setpoint. The UMCS will reset the hot water supply temperature setpoint with respect to the outside air temperature in a linear schedule as shown.

(3) Cooling Mode. When the cooling mode is selected, the steam control valve will be closed, the system changeover valves will close to the hot water flow and open to the chilled water flow. Chilled water temperature control will remain under local controls.

f. High-Temperature Hot Water/ Hot Water Converter with Dual Temperature Distribution System Sequence of Operation (Figure 8-6 and Table 8-6).

(1) All Modes. The UMCS will start and stop the distribution pump based on the signal from an outside-air temperature sensor as shown. The UMCS will enable control of the high temperature hot water/hot water converter control valve when the distribution pump is operating and the system is in heating mode. When the system is not in heating mode, control of the high temperature hot water valve will be disabled. Heating and cooling modes will be initiated by the UMCS and confirmed by monitoring the position of the changeover valves. UMCS will not make the heating to cooling changeover until the return water temperature drops below 90 degrees F and will not make the cooling to heating changeover until the return water temperature raises above 60 degrees F.

(2) Heating Mode. When the heating mode is selected, the system changeover valves will close to the chilled water flow and will open to flow through the high temperature hot water converter. The UMCS will control the hot water supply temperature by modulating the high temperature hot water control valve in response to a temperature sensor in the hot water supply line to maintain its setpoint. The UMCS will reset the hot water supply temperature setpoint with respect to the outside air temperature in a linear schedule as shown.

(3) Cooling Mode. When the cooling mode is selected, the high temperature hot water control valve will be closed, the system changeover valves will close to the hot water flow and open to the chilled water flow. Chilled water temperature control will remain under local controls.

g. Dual-Temperature System with Hot Water Boiler and Air-Cooled Chiller Sequence of Operation (Figure 8-7 and Table 8-7).

(1) All Modes. The UMCS will start and stop the distribution pump based on the signal from an outside-air temperature sensor as shown. The UMCS will enable control of the hot water boiler bypass valve when pump is operating and the system is in heating mode. When the system is not in heating mode the boiler bypass valve will be disabled. The UMCS will enable control of the air-cooled chiller when the distribution pump is operating and the system is in cooling mode. Heating and cooling modes will be initiated by the UMCS and confirmed by monitoring the position of the changeover valves. UMCS will not make the heating to cooling changeover until the return water temperature drops below 90 degrees F and will not make the cooling to heating changeover until the return water temperature rises above 60 degrees F.

(2) Heating Mode. When the heating mode is selected, the system changeover valves will close to the chilled water flow and will open to flow through the hot water boiler. The UMCS will enable local control of the hot water boiler. The UMCS will control the hot water supply temperature by modulating the hot water boiler bypass valve in response to a temperature sensor located in the hot water supply line to maintain its setpoint. The UMCS will reset the hot water supply temperature setpoint with respect to the outside air temperature in a linear schedule as shown. Reduced-flow control of the hot water bypass valve will be coordinated with the boiler manufacturer's recommendations and boiler safety settings. The UMCS will disable boiler operation when the distribution pump is off. The UMCS shall reset the hot water supply temperature setpoint with respect to outside air temperature in a linear schedule as shown.

(3) Cooling Mode. When the cooling mode is selected, the hot water boiler bypass valve will be closed to the boiler, the system changeover valves will close to the hot water flow and open to the chilled water flow. The UMCS will enable local control of the air-cooled chiller and condenser. Chilled water supply temperature will remain under local controls. When the distribution pump is not operating the air-cooled chiller local controls will be disabled.

h. Water-Cooled Chiller System Sequence of Operation (Figure 8-8 and Table 8-8).

(1) All Modes. The UMCS will enable and disable the chiller plant operation based on occupancy schedule, heating/cooling operation, and outside air temperature. When the chiller is stopped, the chilled water and condenser water pumps shall have delayed shutdown after compressor shutdown.

(2) Chiller Control. The UMCS will first start the chilled water pump and the condenser water pump. The chiller local control interlocks will operate the chiller to maintain a constant chilled water supply temperature after flow has been established. The UMCS will reset the chiller's local control chilled water supply temperature setpoint based on the chilled water temperature as shown.

(3) Cooling Tower Control. The UMCS will start/stop the cooling tower fan, modulate the condenser water bypass control valve, and select the fan speed as required to maintain condenser water supply temperature setpoint. When the chiller is stopped, the chilled water and condenser water pumps will have delayed shutdown after compressor shutdown.

i. Multizone Air Handling System with Hot Water and Chilled Water Coils Sequence of Operation (Figure 8-9 and Table 8-9).

(1) Outside-Air, Return-Air, and Relief-Air Dampers.

(a) Occupied Mode. The minimum outside air damper will open. The maximum outside-air, return-air, and relief-air dampers will be modulated under mixed-air temperature and economizer control.

(b) Unoccupied Mode. The dampers will return to their normal positions as shown.

(2) Supply-Fan and Return-Fan Control.

(a) Occupied Mode. Supply and return fans will start in sequence, and will operate continuously.

(b) Unoccupied Mode. Supply and return fans will be cycled on and off according to the night setback control setpoint.

(3) Hot-Deck Heating Coil - All Modes. The UMCS will modulate the control valve from the signal of a temperature-sensing element and transmitter located in the coil discharge air to maintain the setpoint. The UMCS will reset the hot-deck temperature setpoint with respect to the coldest space zone temperature signal as directed by the hot deck-cold deck temperature reset program.

(4) Freeze Protection - All Modes. A low temperature device, located as shown, will stop the supply and return fans, cause the outside-air, return-air, and relief-air dampers to return to their normal position, and will initiate a low-temperature alarm if the temperature drops below the low temperature device setpoint. Return to the expected mode of operation will require manual reset at the low temperature device. The UMCS will indicate an alarm condition when the low temperature device trips.

(5) Cold-Deck Cooling Coil.

(a) Occupied Mode. The control valve will be modulated by the UMCS from the signal of a temperature-sensor located in the coil discharge air to maintain the setpoint. The UMCS will reset the cold-deck temperature setpoint with respect to the hottest space zone temperature as directed by the hot deck-cold deck temperature reset program.

(b) Unoccupied Mode. The UMCS will close the cooling-coil control valve to the coil.

(6) Mixed-Air Temperature Control. When the UMCS places the system in the economizer operation, it will modulate the dampers from the signal of a temperature sensor in the mixed-air stream to maintain the setpoint based on the conditions shown in Table 8-17.

Table 8-17. Mixed-Air Damper Modulation.

Condition No.	Description	Control
1	OA temperature < SA temperature < Changeover temperature	Modulate OA, RA, and relief dampers to maintain mixed air temperature at cold deck supply temperature setpoint minus 2 degrees F.
2	SA temperature < OA temperature < Changeover temperature	Set OA and relief dampers at 100% open; RA dampers closed.
3	SA temperature < Changeover temperature < OA temperature	Set OA and relief dampers at their minimum positions, and set RA damper at its corresponding open position.

(a) Zone-Damper Control - All Modes. A space temperature sensor for each zone will signal the UMCS to gradually operate the zone-mixing damper to heat and cool its respective zone by mixing cold-deck air and hot-deck air to maintain the zone setpoint. On a rise in space temperature, the hot-deck damper will gradually close, and the cold-deck damper will gradually open.

(b) Smoke Control. Smoke detectors in the supply-air and return-air ductwork will stop the supply fan and the return fan and initiate a smoke alarm if smoke is detected at either location. Restarting the supply fan and the return fan will require manual reset at the smoke detectors.

j. Dual Duct Air Handling System with Hot Water and Chilled Water Coils Sequence of Operation (Figure 8-10 and Table 8-10).

(1) Outside-Air, Return-Air, and Relief-Air Dampers.

(a) Occupied Mode. The minimum outside-air damper will open. The maximum outside-air, return-air, and relief-air dampers will be modulated under mixed-air temperature and economizer control.

(b) Unoccupied Mode. The dampers will return to their normal positions as shown.

(2) Supply-Fan and Return-Fan Control.

(a) Occupied Mode. Supply and return fans will start in sequence, and will operate continuously.

(b) Unoccupied Mode. Supply and return fans will cycle on and off according to the night setback control setpoint.

(3) Hot-Deck Heating Coil - All modes. The UMCS will modulate the control valve from the signal of a temperature-sensor located in the coil discharge air to maintain the setpoint. The UMCS will reset the hot-deck temperature setpoint with respect to the coldest space zone temperature as directed by the hot deck-cold deck temperature reset program.

(4) Freeze Protection - All Modes. A low temperature device, located as shown, will stop the supply and return fans, cause the outside-air, return-air, and relief-air dampers to return to their normal position, and will initiate a low-temperature alarm if the temperature drops below the low temperature setpoint. Return to the expected mode of operation will require manual reset at the low temperature device. The UMCS will indicate an alarm condition when the low temperature device trips.

(5) Cold-Deck Cooling Coil.

(a) Occupied Mode. The control valve will be modulated by the UMCS from the signal of a temperature-sensor located in the coil discharge air to maintain the setpoint. The UMCS will reset the cold-deck temperature setpoint with respect to the hottest space zone temperature in a linear schedule as shown.

(b) Unoccupied Mode. The UMCS will close the cooling-coil control valve to the coil.

(6) Mixed-Air Temperature Control. When the UMCS places the system in the economizer operation, it will modulate the dampers from the signal of a temperature sensor in the mixed-air stream to maintain the setpoint based on the conditions shown in Table 8-18.

Table 8-18. Mixed-Air Damper Modulation.

Condition No.	Description	Control
1	OA temperature < SA temperature < Changeover temperature	Modulate OA, RA, and relief dampers to maintain mixed air temperature at cold deck supply temperature setpoint minus 2 degrees F.

2	SA temperature < OA temperature < Changeover temperature	Set OA and relief dampers at 100% open; RA dampers closed.
3	SA temperature < Changeover temperature < OA temperature	Set OA and relief dampers at their minimum positions, and set RA damper at its corresponding open position.

(7) Dual-Duct Terminal Box - All Modes. A space temperature sensor for each zone will signal the UMCS to gradually operate the control dampers of the dual-duct box to heat and cool its respective zone by mixing cold-deck air and hot-deck air to maintain the zone setpoint. On a rise in space temperature, the hot-deck damper will gradually close, and the cold-deck damper will gradually open.

(8) Smoke Control. Smoke detectors in the supply-air and return-air ductwork will stop the supply fan and the return fan and initiate a smoke alarm if smoke is detected at either location. Restarting the supply fan and the return fan will require manual reset at the smoke detectors.

k. Bypass Multizone Air Handling System with Hot Water and Chilled Water Coils Sequence of Operation (Figure 8-11 and Table 8-11).

(1) Outside-Air, Return-Air, and Relief-Air Dampers.

(a) Occupied Mode. The minimum outside-air damper will open. The maximum outside-air, return-air, and relief-air dampers will be modulated under mixed-air temperature and economizer control.

(b) Unoccupied Mode. The dampers will return to their normal positions as shown.

(2) Supply-Fan and Return-Fan Control.

(a) Occupied Mode. Supply and return fans will start in sequence and will operate continuously.

(b) Unoccupied Mode. Supply fan and return fans will cycle on and off according to the night setback control setpoint.

(3) Freeze Protection - All Modes. A low temperature device, located as shown, will stop the supply and return fans, cause the outside-air, return-air, and relief-air dampers to return to their normal position, and will initiate a low-temperature alarm if the temperature drops below the low temperature device setpoint as shown. Return to the expected mode of operation will require manual reset at the low temperature device. The UMCS will indicate an alarm condition when the low temperature device trips.

(4) Cold-Deck Cooling Coil.

(a) Occupied Modes. The control valve will be modulated by the UMCS from the signal of a temperature-sensor located in the coil discharge air to maintain the setpoint. The UMCS shall reset the cold-deck temperature setpoint with respect to the hottest space zone temperature as directed by the hot deck-cold deck temperature reset program.

(b) Unoccupied Mode. The UMCS will close the cooling-coil control valve to the coil.

(5) Mixed-Air Temperature Control. When the UMCS places the system in the economizer operation, it will modulate the dampers from the signal of a temperature sensor in the mixed-air stream to maintain the setpoint based on the conditions shown in Table 8-19.

Table 8-19. Mixed-Air Damper Modulation.

Condition No.	Description	Control
1	OA temperature < SA temperature < Changeover temperature	Modulate OA, RA, and relief dampers to maintain mixed air temperature at cold deck supply temperature setpoint minus 2 degrees F.
2	SA temperature < OA temperature < Changeover temperature	Set OA and relief dampers at 100% open; RA dampers closed.
3	SA temperature < Changeover temperature < OA temperature	Set OA and relief dampers at their minimum positions, and set RA damper at its corresponding open position.

(6) Zone-Damper and Heating Coil Control - All Modes. A space temperature sensor for each zone will signal the UMCS to modulate the zone-mixing damper and heating coil valve to heat and cool its respective zone by mixing cold-deck air and bypass-deck air to maintain the zone setpoint. On a rise in space temperature, the heating coil valve will gradually close, and after a selected dead band the bypass-deck damper will gradually close, and the cold-deck damper will gradually open in sequence.

(7) Smoke Control. Smoke detectors in the supply-air and return-air ductwork will stop the supply fan and the return fan and initiate a smoke alarm if smoke is detected at either location. Restarting the supply fan and the return fan will require manual reset at the smoke detectors.

l. VAV Air Handling System with Hot Water and Chilled Water Coils Sequence of Operation (Figure 8-12 and Table 8-12).

(1) Outside-Air, Return-Air, and Relief-Air Dampers.

(a) Occupied Mode. The minimum outside-air damper will open. The maximum outside-air, return-air, and relief-air dampers will be modulated under mixed-air temperature and economizer control.

(b) Unoccupied Mode. The dampers will return to their normal positions as shown.

(2) Supply-Fan Control.

(a) Occupied Mode. The supply fan will start and will operate continuously.

(b) Unoccupied Mode. The supply fan will cycle on and off according to the night setback schedule setpoint.

(3) Supply-Duct Pressure Control. When the supply fan starts, the UMCS will modulate the fan inlet vanes from the signal of a static pressure sensor to maintain the setpoint. When the fan is off the inlet vanes will be closed.

(4) Freeze Protection - All Modes. A low temperature device, located as shown, will stop the supply fan, cause the outside-air, return-air, and relief-air dampers to return to their normal position, and will initiate a low-temperature alarm if the temperature drops below the low temperature device's setpoint.

Return to the normal mode of operation will require manual reset at the low temperature device. The UMCS will indicate an alarm condition when the low temperature device trips.

(5) Cooling-Deck Coil and Preheat Coil Control.

(a) Occupied Mode. The control valves will be modulated in sequence by the UMCS from the signal of a temperature-sensor located in the fan discharge- air duct to maintain the setpoint.

(b) Unoccupied Mode. The UMCS will close the cooling-coil control valve to the coil and will open the preheat-coil control valve to the coil.

(6) Mixed-Air Temperature Control. When the UMCS places the system in the economizer operation, it will modulate the dampers from the signal of a temperature sensor in the mixed-air stream to maintain the setpoint based on the conditions shown in Table 8-20.

Table 8-20. Mixed-Air Damper Modulation.

Condition No.	Description	Control
1	OA temperature < SA temperature < Changeover temperature	Modulate OA, RA, and relief dampers to maintain mixed air temperature at cold deck supply temperature setpoint minus 2 degrees F.
2	SA temperature < OA temperature < Changeover temperature	Set OA and relief dampers at 100% open; RA dampers closed.
3	SA temperature < Changeover temperature < OA temperature	Set OA and relief dampers at their minimum positions, and set RA damper at its corresponding open position.

(7) Pressure-Independent VAV Terminal Box Control. The control damper in the VAV box will modulate in response to the signal from a flow-sensing element (at the inlet or discharge of the VAV terminal box) to the UMCS Unitary Controller. The UMCS will control the VAV box damper from its minimum-flow position to its full-flow position from the signal of a space temperature sensing element and transmitter. When the space temperature decreases, the damper will gradually close. If the space temperature continues to drop after the damper has reached its minimum-flow position, the reheat coil valve will be controlled to maintain the space temperature setpoint.

(8) Smoke Control. Smoke detectors in the supply-air and return-air ductwork will stop the supply fan and initiate a smoke alarm if smoke is detected at either location. Restarting the supply fan will require manual reset at the smoke detectors.

m. VAV Air Handling System with Return Fan and Hot Water/Chilled Water Coils Sequence of Operation (Figure 8-13 and Table 8-13).

(1) Outside-Air, Return-Air, and Relief-Air Dampers.

(a) Occupied Mode. The minimum outside-air damper will open. The maximum outside-air, return-air, and relief-air dampers will be modulated under mixed-air temperature and economizer control.

(b) Unoccupied Mode. The dampers will return to their normal positions as shown.

(2) Supply-Fan and Return-Fan Control.

(a) Occupied Mode. Supply fan and return fans will start in sequence and will operate continuously.

(b) Unoccupied Mode. Supply and return fans will cycle on and off according to the night setback schedule setpoint.

(3) Supply-Duct Pressure Control. When the supply fan starts, the UMCS will modulate the fan inlet vanes from the signal of a static pressure sensor to maintain the setpoint. When the fan is off the inlet vanes will be closed.

(4) Return Fan Volume Control. When the return fan starts, the UMCS will modulate the fan inlet vanes from the signals of airflow measurement stations and transmitters in the return and supply ducts in order to maintain a constant flow differential setpoint between supply and return airflows.

(5) Freeze Protection - All Modes. A low temperature device, located as shown, will stop the supply and return fans, cause the outside-air, return-air, and relief-air dampers to return to their normal position, and will initiate a low-temperature alarm if the temperature drops below the low temperature device's setpoint. Return to the normal mode of operation will require manual reset at the low temperature device. The UMCS will indicate an alarm condition when the low temperature device trips.

(6) Cooling Coil and Preheat Coil Control.

(a) Occupied Mode. The control valves will be modulated in sequence by the UMCS from the signal of a temperature-sensor located in the supply fan discharge air duct to maintain the setpoint.

(b) Unoccupied Mode. The UMCS will close the cooling-coil control valve to the coil and will open the preheat-coil control valve to the coil.

(7) Mixed-Air Temperature Control. When the UMCS places the system in the economizer operation, it will modulate the dampers from the signal of a temperature sensor in the mixed-air stream to maintain the setpoint based on the conditions shown in Table 8-21.

Table 8-21. Mixed-Air Damper Modulation.

Condition No.	Description	Control
1	OA temperature < SA temperature < Changeover temperature	Modulate OA, RA, and relief dampers to maintain mixed air temperature at cold deck supply temperature setpoint minus 2 degrees F.
2	SA temperature < OA temperature < Changeover temperature	Set OA and relief dampers at 100% open; RA dampers closed.
3	SA temperature < Changeover temperature < OA temperature	Set OA and relief dampers at their minimum positions, and set RA damper at its corresponding open position.

(8) Pressure-Independent VAV Terminal Box Control. The control damper in the VAV box will modulate in response to the signal from a flow-sensing element at the inlet (or discharge) of the VAV terminal box to the UMCS Unitary Controller. The UMCS will control the VAV box damper from its

minimum-flow position to its full-flow position from the signal of a space temperature sensing element and transmitter. When the space temperature decreases, the damper will gradually close. If the space temperature continues to drop after the damper has reached its minimum-flow position, the reheat coil valve will be controlled to maintain the space temperature setpoint.

(9) Smoke Control. Smoke detectors in the supply-air and return-air ductwork will stop the supply fan and the return fan and initiate a smoke alarm if smoke is detected at either location. Restarting the supply fan and the return fan will require manual reset at the smoke detectors.

n. Single Zone Air Handling System with Hot Water/Chilled Water Coils and Humidification Sequence of Operation (Figure 8-14 and Table 8-14).

(1) Outside-Air, Return-Air, and Relief-Air Dampers.

(a) Occupied Mode. The minimum outside air will open. The maximum outside-air, return-air, and relief-air dampers will be modulated under mixed-air temperature and economizer control.

(b) Unoccupied Mode. The dampers will return to their normal positions as shown.

(2) Supply-Fan Control.

(a) Occupied Mode. The supply fan will start and will operate continuously.

(b) Unoccupied Mode. The supply fan will cycle on and off according to the night setback schedule setpoint.

(c) Freeze Protection - All Modes. A low temperature device, located as shown, will stop the supply and return fans, cause the outside-air, return-air, and relief-air dampers to return to their normal position, and will initiate a low-temperature alarm if the temperature drops below the low temperature device's setpoint as shown. Return to the normal mode of operation will require manual reset at the low temperature device. The UMCS panel will indicate an alarm condition when the low temperature device trips.

(3) Cooling Coil and Heating Coil Control.

(a) Occupied Mode. The control valves will be modulated in sequence by the UMCS from the signal of the space temperature sensor to maintain its setpoint. On a rise in space temperature, the UMCS will gradually close the heating-coil valve and after passing through a deadband, the UMCS will gradually operate the outside-air damper to admit outside-air beyond the minimum quantity. After the outside air damper is fully open the UMCS will then operate the cooling-coil valve to maintain the setpoint as shown.

(b) Unoccupied Mode - The UMCS will close the cooling-coil control valve to the coil and will open the heating-coil control valve to the coil.

(4) Mixed-Air Temperature Control. When the UMCS places the system in the economizer operation, it will modulate the dampers from the signal of the space temperature sensor to maintain the setpoint based on the conditions shown in Table 8-22.

Table 8-22. Mixed-Air Damper Modulation.

Condition No.	Description	Control
1	OA temperature < Changeover temperature	Modulate OA and relief dampers open, and the RA dampers closed to maintain the space temperature

		cooling setpoint.
2	Changeover temperature < OA temperature	Set OA and relief dampers at their minimum positions, and set RA damper at its corresponding open position.

(5) Smoke Control. Smoke detectors in the supply-air and return-air ductwork will stop the supply fan and initiate a smoke alarm if smoke is detected at either location. Restarting the supply fan will require manual reset at the smoke detectors.

(6) Humidity Control.

(a) Occupied Mode. The UMCS will gradually operate the humidifier valve from the signal of the return duct relative-humidity sensor /transmitter to maintain relative-humidity space low limit setpoint. If the return duct relative humidity rises above its space high limit setpoint the UMCS will temporarily transfer control of the cooling coil control valve from temperature control to relative humidity control. When the return duct relative humidity drops to its setpoint, control of the cooling coil control valve will be transferred to the temperature control loop. The UMCS will monitor a duct high limit relative-humidity sensor in the supply duct downstream of the humidifier and will modulate the humidifier valve to a fully closed position when the duct high limit setpoint is exceeded.

(b) Unoccupied Mode. The humidifier valve will be closed.

(7) Smoke Control. Smoke detectors in the supply-air and return-air ductwork will stop the supply fan and initiate a smoke alarm if smoke is detected at either location. Restarting the supply fan will require manual reset at the smoke detector.

o. Single Zone Air Handling System with Hot Water and DX Refrigeration Coils Sequence of Operation (Figure 8-15 and Table 8-15).

(1) Outside-Air, Return-Air, and Relief-Air Dampers.

(a) Occupied Mode. The minimum outside-air damper will open. The maximum outside-air, return-air, and relief-air dampers will be modified under mixed-air temperature and economizer control.

(b) Unoccupied Mode. The dampers will return to their normal positions as shown.

(2) Supply-Fan Control.

(a) Occupied Mode. The supply fan will start and will operate continuously.

(b) Unoccupied Mode. The supply fan will cycle on and off according to the night setback schedule setpoint.

(3) Freeze Protection - All Modes. A low temperature device, located as shown, will stop the supply and return fans, cause the outside-air, return-air, and relief-air dampers to return to their normal position, and will initiate a low-temperature alarm if the temperature drops below the low temperature device's setpoint as shown. Return to the normal mode of operation will require manual reset at the low temperature device. The UMCS will indicate an alarm condition when the low temperature device trips.

(4) Direct Expansion Cooling Coil and Heating Coil Control.

(a) Occupied Modes. On a rise in space temperature, the UMCS will first gradually close the heating-coil valve. After passing through a deadband. The UMCS will then gradually operate the outside-air damper to admit outside-air beyond the minimum quantity and after the outside air damper is fully open the UMCS will then operate the DX stages of cooling in sequence.

(b) Unoccupied Mode. Cooling will be off and the heating-coil control valve will open to the coil.

(5) Mixed-Air Temperature Control. When the UMCS places the system in the economizer operation, it will modulate the dampers from the signal of the space temperature sensor to maintain the setpoint based on the conditions shown in Table 8-23.

Table 8-23. Mixed-Air Damper Modulation.

Condition No.	Description	Control
1	OA temperature < Changeover temperature	Modulate OA and relief dampers open, and the RA dampers closed to maintain the space temperature cooling setpoint.
2	Changeover temperature < OA temperature	Set OA and relief dampers at their minimum positions, and set RA damper at its corresponding open position.

(6) Smoke Control. Smoke detectors in the supply-air and return-air ductwork will stop the supply fan and initiate a smoke alarm if smoke is detected at either location. Restarting the supply fan will require manual reset at the smoke detectors.

p. Heating and Ventilating System Sequence of Operation (Figure 8-16 and Table 8-16).

(1) Outside-Air, Return-Air, and Relief-Air Dampers.

(a) Occupied Mode. The outside air will open to its minimum position at start-up. The outside-air, return-air, and relief-air dampers will be modulated under mixed-air temperature control.

(b) Unoccupied Mode. The dampers will return to their normal positions as shown.

(2) Ventilation Delay Mode of Operation. During the ventilation delay mode, the dampers remain positioned in the unoccupied mode while the supply fan runs continuously. Until the ventilation delay mode ends, the HVAC system circulates return air to bring the building to comfort conditions, using a minimum of energy.

(3) Supply-Fan Control.

(a) Occupied Mode. The supply fan will start and will operate continuously.

(b) Unoccupied Mode. The supply fan will cycle on and off according to the night setback schedule setpoint.

(4) Freeze Protection - All Modes. A low temperature device, located as shown, will stop the supply fan, cause the outside-air, return-air, and relief-air dampers to return to their normal position, and will initiate a low-temperature alarm if the temperature drops below the low temperature device's setpoint as shown. Return to the normal mode of operation will require manual reset at the low temperature device. The UMCS panel will indicate an alarm condition when the low temperature device trips.

(5) Heating Coil Control.

(a) Occupied Mode. The control valve will be modulated by the UMCS from the signal of the space temperature sensor to maintain its setpoint. On a rise in space temperature, the UMCS will gradually close the heating coil valve and after passing through a deadband, the UMCS will gradually operate the outside-air damper to admit outside-air beyond the minimum quantity.

(b) Unoccupied Mode. The UMCS will open the heating coil control valve to the coil.

(6) Mixed-Air Temperature Control. The UMCS will modulate the outside air, return air, and relief air dampers from the signal of the space temperature sensor to maintain the space temperature at a control setpoint 4 degrees F higher than the heating setpoint. When the space temperature continues to rise, the outside air and relief air damper shall modulate to 100% open, and the return air damper shall modulate closed, and stay at this position until the space temperature drops below the control setpoint. When the space temperature drops below the control setpoint, the outside air and relief air dampers will modulate to their minimum position and the return air damper will go to its corresponding position.

(7) Smoke Control. Smoke detectors in the supply-air ductwork will stop the supply fan and initiate a smoke alarm if smoke is detected. Restarting the supply fan will require manual reset at the smoke detector.

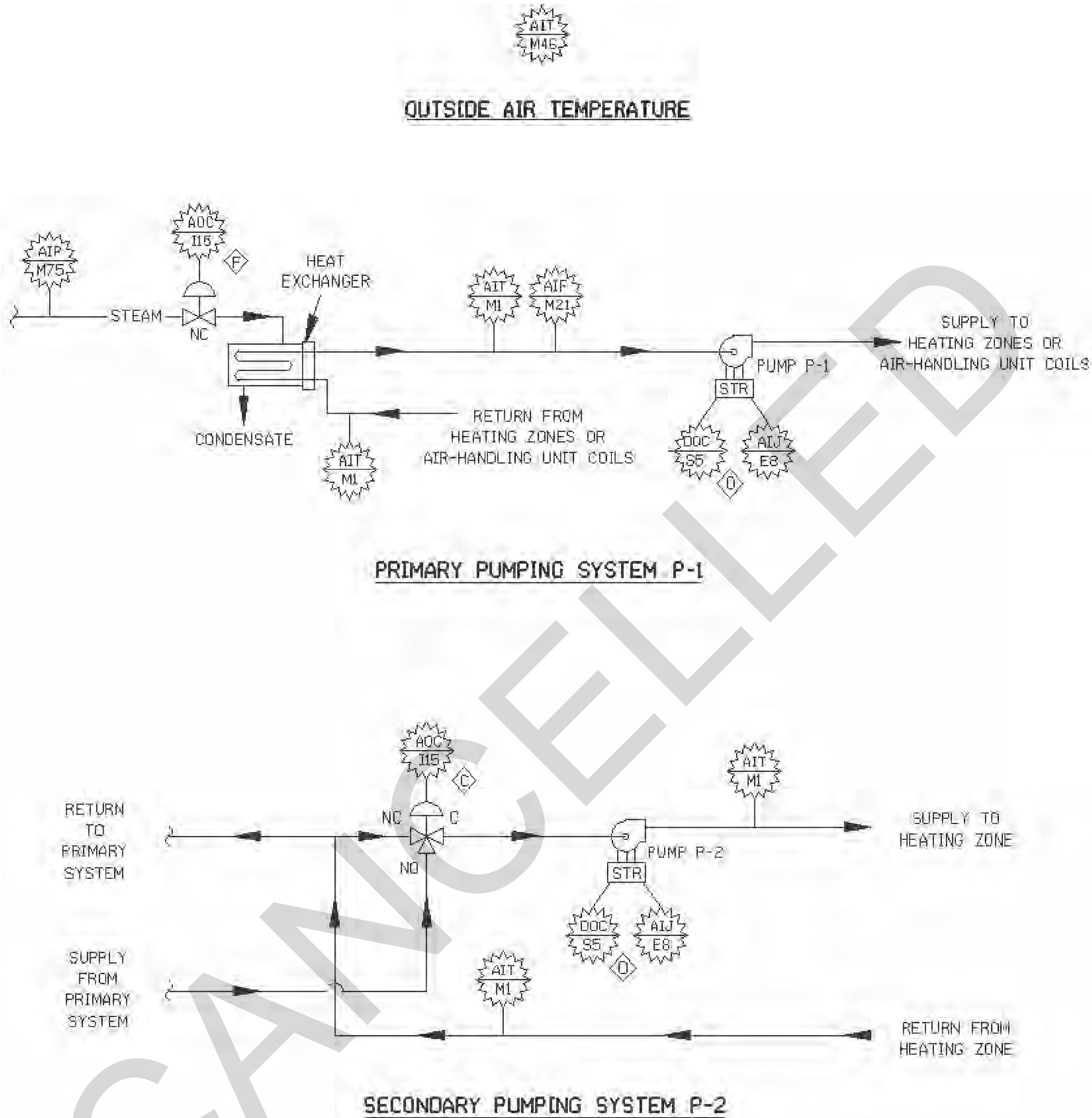


Figure 8-1. Steam/HW Converter and Primary/Secondary Heating System.

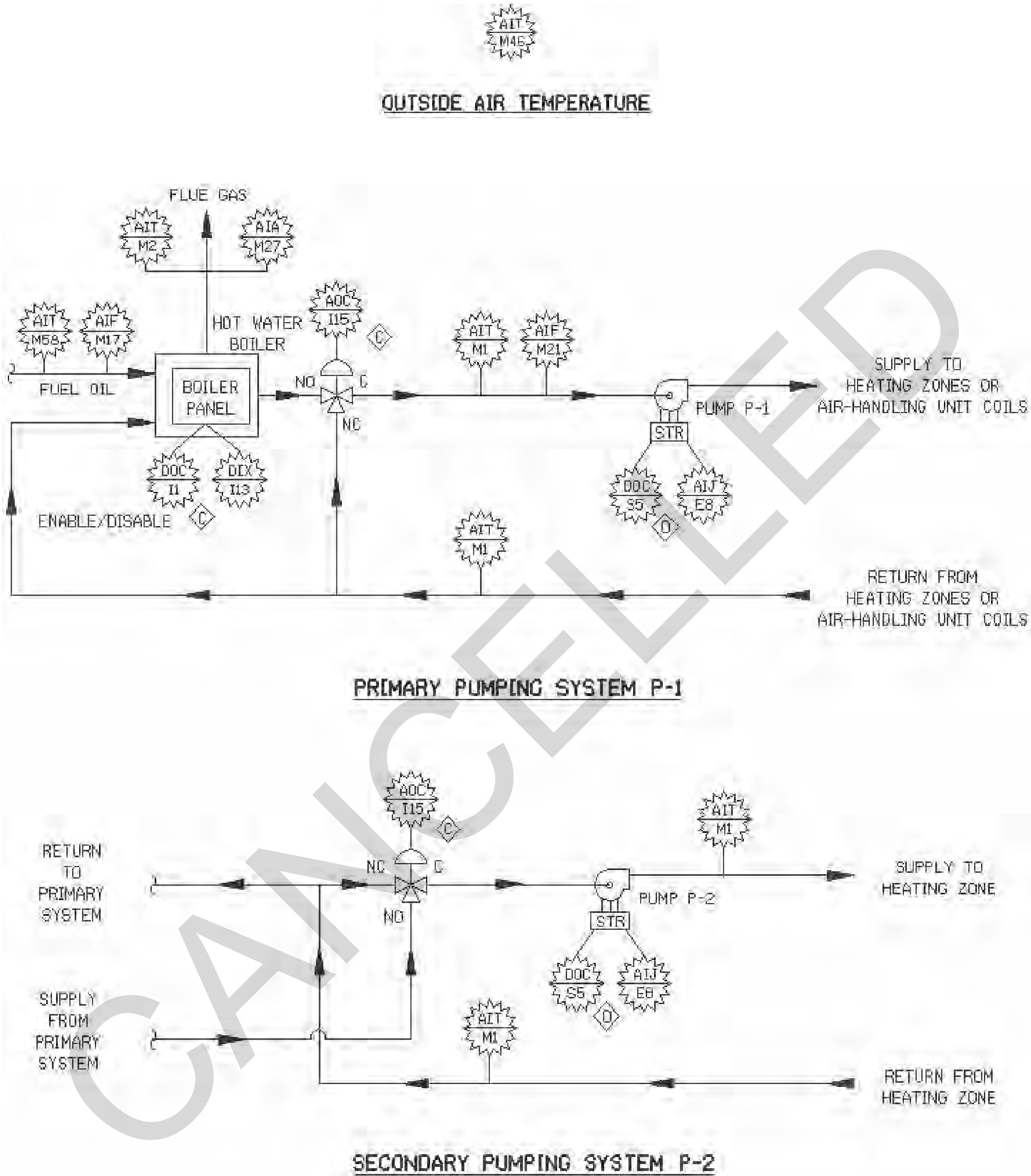


Figure 8-2. Hot Water Boiler and Primary/Secondary Heating System.

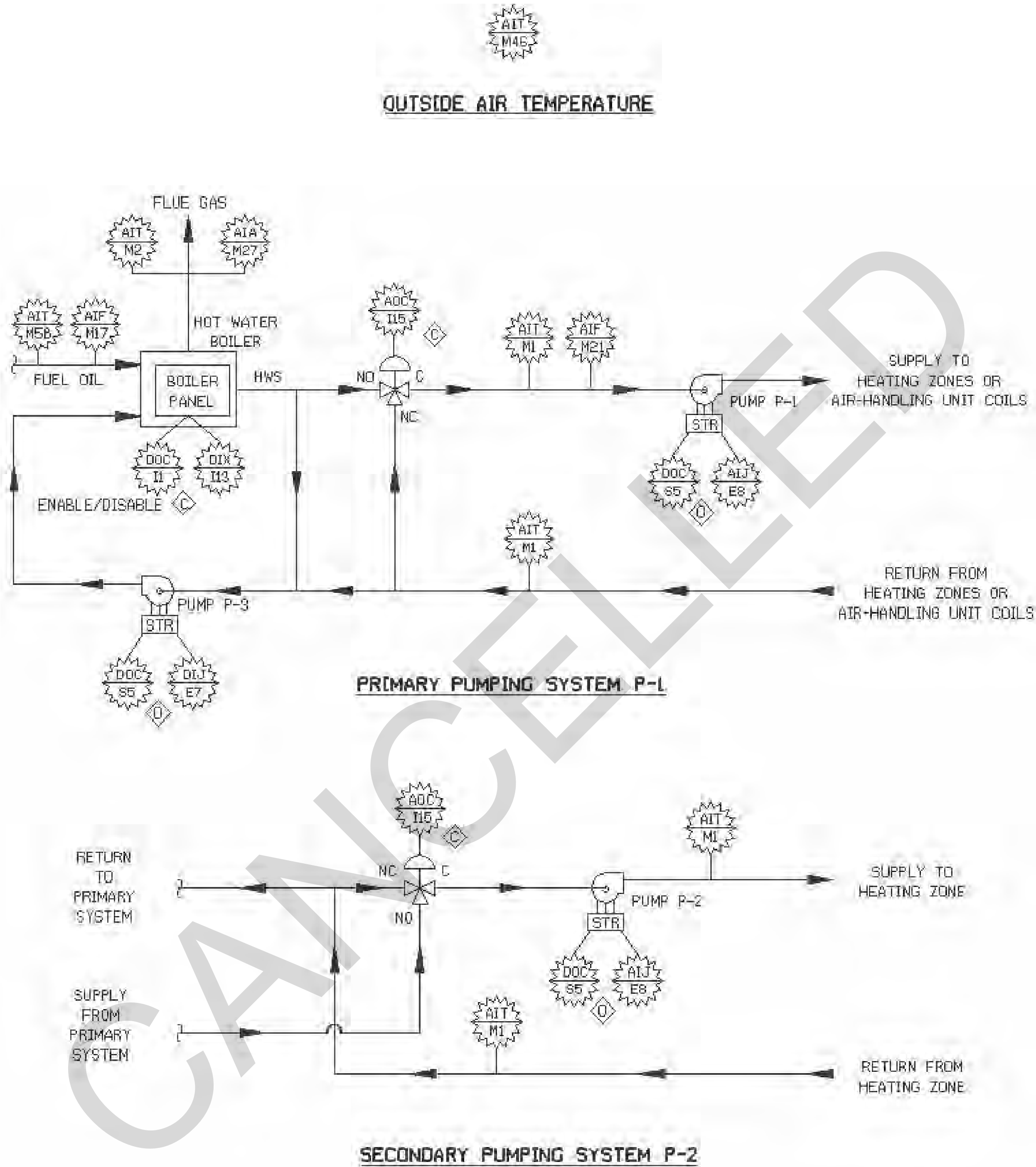


Figure 8-3. Hot Water Boiler with Constant Volume Circulating Loop and Primary/Secondary Heating System.

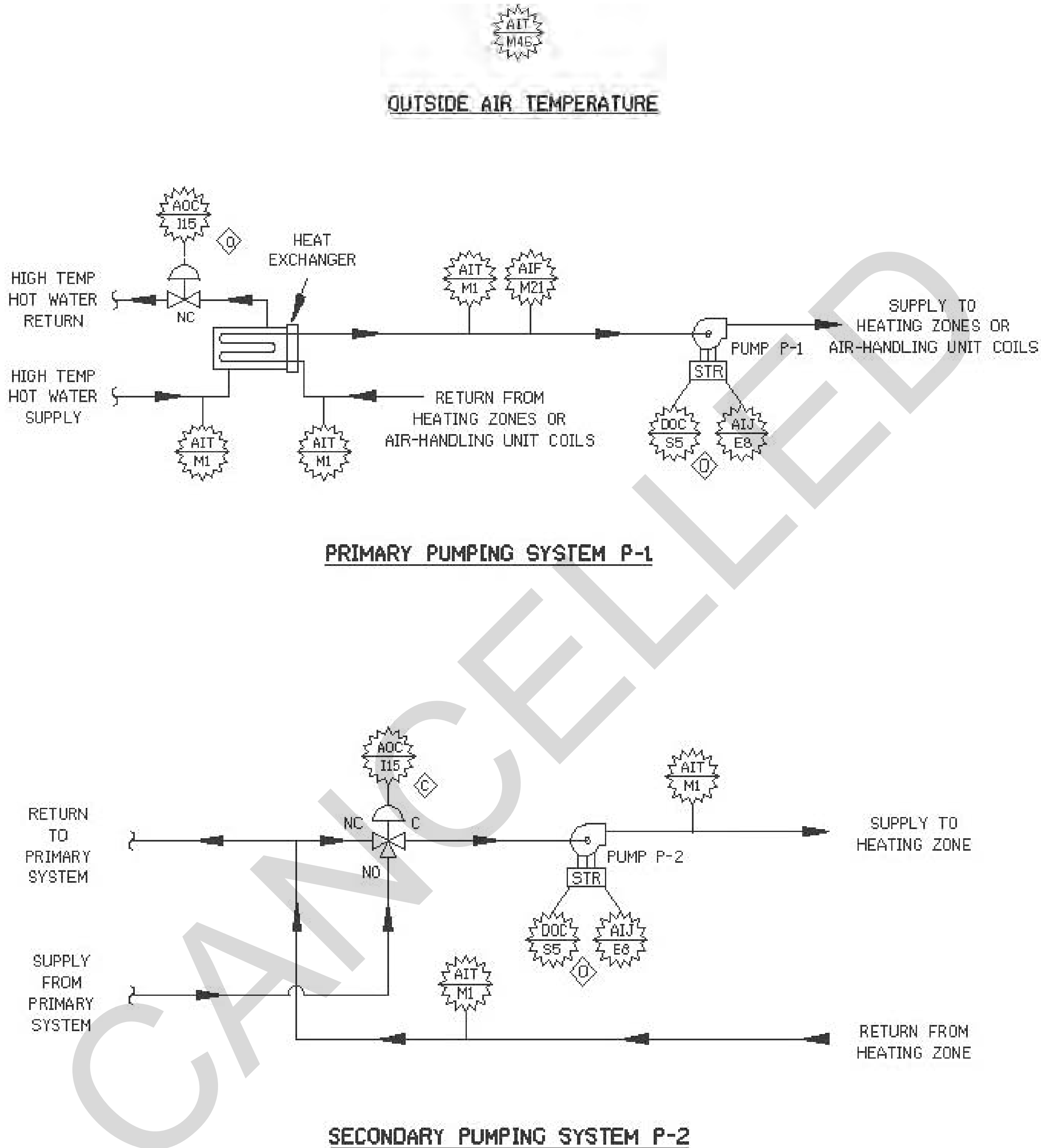


Figure 8-4. High Temperature HW/HW Converter
And Primary/Secondary Heating System.

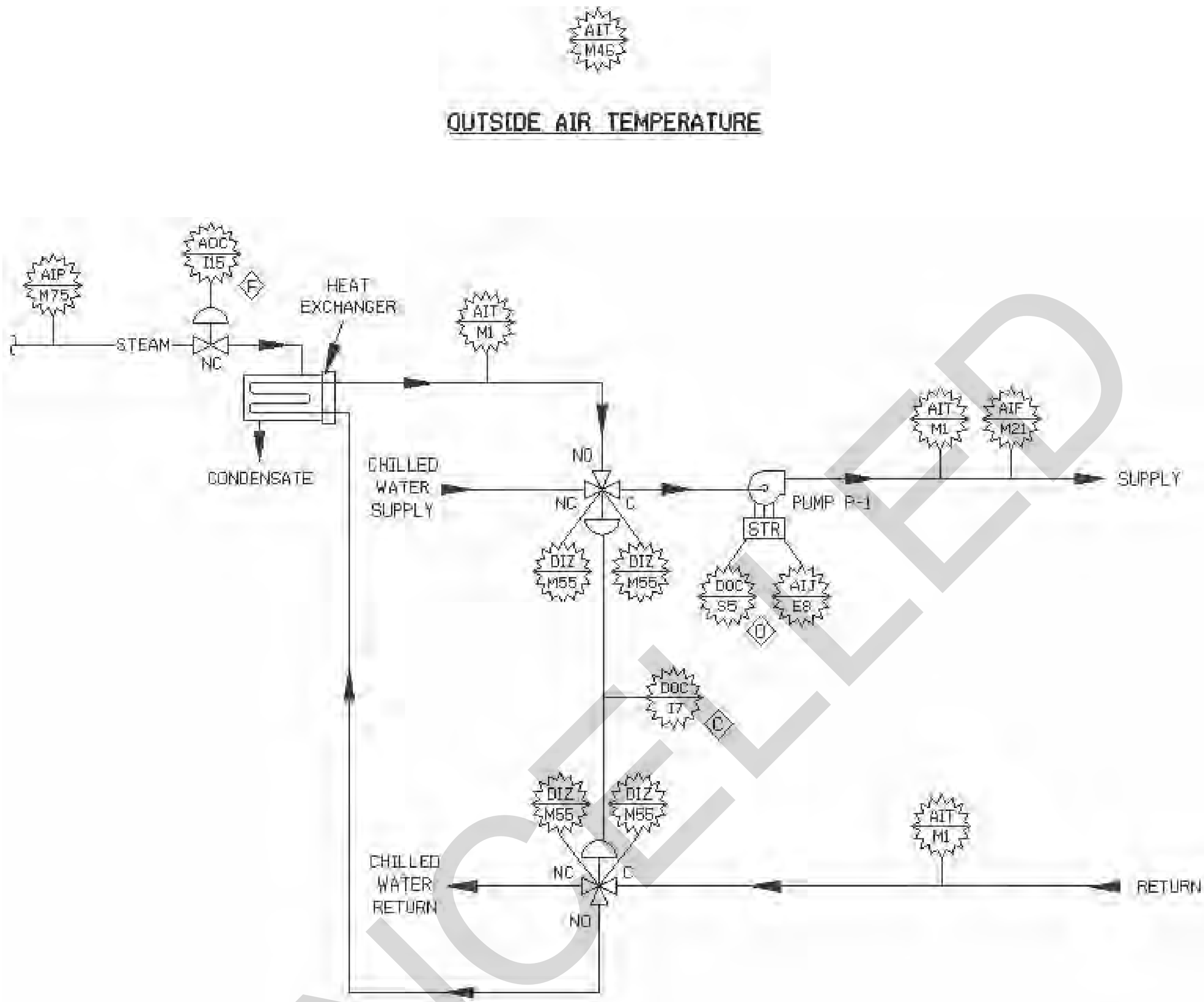


Figure 8-5. Steam/HW Converter with Dual Temperature Distribution System.

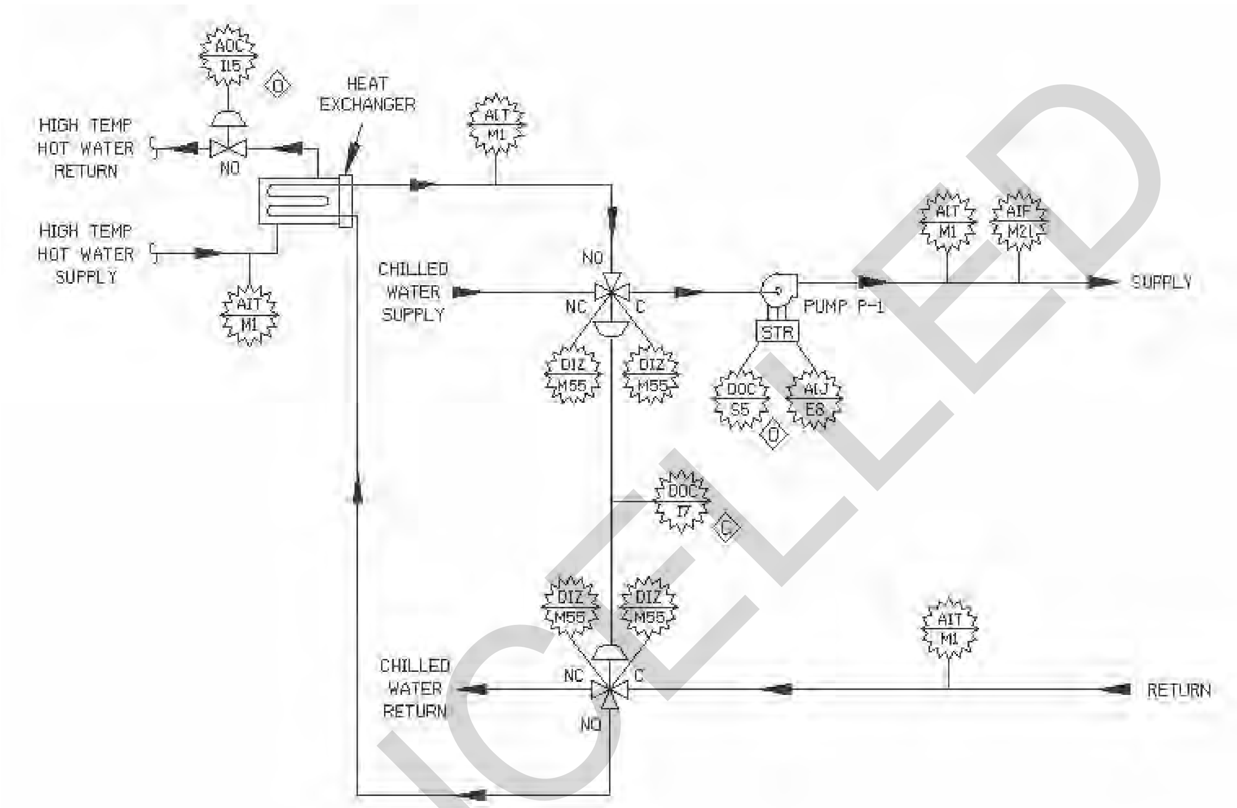
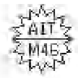


Figure 8-6. High Temperature HW/HW Converter with Dual Temperature Distribution System.



OUTSIDE AIR TEMPERATURE

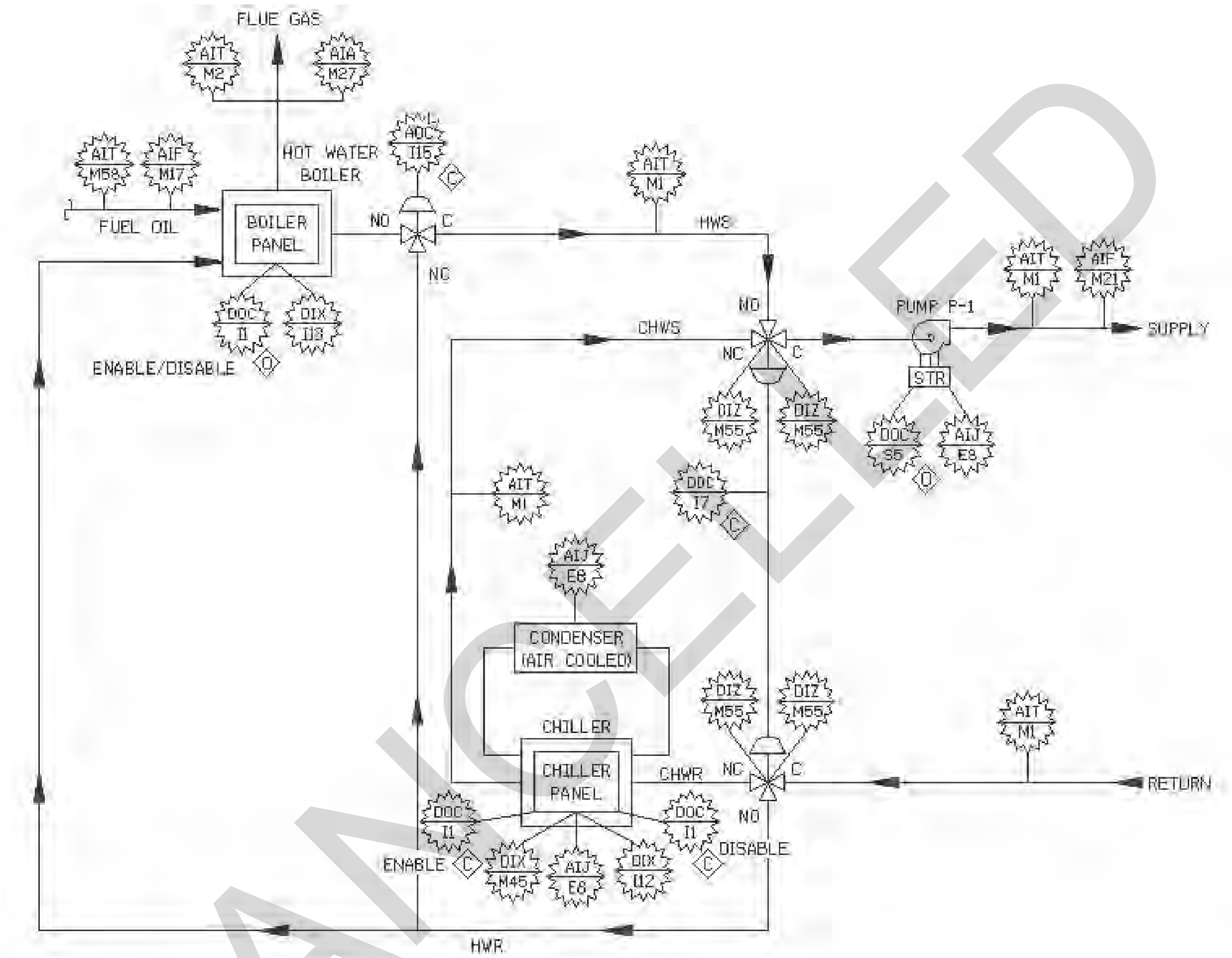


Figure 8-7. Dual Temperature System with Hot Water
Boiler and Air-Coiled Chiller.

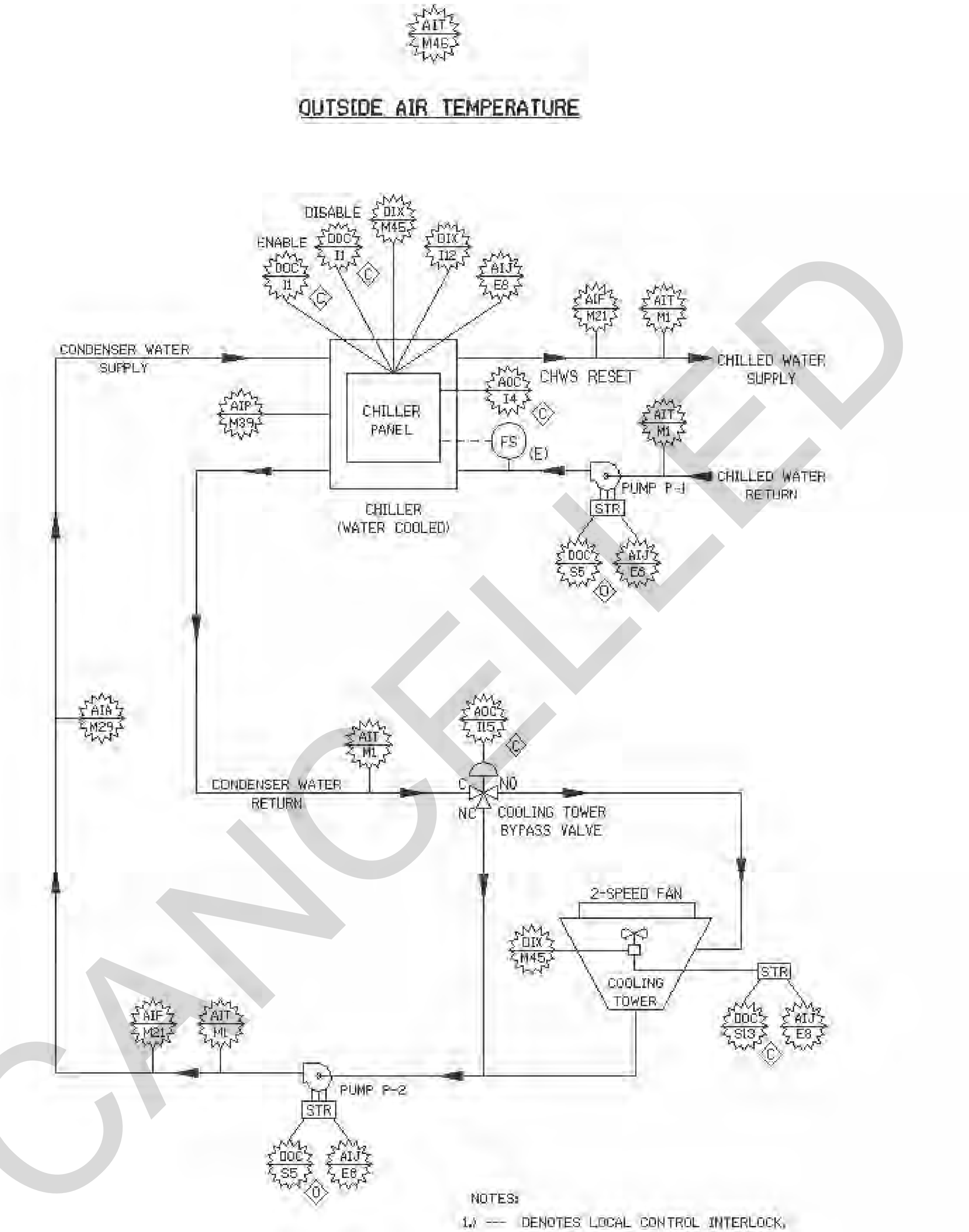
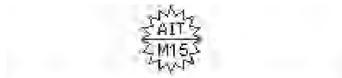


Figure 8-8. Water-Cooled Chiller.



OUTSIDE AIR TEMPERATURE

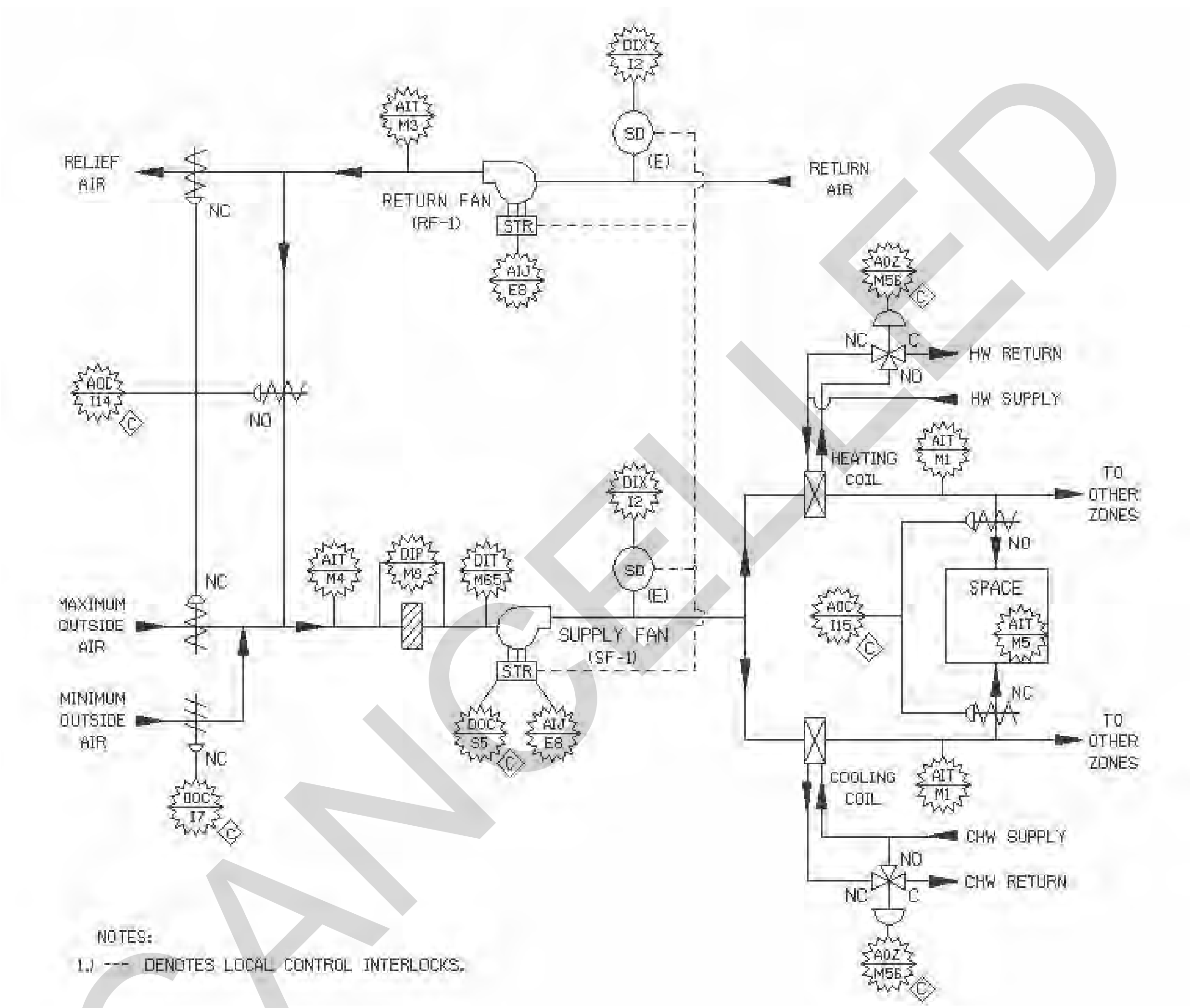


Figure 8-9. Multi-Zone Air Handling System with Hot Water and Chilled Water Coils.

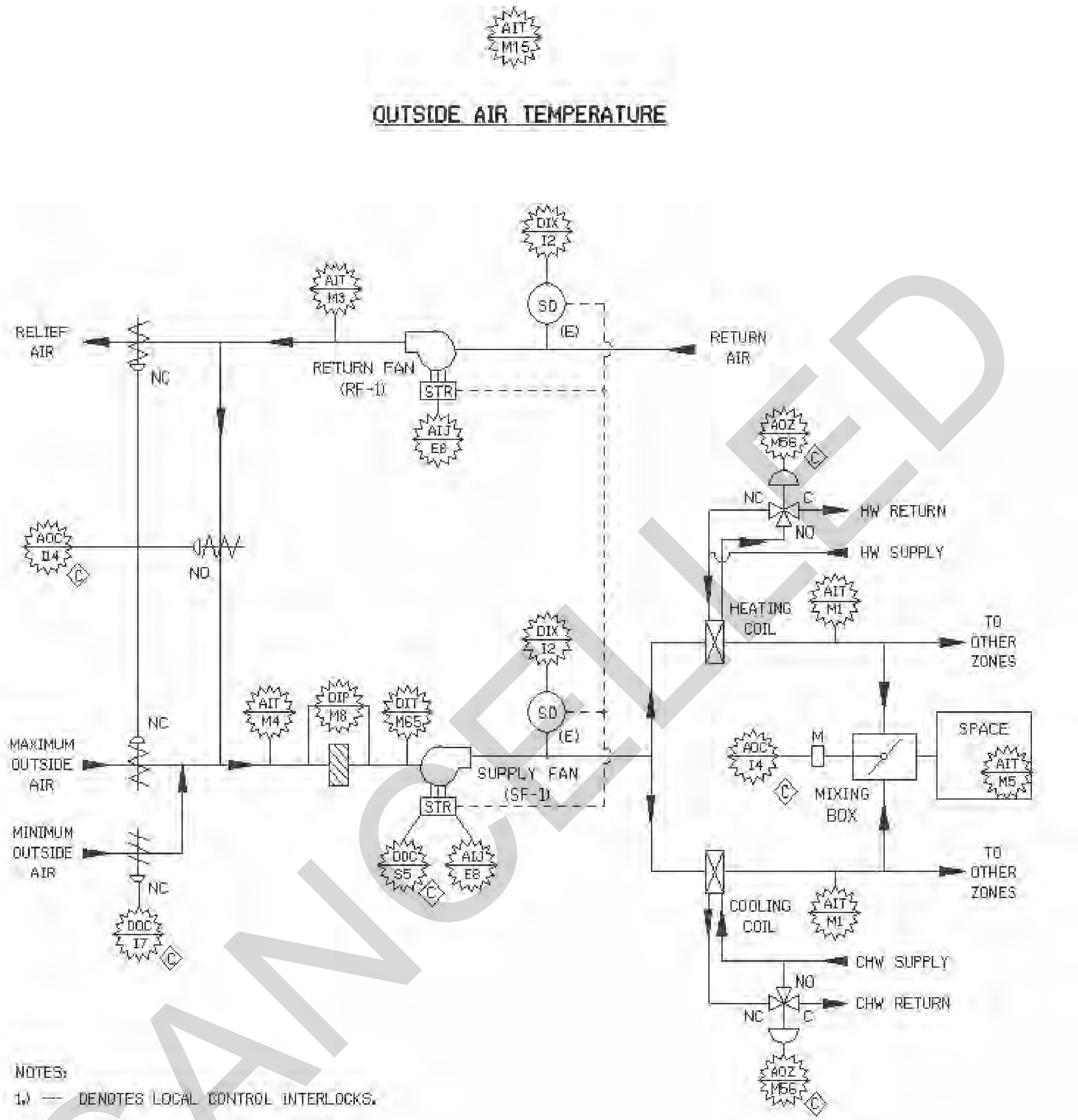
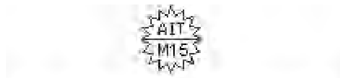


Figure 8-10. Dual Duct Air Handling System with Hot Water and Chilled Water Coils.



OUTSIDE AIR TEMPERATURE

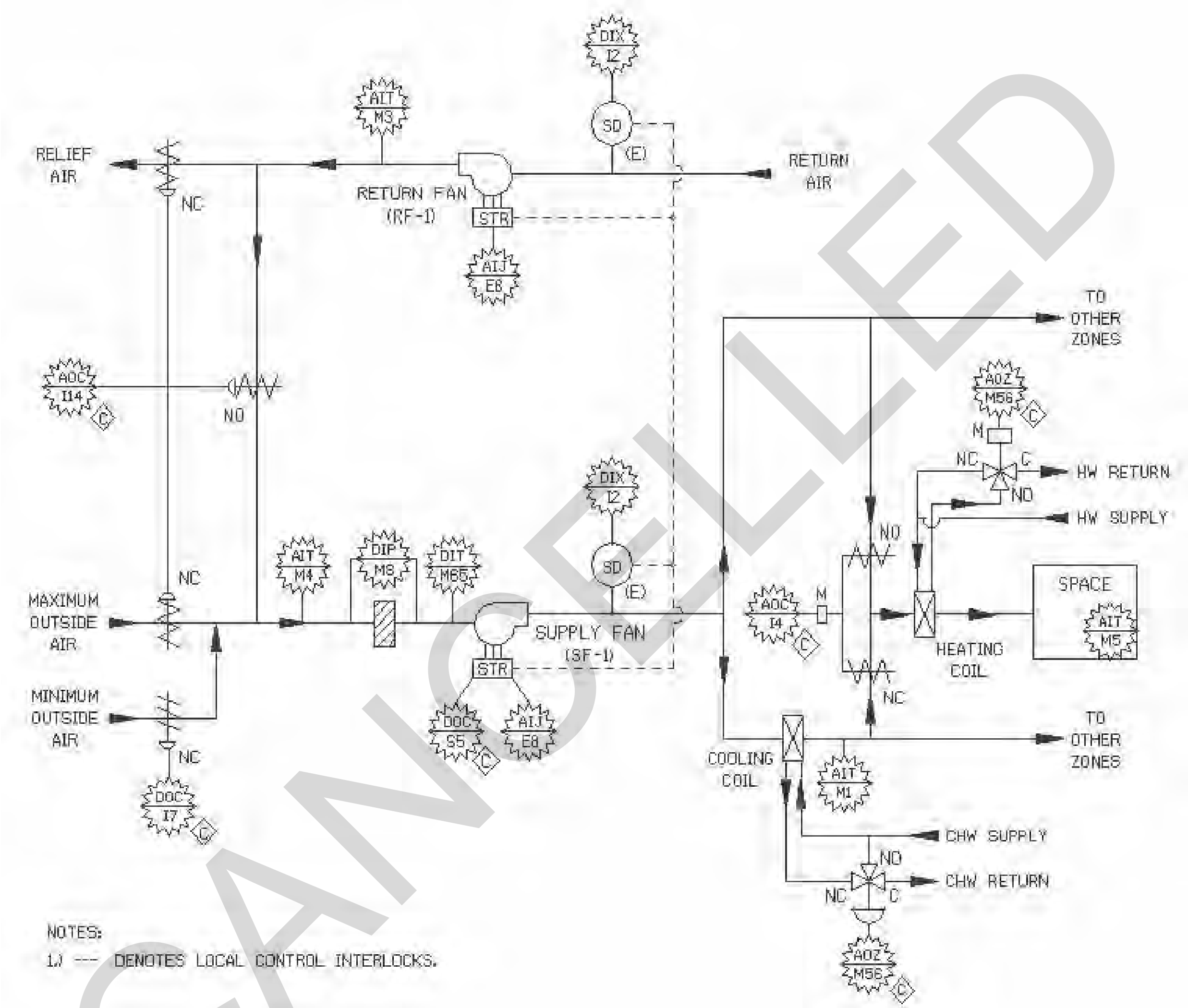
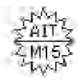
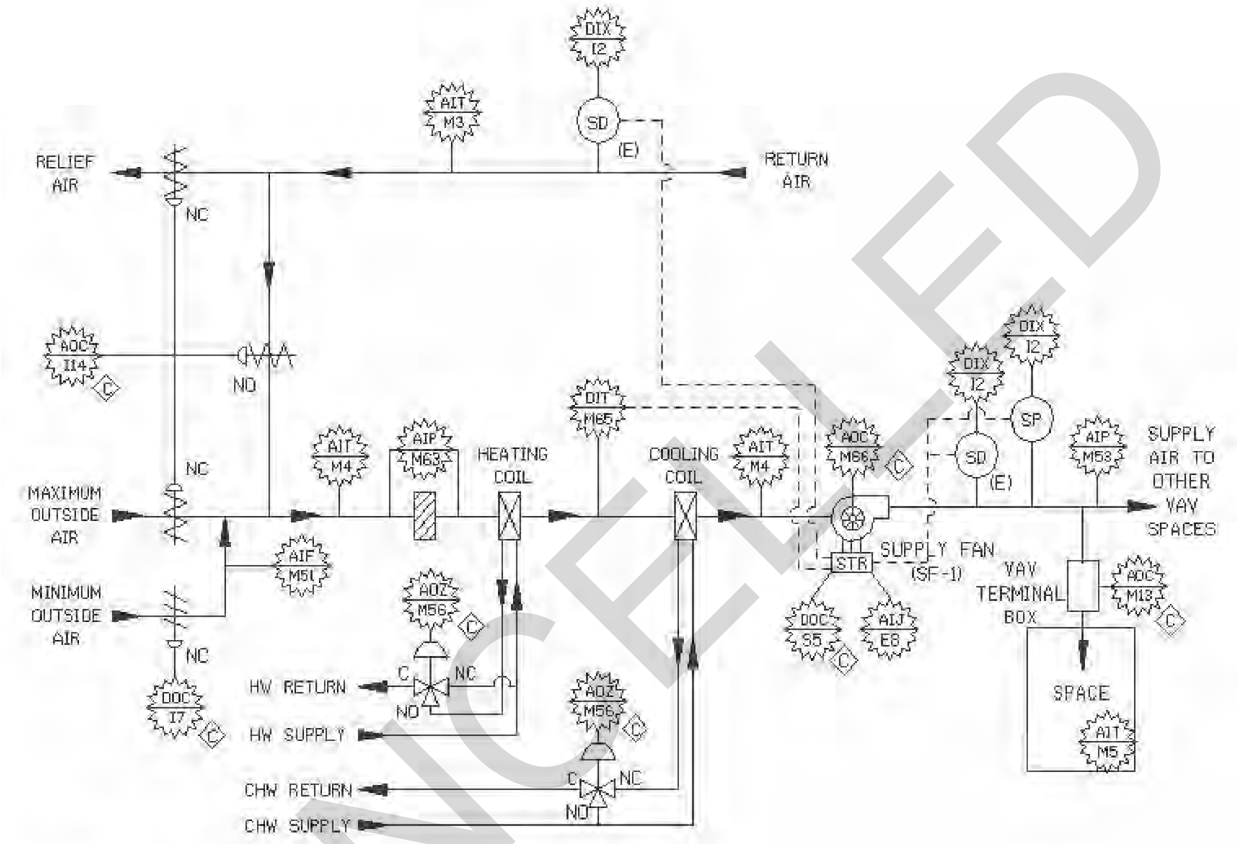


Figure 8-11. Bypass Multi-Zone Air Handling System with Hot Water and Chilled Water Coils.



OUTSIDE AIR TEMPERATURE



NOTES:
1.) --- DENOTES LOCAL CONTROL INTERLOCKS.

Figure 8-12. VAV Air Handling System with Hot Water and Chilled Water Coils.

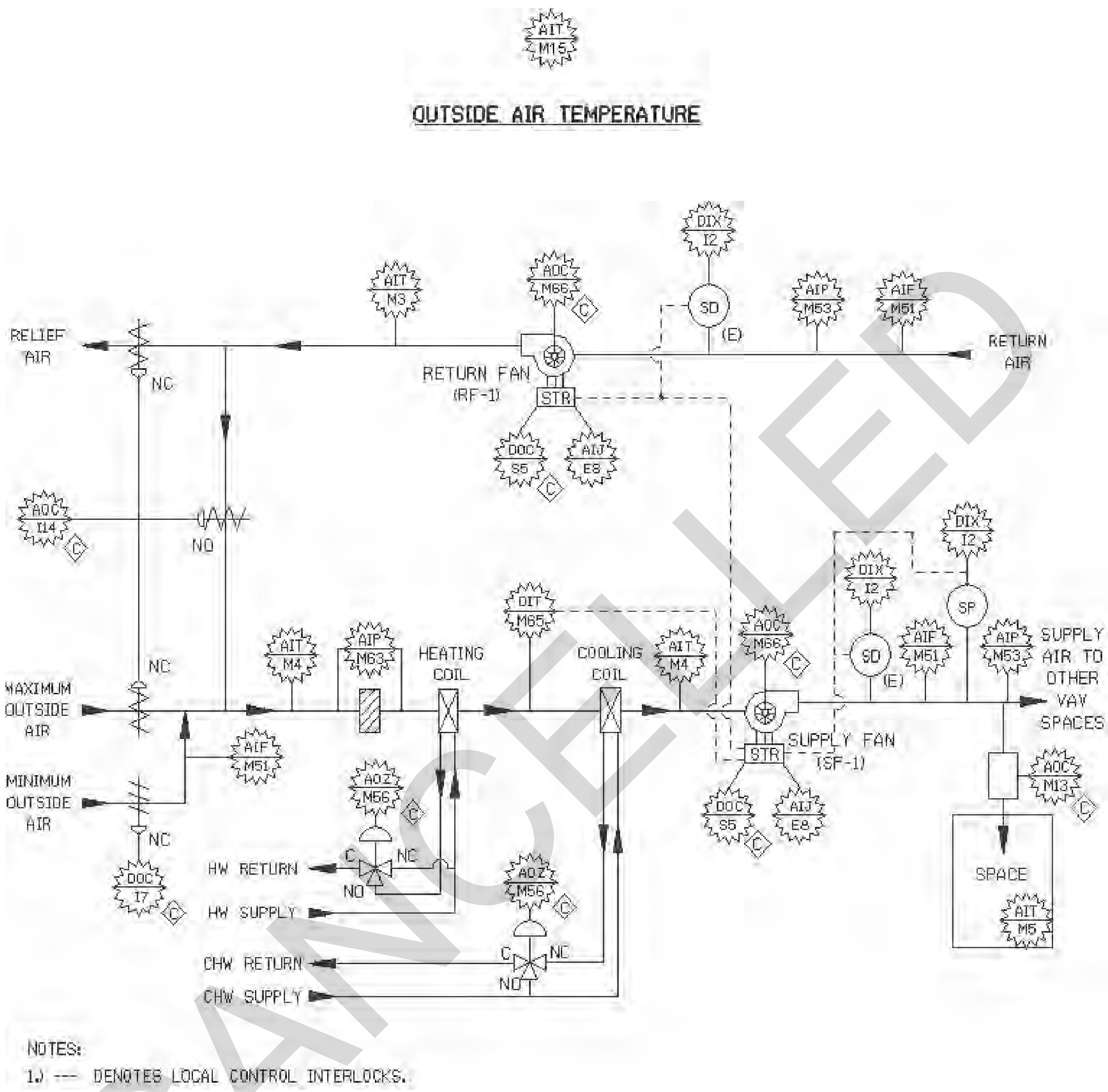


Figure 8-13. VAV Air Handling System with Return Fan and Hot Water/Chilled Water Coils.

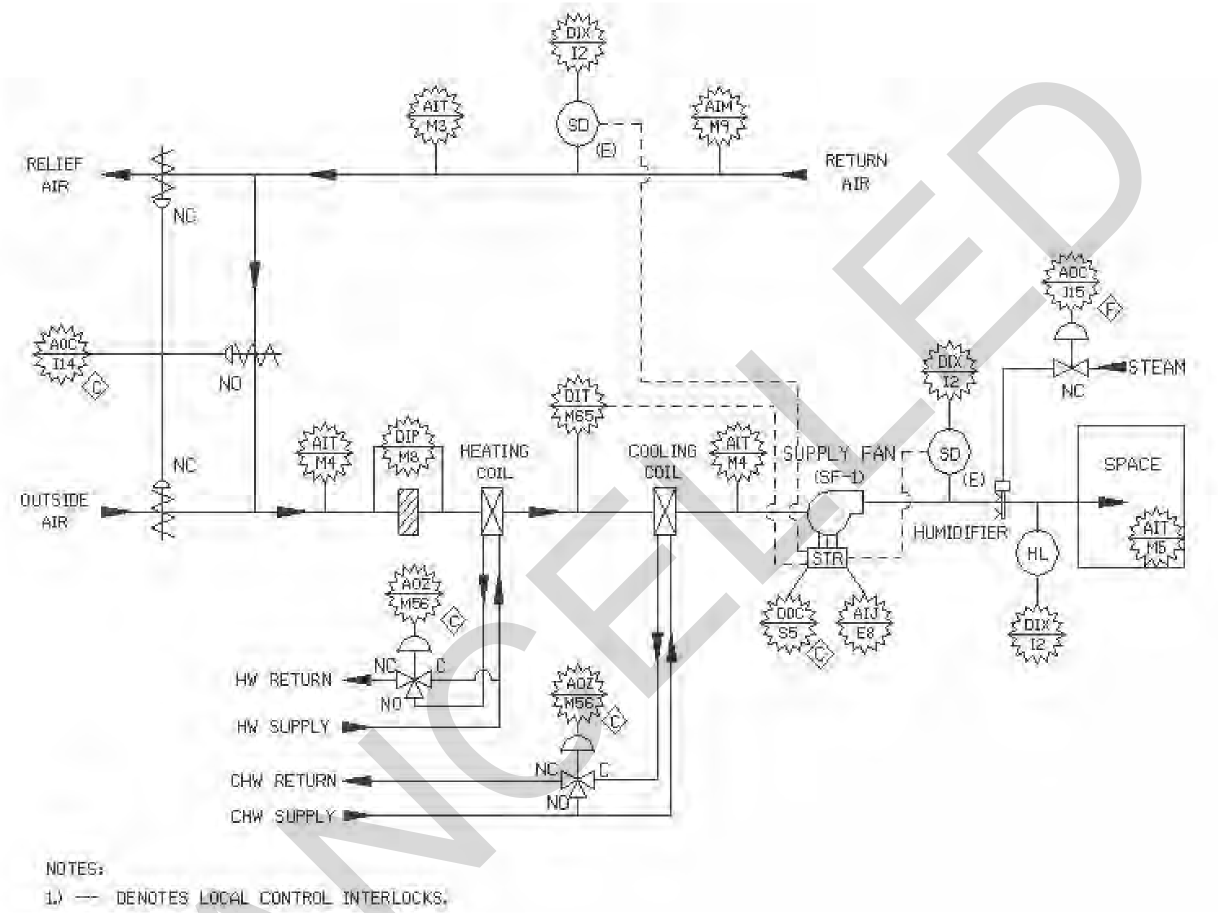
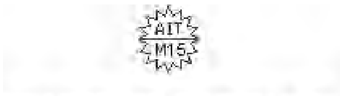


Figure 8-14. Single Zone Air Handling System with Hot Water/Chilled Water Coils and Humidification.



OUTSIDE AIR TEMPERATURE

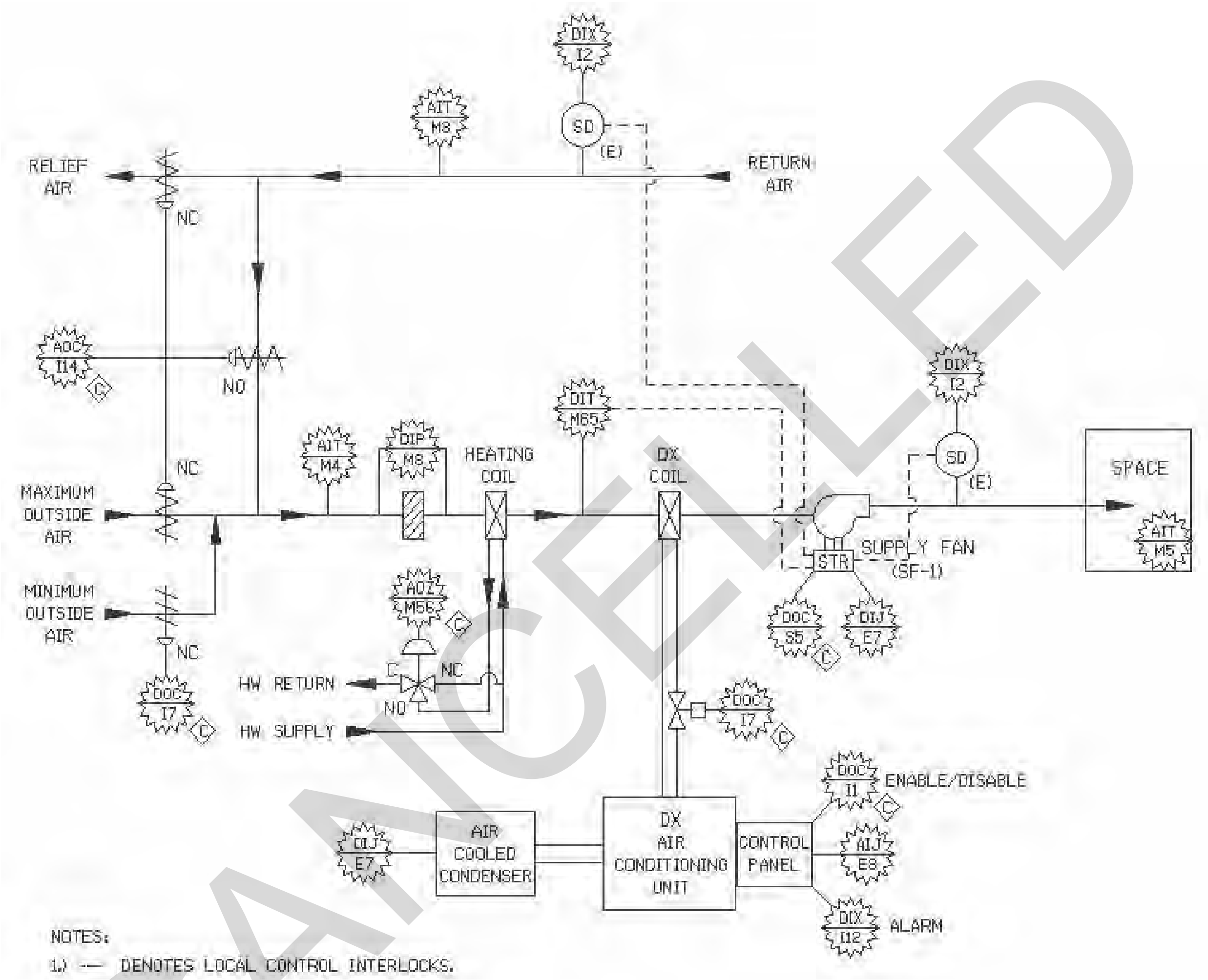


Figure 8-15. Single Zone Air Handling System with Hot Water and DX Refrigeration Coils.

OUTSIDE AIR TEMPERATURE

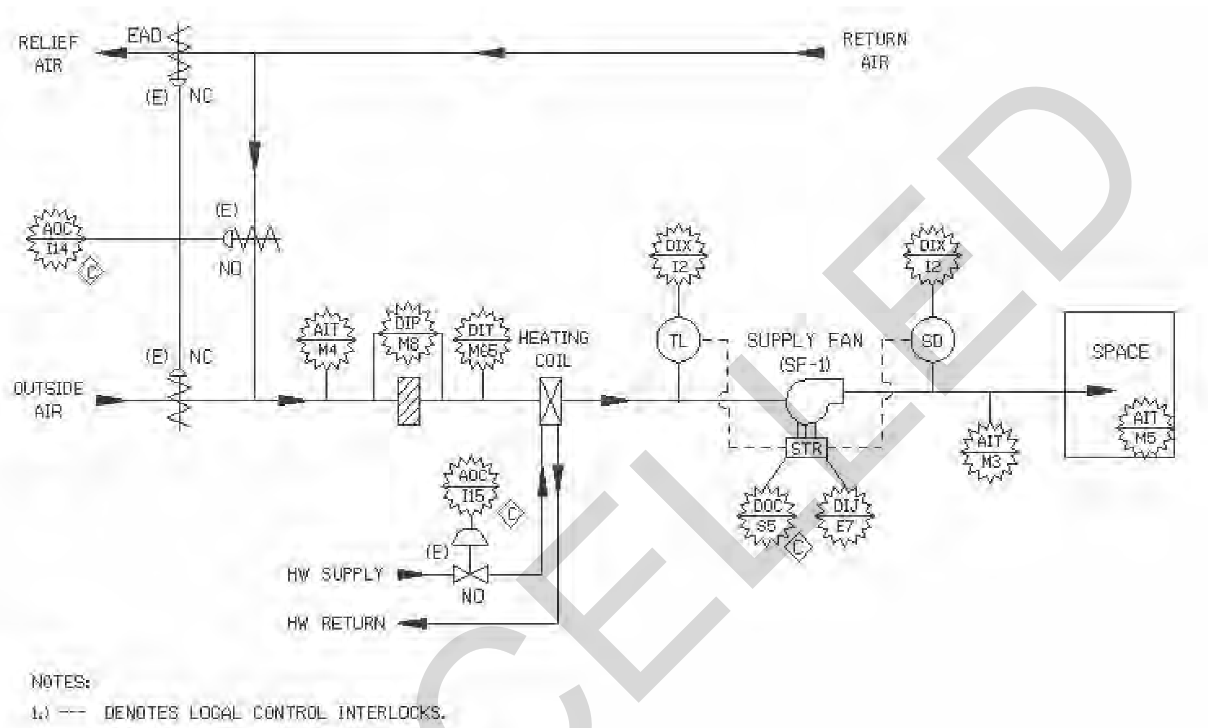


Figure 8-16. Heating and Ventilating System.

Table 8-1. Database Table for Steam/HW Converter and Primary/Secondary Heating System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 30			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
PRIMARY HW SUPPLY TEMP	SEE RESET SCH.		SP +/- 5 DEG.F		SEE RESET SCH.		SP +/- 5 DEG.F	
PRIMARY SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)	
SECONDARY HW SUPPLY TEMP.			160 DEG. F				160 DEG. F	
SECONDARY HW RETURN TEMP			140 DEG. F				140 DEG. F	
STEAM PRESSURE			XX PSI				XX PSI	

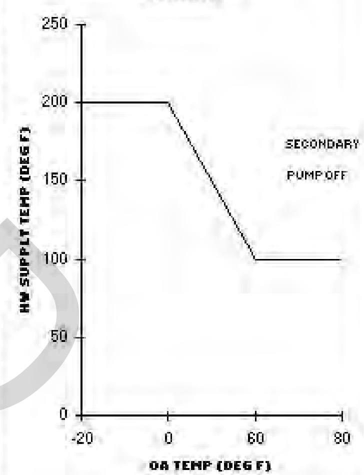
SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

PRIMARY SUPPLY TEMP RESET SCHEDULE



OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

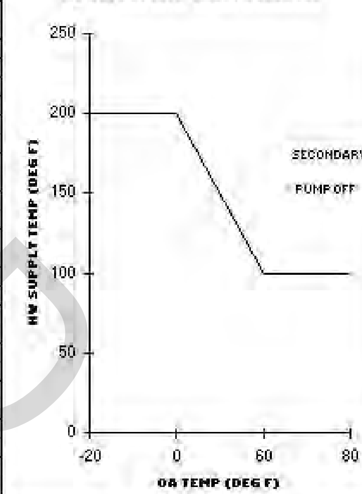
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-2	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-2. Database Table for Hot Water Boiler and Primary/Secondary Heating System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 30			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
PRIMARY HW SUPPLY TEMP	SEE RESET SCH.		SP +/- 5 DEG. F		SEE RESET SCH.		SP +/- 5 DEG. F	
PRIMARY SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)	
SECONDARY HW SUPPLY TEMP.			160 DEG. F				160 DEG. F	
SECONDARY HW RETURN TEMP.			140 DEG. F				140 DEG. F	
FLUE GAS TEMP			XX DEG. F				XX DEG. F	
FLUE GAS O2			XX % O2				XX % O2	
FUEL FLOW			XX GPM				XX GPM (LOW)	
FUEL TEMP			XX DEG. F				XX DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	X
CONDENSER WATER TEMPERATURE RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS



OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-2	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
HW BOILER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-3. Database Table for Hot Water Boiler with Constant Volume Circulating Loop and Primary/Secondary Heating System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 30			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	SUMMER COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
PRIMARY HW SUPPLY TEMP	SEE RESET SCH.		SP +/-5 DEG. F		SEE RESET SCH.		SP +/-5 DEG. F	
PRIMARY SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)	
SECONDARY HW SUPPLY TEMP.			160 DEG. F				160 DEG. F	
SECONDARY HW RETURN TEMP.			140 DEG. F				140 DEG. F	
FLUE GAS TEMP			XX DEG. F				XX DEG. F	
FLUE GAS O2			XX % O2				XX % O2	
FUEL FLOW			XX GPM				XX GPM (LOW)	
FUEL TEMP			XX DEG. F				XX DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	X
CONDENSER WATER TEMPERATURE RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-2	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-3	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
HW BOILER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

ADDITIONAL SETTINGS

HW SUPPLY TEMP RESET SCHEDULE

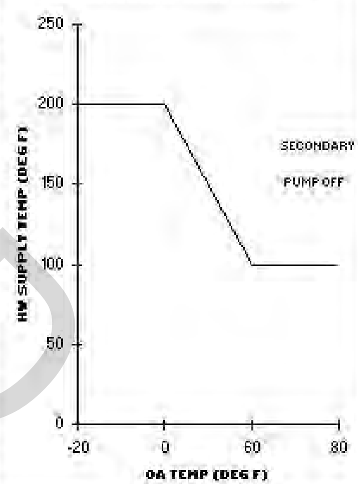


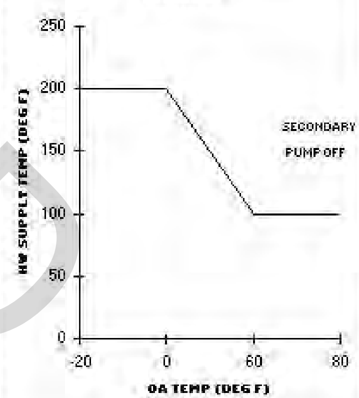
Table 8-4. Database Table for High Temperature HW/HWConverter and Primary/Secondary Heating System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 30			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
PRIMARY HW SUPPLY TEMP	SEE RESET SCH.		SP +/- 5 DEG.F		SEE RESET SCH.		SP +/- 5 DEG.F	
PRIMARY SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)	
SECONDARY HW SUPPLY TEMP.	160 DEG.F		SP +/- 5 DEG.F		160 DEG.F		SP +/- 5 DEG.F	
SECONDARY HW RETURN TEMP			140 DEG.F				140 DEG.F	
HIGH TEMP. HW SUPPLY			XX DEG.F				XX DEG.F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

PRIMARY SUPPLY TEMP RESET SCHEDULE



OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-2	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-5. Database Table for Steam/HW Converter with Dual Temperature Distribution System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 30			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
HW SUPPLY TEMP	SEE RESET SCH.		SP +/- 5 DEG. F		SEE RESET SCH.		SP +/- 5 DEG. F	
SUPPLY TEMP			XX DEG. F				XX DEG. F	
RETURN TEMP			XX DEG. F				XX DEG. F	
SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)	
STEAM PRESSURE			48 DEG. F				XX PSI	

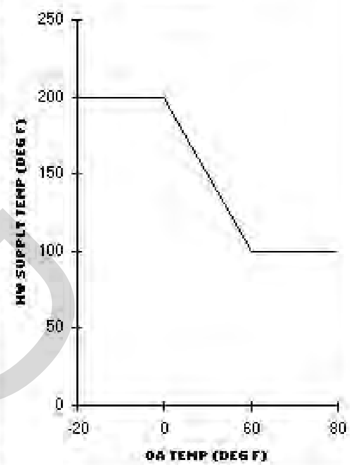
SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

PRIMARY SUPPLY TEMP RESET SCHEDULE



OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-6. Database Table for High Temp HW/HW Converter with Dual Temperature Distribution System.

INSTALLATION: SITE NAME | **AREA:** | **BLDG:** | **LOCATION:** | **ALARM DELAY ON STARTUP: 30**

SYSTEM OPERATING PARAMETERS

PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
HW SUPPLY TEMP	SEE RESET SCH.		SP +/- 5 DEG. F		SEE RESET SCH.		SP +/- 5 DEG. F	
SUPPLY TEMP			XX DEG. F				XX DEG. F	
RETURN TEMP			XX DEG. F				XX DEG. F	
SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)	
HIGH TEMP HW SUPPLY			XX DEG. F				XX DEG. F	

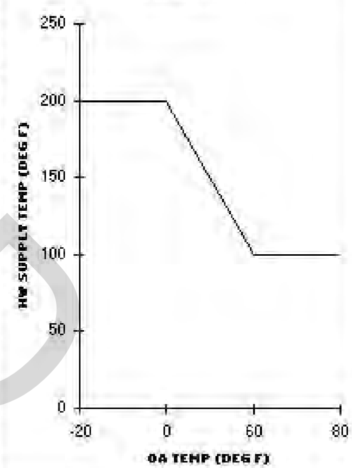
SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

PRIMARY SUPPLY TEMP RESET SCHEDULE



OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-7. Database Table for Dual Temperature System with Hot Water Boiler and Air-Cooled Chiller.

INSTALLATION: SITE NAME | AREA: | BLDG: | LOCATION: | ALARM DELAY ON STARTUP: 30

SYSTEM OPERATING PARAMETERS

PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
HW SUPPLY TEMP	SEE RESET SCH.		SP +/- 5 DEG. F		SEE RESET SCH.		SP +/- 5 DEG. F	
SUPPLY TEMP			XX DEG. F				XX DEG. F	
RETURN TEMP			XX DEG. F				XX DEG. F	
SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)	
FLUE GAS TEMP			XX DEG. F				XX DEG. F	
FLUE GAS 02			XX% 02				XX% 02	
FUEL FLOW			XX GPM				XX GPM (LOW)	
FUEL TEMP			XX DEG. F				XX DEG. F	

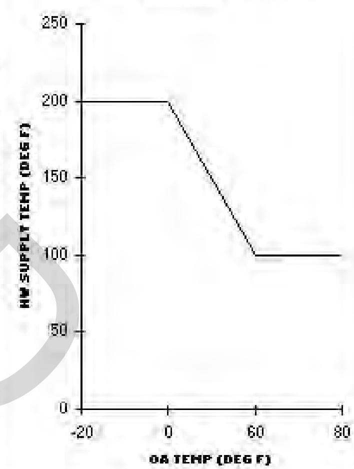
SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

PRIMARY SUPPLY TEMP RESET SCHEDULE



OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
HW BOILER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
CHILLER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-8. Database Table for Water-Cooled Chiller.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 15			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
CHWS TEMPERATURE	42 DEG. F		SP (+/-) 0.5 DEG. F	XX DEG. F				
CHWR TEMPERATURE			XX 2 DEG. F					
CWS TEMPERATURE	73 DEG. F		SP (+/-) 2 DEG. F					
CWR TEMPERATURE			XX 2 DEG. F					
CHWS FLOW			XX 5 GPM					
CWS FLOW			XX 5 GPM					
CWS pH LEVEL			6 pH/8 pH					

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
	X
	X
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
CHILLER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
COOLING TOWER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
CHW PUMP	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
CW PUMP	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-9. Database Table for Multi-Zone Air Handling System with Hot Water and Chilled Water Coils

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAT ON STARTUP: 15			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG. F	
HOT DECK TEMP	PER RESET SCH.		SP (+/-) 2 DEG. F		PER RESET SCH.		SP (+/-) 2 DEG. F	
COLD DECK TEMP	PER RESET SCH.		SP (+/-) 2 DEG. F		PER RESET SCH.		SP (+/-) 2 DEG. F	
ZONE SPACE TEMP	75 DEG. F	82 DEG. F	SP (+/-) 2 DEG. F	80 DEG. F	68 DEG. F	58 DEG. F	SP (+/-) 2 DEG. F	63 DEG. F
FILTER			1.25" WC				1.25" WC	
LOW TEMP DEVICE			35 DEG. F				35 DEG. F	

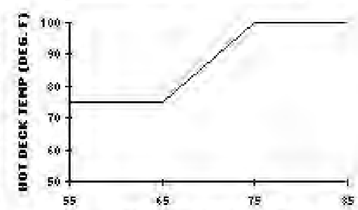
OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
RETURN FAN RF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	X
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	

ADDITIONAL SETTINGS

HOT DECK TEMP RESET SCHEDULE



COLD DECK TEMP RESET SCHEDULE

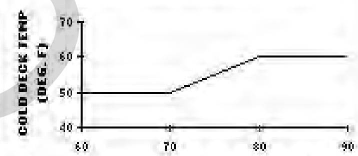


Table 8-10. Database Table for Dual Duct Air Handling System with Hot Water and Chilled Water Coils

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:	ALARM DELAY ON STARTUP: 15

SYSTEM OPERATING PARAMETERS

PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG. F	
HOT DECK TEMP	PER RESET SCH.		SP (+/-) 2 DEG. F		PER RESET SCH.		SP (+/-) 2 DEG. F	
COLD DECK TEMP	PER RESET SCH.		SP (+/-) 2 DEG. F		PER RESET SCH.		SP (+/-) 2 DEG. F	
ZONE SPACE TEMP	75 DEG. F	82 DEG. F	SP (+/-) 2 DEG. F	80 DEG. F	68 DEG. F	58 DEG. F	SP (+/-) 2 DEG. F	63 DEG. F
FILTER			1.25" WC				1.25" WC	
LOW TEMP DEVICE			35 DEG. F				35 DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	X
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	

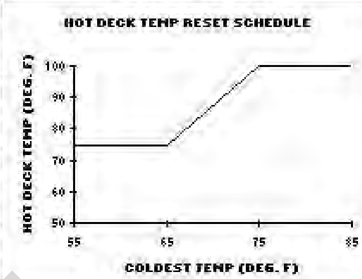
OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
RETURN FAN RF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

ADDITIONAL SETTINGS



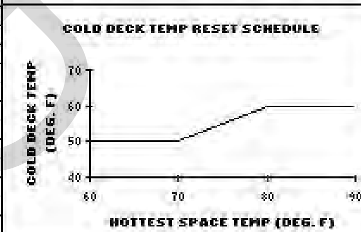


Table 8-11. Database Table for Bypass Multi-Zone Air Handling System with Hot Water and Chilled Water Coils

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 15			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	**COOLING**				**HEATING**			
	DEFAULT OCCUPIED SETPOINT	**DEFAULT UNOCCUPIED SETPOINT**	**ALARM LIMIT SETTINGS**	**DEMAND LIMIT SETPOINT**	**DEFAULT OCCUPIED SETPOINT**	**DEFAULT UNOCCUPIED SETPOINT**	**ALARM LIMIT SETTINGS**	**DEMAND LIMIT SETPOINT**
HOT DECK TEMP	PER RESET SCH.		SP (+/-) 2 DEG. F		PER RESET SCH.		SP (+/-) 2 DEG. F	
COLD DECK TEMP	PER RESET SCH.		SP (+/-) 2 DEG. F		PER RESET SCH.		SP (+/-) 2 DEG. F	
ZONE SPACE TEMP	75 DEG. F	82 DEG. F	SP (+/-) 2 DEG. F	80 DEG. F	68 DEG. F	58 DEG. F	SP (+/-) 2 DEG. F	63 DEG. F
FILTER			1.25" WC				1.25" WC	
LOW TEMP DEVICE			35 DEG. F				35 DEG. F	

OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
RETURN FAN RF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	X
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	

ADDITIONAL SETTINGS

COLD DECK TEMP RESET SCHEDULE

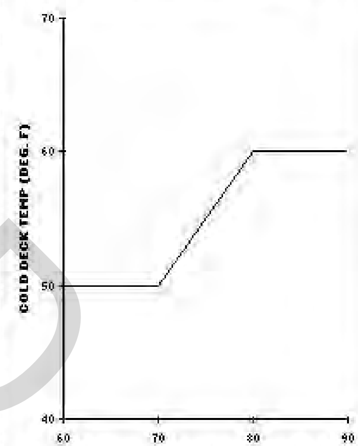


Table 8-12. Database Table for VAV Air Handling System with Hot Water and Chilled Water Coils

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 15			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
SUPPLY AIR TEMP	55 DEG. F		SP (+/-) 2 DEG. F		55 DEG. F		SP (+/-) 2 DEG. F	
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG. F	
SPACE TEMP	75 DEG. F	82 DEG. F	SP (+/-) 2 DEG. F	80 DEG. F	68 DEG. F	58 DEG. F	SP (+/-) 2 DEG. F	63 DEG. F
FILTER			1.25" WC				1.25" WC	
SUPPLY AIR STATIC PRESS.	SYSTEM SPECIFIC		SP (+/-) 0.5" W.C.		SYSTEM SPECIFIC		SP (+/-) 0.5" W.C.	
LOW TEMP DEVICE			35 DEG. F				35 DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	X
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	

ADDITIONAL SETTINGS

OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-13. Database Table for VAV Air Handling System with Return Fan and Hot Water/Chilled Water Coils

INSTALLATION: SITE NAME | AREA: | BLDG: | LOCATION: | ALARM DELAY ON STARTUP: 15

SYSTEM OPERATING PARAMETERS

PARAMETERS	HEATING				COOLING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
SUPPLY AIR TEMP	55 DEG. F		SP (+/-) 2 DEG. F		55 DEG. F		SP (+/-) 2 DEG. F	
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG. F	
SPACE TEMP	75 DEG. F	82 DEG. F	SP (+/-) 2 DEG. F	80 DEG. F	68 DEG. F	58 DEG. F	SP (+/-) 2 DEG. F	63 DEG. F
FILTER			1.25" WC				1.25" WC	
SUPPLY AIR STATIC PRESS.	SYSTEM SPECIFIC		SP (+/-) 0.5" W.C.		SYSTEM SPECIFIC		SP (+/-) 0.5" W.C.	
LOW TEMP DEVICE			35 DEG. F				35 DEG. F	
RETURN FAN FLOW	SUPPLY CFM (-) MIN. OA CFM		SP (+/-) XX CFM		SUPPLY CFM (-) MIN. OA CFM		SP (+/-) XX CFM	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	X
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	

ADDITIONAL SETTINGS

OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
RETURN FAN RF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-14. Database Table for Single Zone Air Handling System With Hot Water/Chilled Water Coils andHumidification.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 15			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG F	
SPACE TEMP	75 DEG. F	82 DEG. F	SP (+/-) 2 DEG. F	80 DEG. F	68 DEG. F	58 DEG. F	SP (+/-) 2 DEG F	63 DEG. F
FILTER			1.25" WC				1.25"	
LOW TEMP DEVICE			35 DEG. F				35 DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	
ADDITIONAL SETTINGS	

OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-15. Database Table for Single Zone Air Handling System with Hot Water and DX Refrigeration Coils.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 15			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG F	
SPACE TEMP	75 DEG. F	82 DEG. F	SP (+/-) 2 DEG. F	80 DEG. F	68 DEG. F	58 DEG. F	SP (+/-) 2 DEG F	63 DEG. F
FILTER			1.25" WC				1.25"	
LOW TEMP DEVICE			35 DEG. F				35 DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	
ADDITIONAL SETTINGS	

OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 8-16. Database Table for Heating and Ventilating System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: 15			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) X DEG. F		PER SEQUENCE		SP (+/-) X DEG. F	
SPACE TEMP	XX DEG. F	XX DEG. F	SP (+/-) X DEG. F		XX DEG. F	XX DEG. F	SP (+/-) X DEG. F	
SUPPLY TEMP			XX DEG. F (LO)				XX DEG. F (LO)	
FILTER			X.XX" WC				X.XX" WC	
LOW TEMP DEVICE			XX DEG. F				XX DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	x
OPTIMUM START/STOP	x
ECONOMIZER	
VENTILATION/RECIRCULATION	x
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTINGS AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	x
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	x
WINTER STEP 2	
ADDITIONAL SETTINGS	

OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN (SF-1)	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

CHAPTER 9

SUPERVISORY CONTROL IMPLEMENTATION

1. GENERAL. The programs described in Chapter 7 can be applied to existing or new systems. Most of these programs may be applied to several types of systems, but others may only be applicable to special types of systems. For example, the boiler monitoring and control program is only applicable to facilities with boiler plants. Due to the interactive nature of the programs, the inputs and/or outputs of one implemented program may provide inputs to other programs.

2. INSTRUMENTS AND INPUTS. Certain instruments and inputs can be common to an entire building or, in some cases, the entire UMCS. Electrical consumption and demand instrumentation do not need to be duplicated except in special cases, such as when a UMCS serves an extremely large geographical area, or multiple utility substations. When applications require OA measurement, the minimum requirement is one OA temperature and one RH instrument (when used) for each building. However, the designer may need to increase the minimum requirements to satisfy site specific building and system conditions. For example, separate OA instruments will be specified where intake temperatures of the OA measured on a roof mounted unit may vary significantly from other air intake locations, causing erroneous economizer calculations.

3. DIAGRAMS. Graphic diagrams of typical systems showing UMCS devices and functions for supervisory control implementation are provided in Figures 9-1 through 9-31. Failure modes will be defined by the designer for each system's controlled devices in the event of a field equipment panel malfunction. Failure modes will be based on climate, type of system, and user requirements. The failure modes shown are for example purposes only. Figures 9-19 through 9-31, which are not accompanied by corresponding database tables, are provided for illustrative purposes only.

4. TABLES. Database tables listing UMCS software and settings applied to typical systems are provided in Tables 9-1 through 9-18. The designer will generate a separate database table for each system to be controlled or monitored by the UMCS. Two or more identical systems within the same building, having the same occupancy schedule, may be listed on the same database table. The table's contents will be tailored to the system being controlled for each specific application.

5. SYMBOLS AND ABBREVIATIONS. A listing of symbols and abbreviations used in the system schematics is provided in Appendix B.

6. ADDITIONAL APPLICATIONS. Additional utility systems monitoring and control applications which have been provided through UMCS, and which have proven beneficial in energy savings, demand savings, labor or other cost savings, are listed below. Each application listing includes typical monitored or controlled parameters. Additional applications will be evaluated for feasibility on individual UMCS projects.

a. Electric Networks (High and Low Tension).

(1) Metering of primary KV.

(2) Breaker status.

(3) Remote breaker control.

(4) Ground fault measurement and alarm

(5) Power factor measurement

b. Stand-by Generators.

(1) Unit status.

(2) Scheduled exercising.

(3) Fuel storage tank levels.

(4) Generator voltage and load.

(5) Run-time monitoring.

c. Power Plants.

(1) Status.

(2) Efficiency.

(3) Fuel storage.

(4) Tank level.

(5) Run-time monitoring.

d. Uninterruptible Power Supplies.

(1) Status.

(2) Battery voltage and charging current.

(3) UPS output voltage and load.

e. Exterior Lighting.

(1) Time scheduled control.

(2) Intensity reduction after “peak” hours.

f. Interior Lighting.

(1) Time scheduled control.

g. Transformer Substations.

(1) Status.

(2) Voltage and load.

(3) Transformer temperature.

h. Switching Stations.

(1) Status.

(2) Breaker control.

i. Frequency Converters.

(1) Status.

(2) Voltage, frequency, and load.

(3) Run-time monitoring.

j. Elevators.

(1) Machine room temperature alarm.

(2) Common alarm from control pane.

k. Water Treatment Systems.

(1) Status.

(2) Hardness of water (ppm).

(3) Consumption.

l. Sewer System.

(1) Flow/level in manholes and retention basins.

(2) Status and run-time of sewage lift pumps.

m. Chlorination (Including Electrolytic) and Fluoridation Systems.

(1) Status.

(2) Chlorine and fluoride concentration (water analysis).

(3) Chlorine and fluoride tank levels.

(4) Water consumption.

n. Booster Stations.

(1) Status.

(2) Alternating of pumps.

(3) Demand limiting of pumps.

(4) Pressure.

(5) Consumption.

o. Water Pumping Stations.

(1) Status.

(2) Demand limiting of pump motors.

(3) Pressure.

(4) Consumption.

p. Irrigation Systems.

(1) Scheduled operation based on rainfall (and, in some cases, residual moisture in the soil).

q. Boiler Plants (Coal, Oil, and Gas).

(1) Energy consumption/heat generation.

(2) Fuel storage tank levels.

r. District Heat Supply.

(1) Metering of demand/consumption.

(2) Night setback.

s. Heating Distribution.

(1) Night setback.

(2) Leak detection for distribution piping.

t. Domestic Hot Water Generators.

(1) Night setback.

u. Cold Storage and Refrigeration Systems.

(1) Unit status/general alarms.

(2) Temperature.

(3) Demand limiting (compressor motors).

v. Air Conditioners, including Window Air Conditioners.

(1) Time scheduled control.

(2) Demand limiting.

w. High Pressure Steam Plants.

(1) Status.

(2) Fuel consumption/tank level.

(3) Steam pressure.

(4) Steam flow.

x. Heat Pumps.

(1) Unit status.

(2) Time scheduled control.

(3) Night setback.

(4) Demand limiting.

y. Laundry Room Equipment (Electric Clothes Dryers).

(a) Demand limiting.

z. Vending Machines.

(1) Demand limiting.

(2) Time-scheduled control of electrical power supply.

aa. Saunas.

(1) Time scheduled control.

(2) Demand limiting.

bb. Humidifiers.

(1) Status.

(2) Demand limiting of electric heating element.

cc. Weather Stations.

(1) Relative humidity.

(2) Wind direction.

(3) Wind velocity.

(4) Cumulative rainfall.

(5) Heating degree days and cooling degree days calculation.

(6) Temperature.

dd. Storage Tanks.

(1) Level alarm (high for waste, low for consumed liquid such as fuel).

(2) Leak detection.

(3) Scheduled waste removal.

ee. Ground Water.

(1) Measurement of level and pH/value.

ff. Medical Gas Systems (Oxygen, Vacuum, etc.).

(1) Status.

(2) Pressure.

(3) Operating hours of compressors, etc..

gg. Compressed Air Systems.

(1) Status.

(2) Pressure.

(3) Operating hours of compressors, etc..

(4) Demand limiting of compressor motors.

hh. Sewage Treatment Plans.

(1) Status.

(2) Operating hours of equipment.

(3) Metering of treated sewage in CFM.

(4) Measuring of chlorine and pH/values.

ii. Water Distribution.

(1) Metering of consumption.

(2) Leak detection.

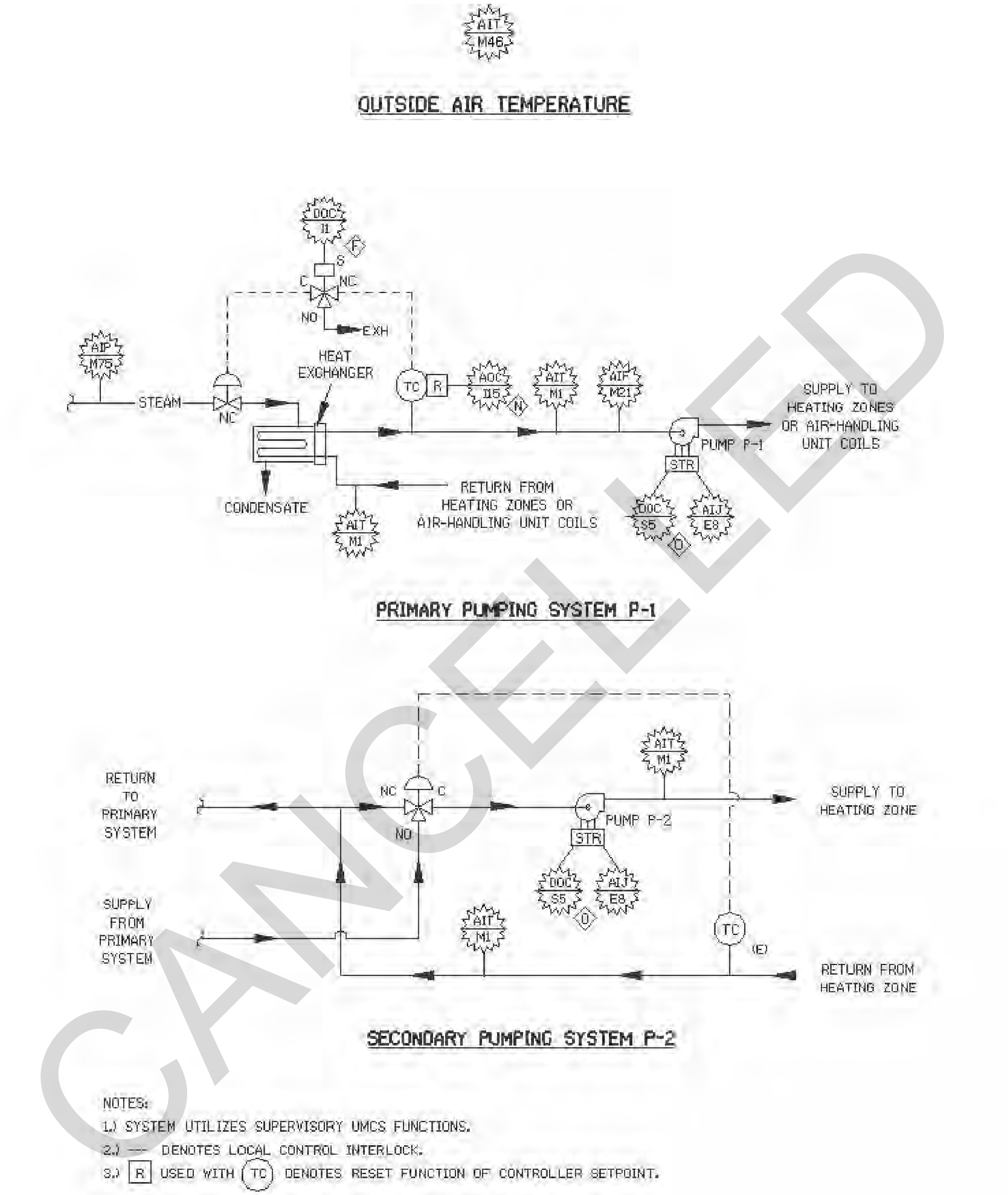


Figure 9-1. Steam/HW Converter and Primary/Secondary Heating System.

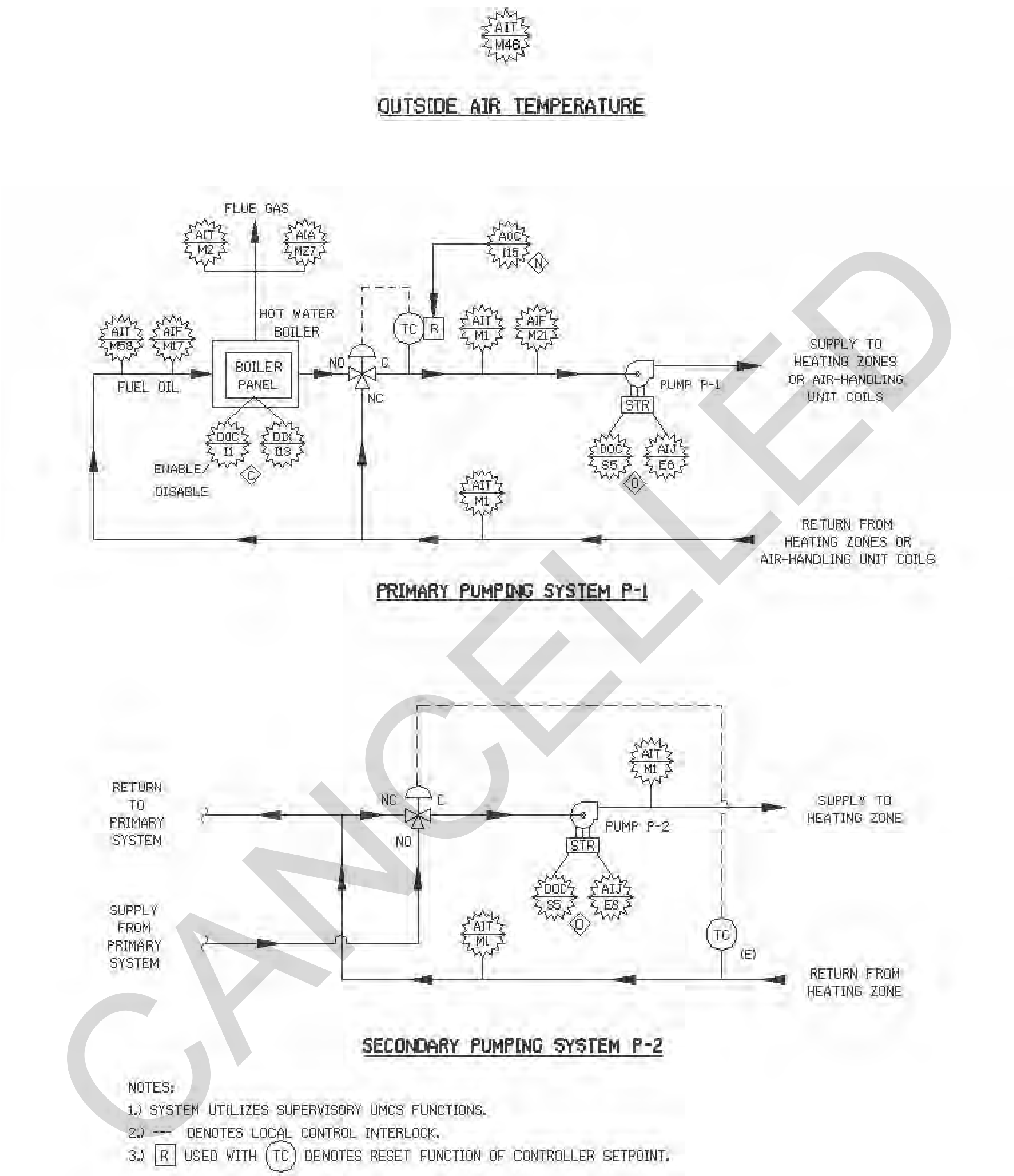


Figure 9-2. Hot Water Boiler and Primary/Secondary Heating System.

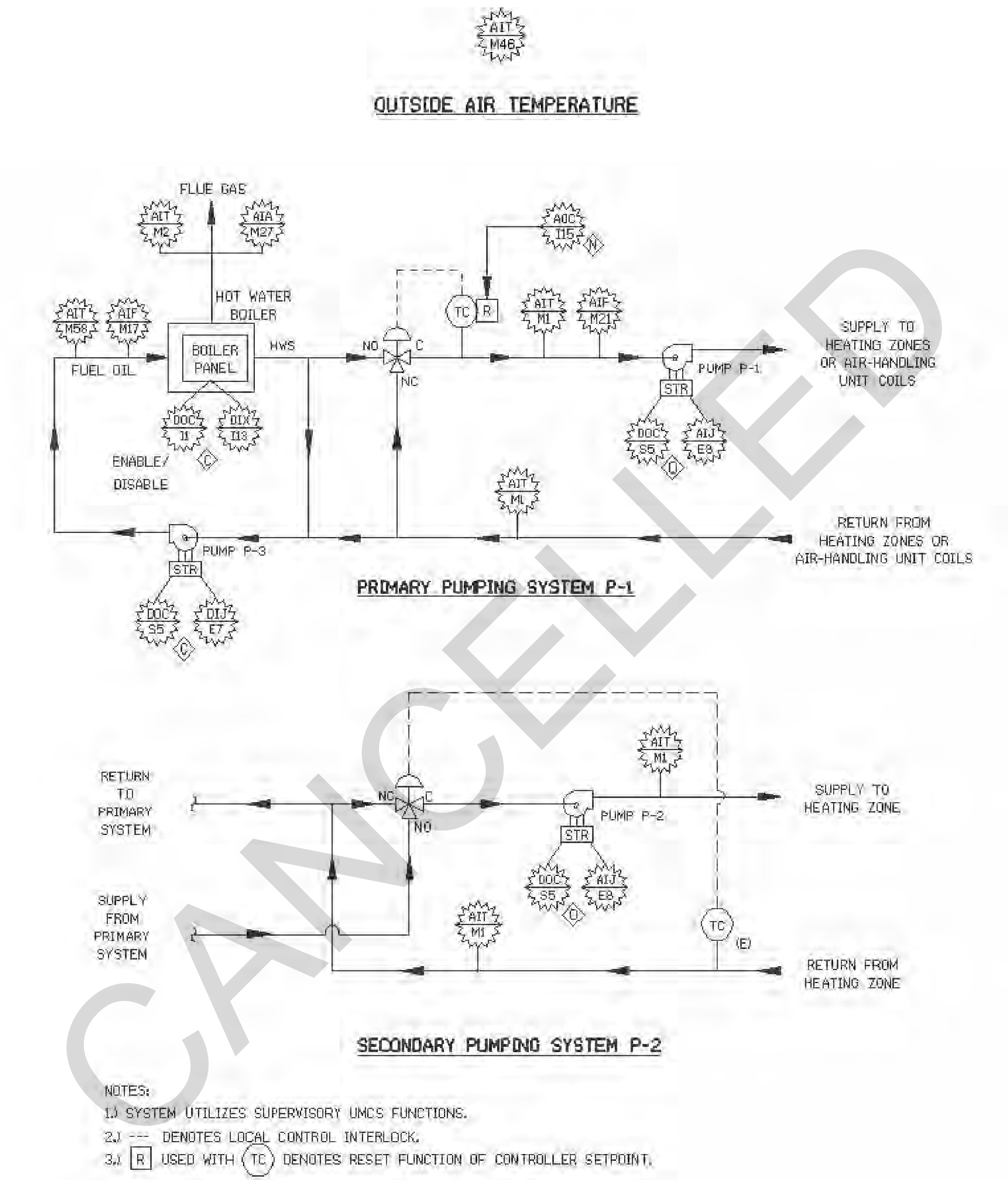


Figure 9-3. Hot Water Boiler with Constant Volume Circulating Loop and Primary/Secondary Heating System.

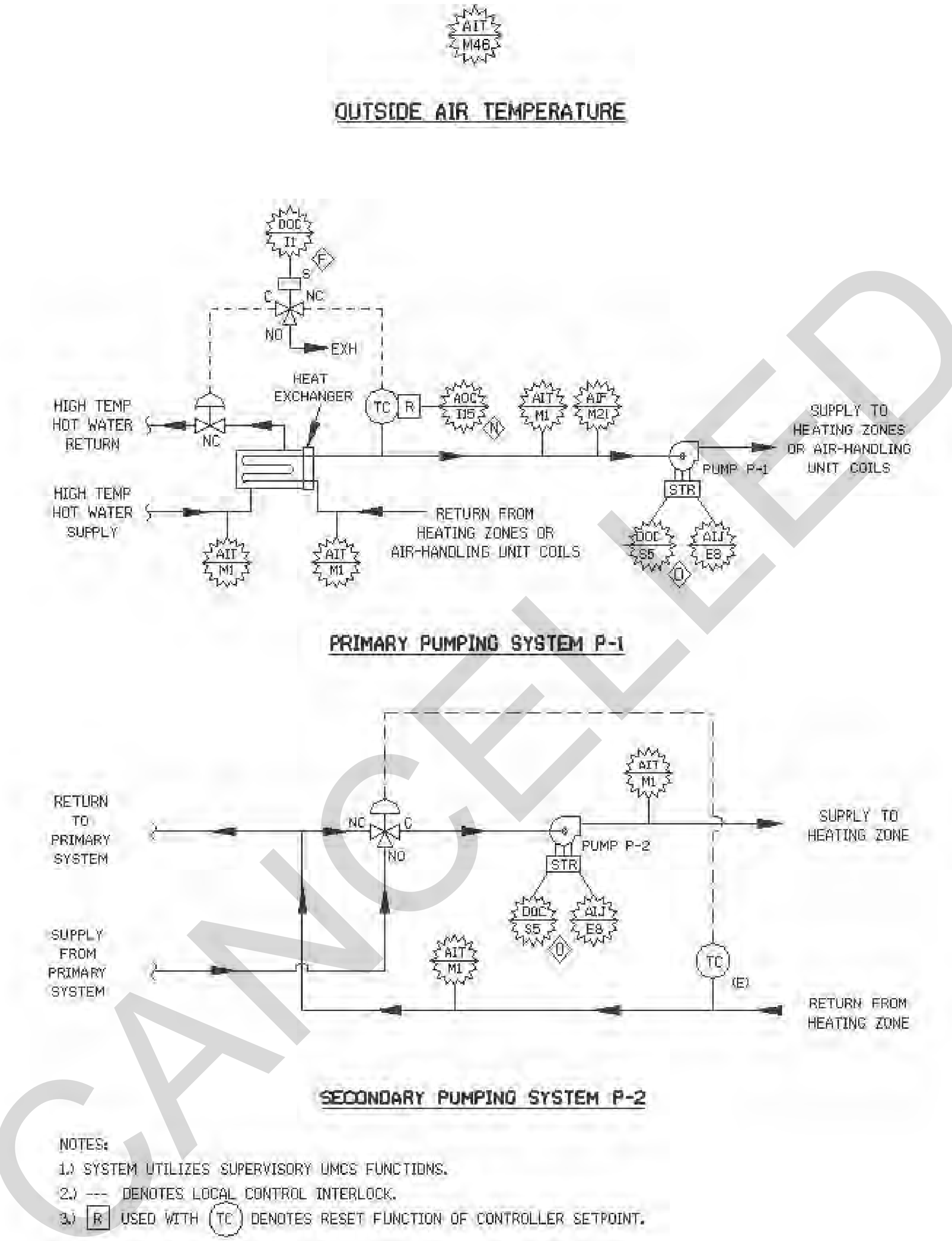


Figure 9-4. High Temperature HW/HW Converter and Primary/Secondary Heating System.

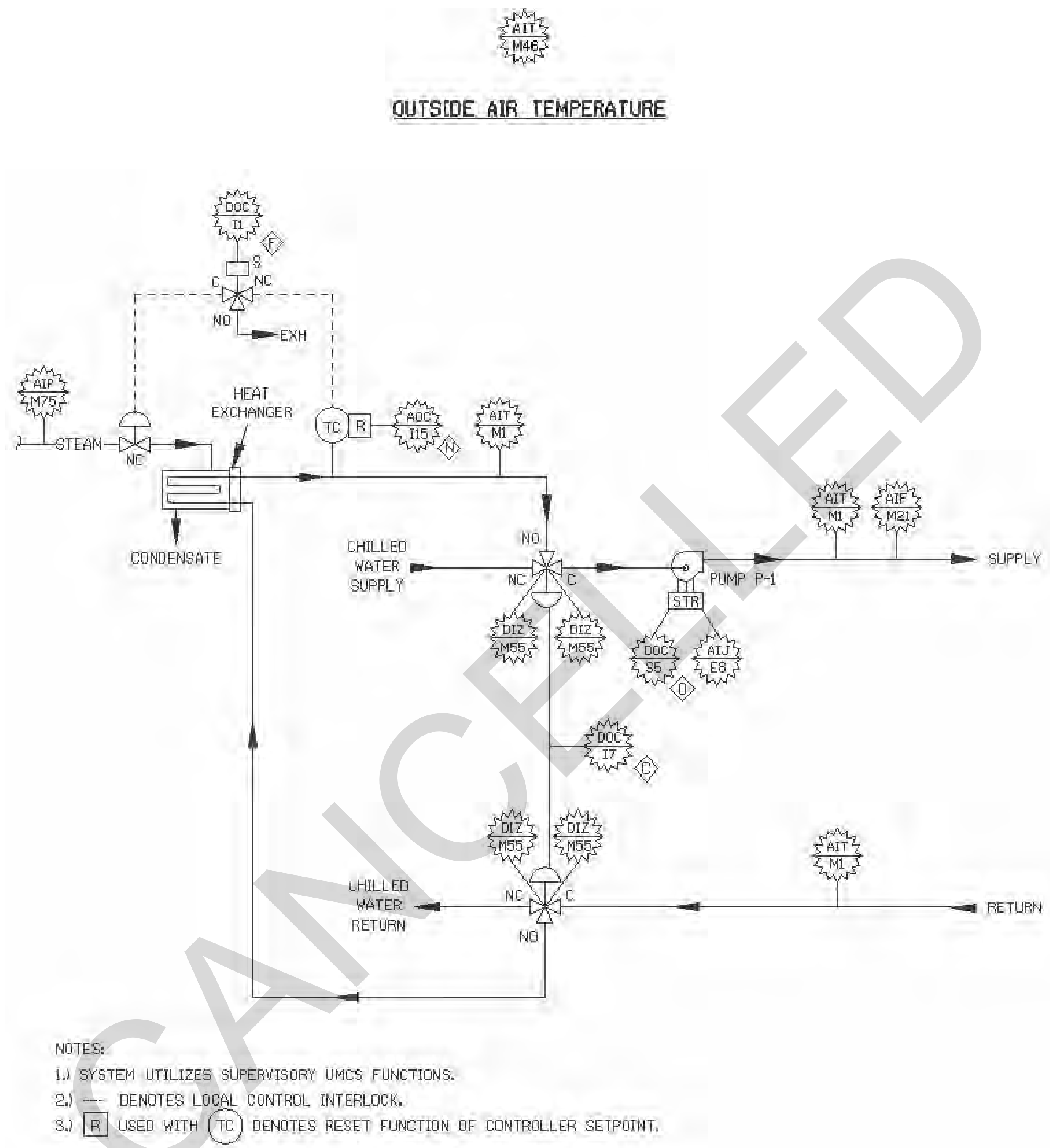


Figure 9-5. Steam/HW Converter with Dual Temperature Distribution System.

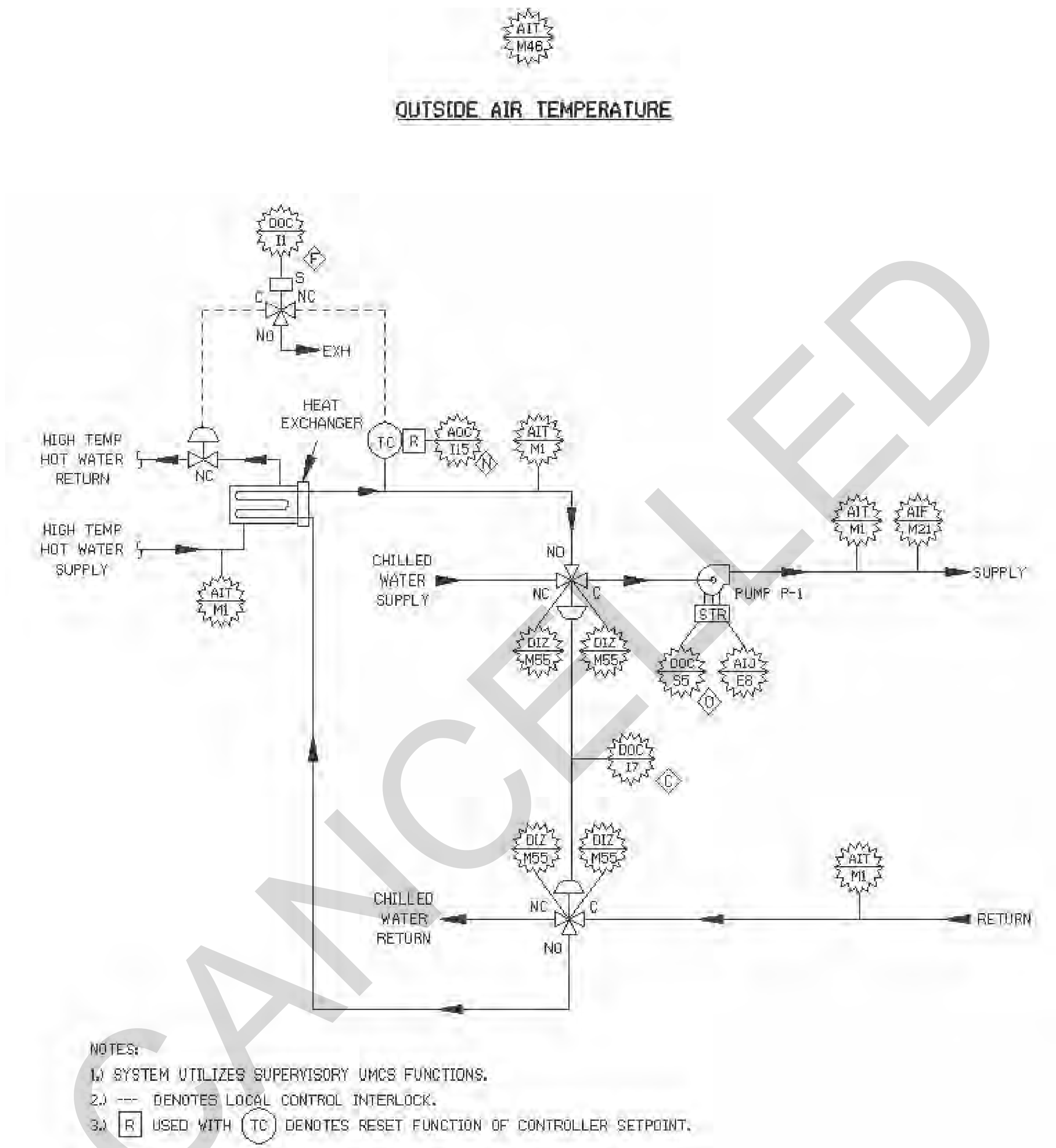


Figure 9-6. High Temperature HW/HW Converter with Dual Temperature Distribution System.

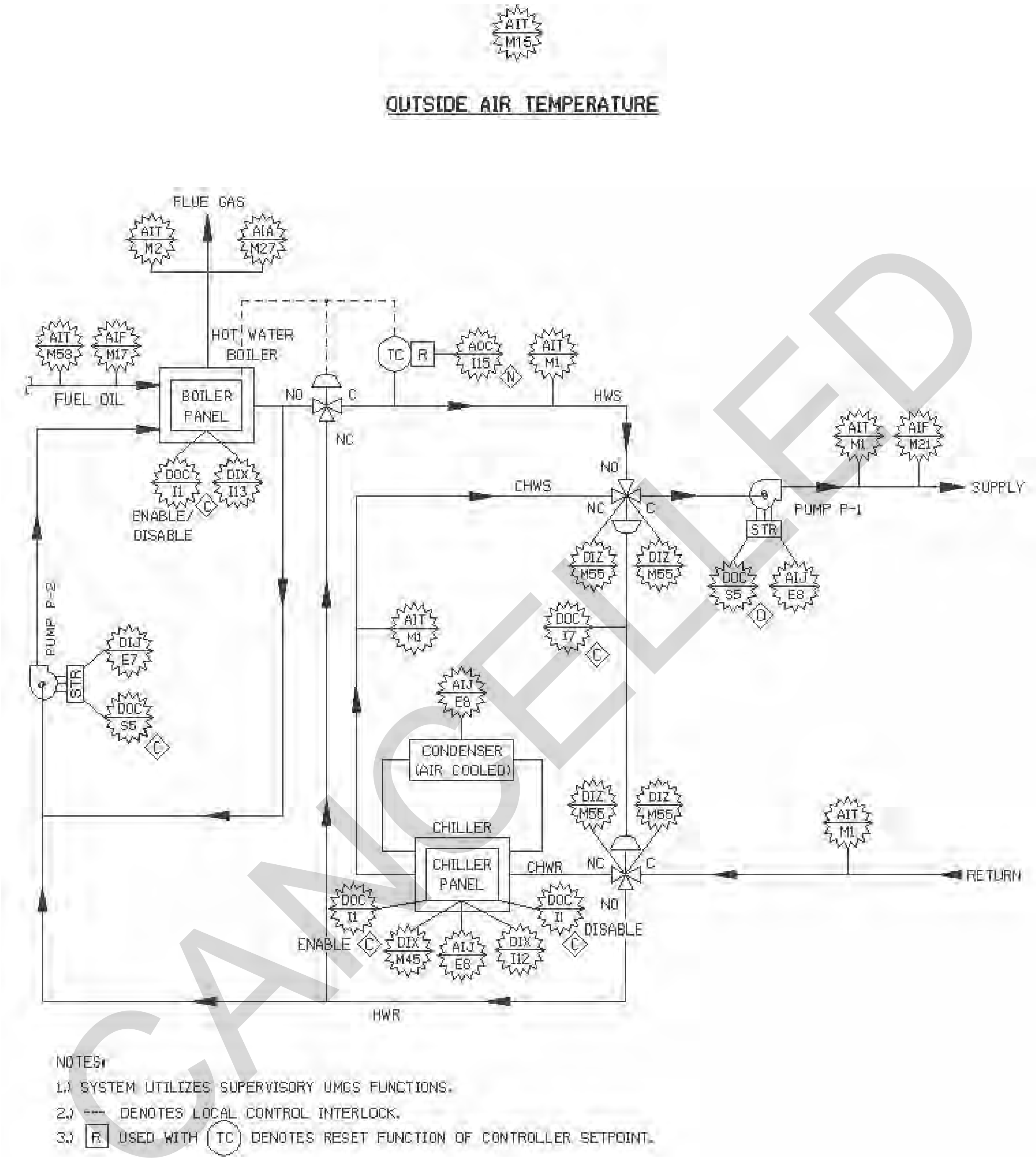


Figure 9-7. Dual Temperature System with Constant Volume Hot Water Circulating Loop and Air-Cooled Chiller.

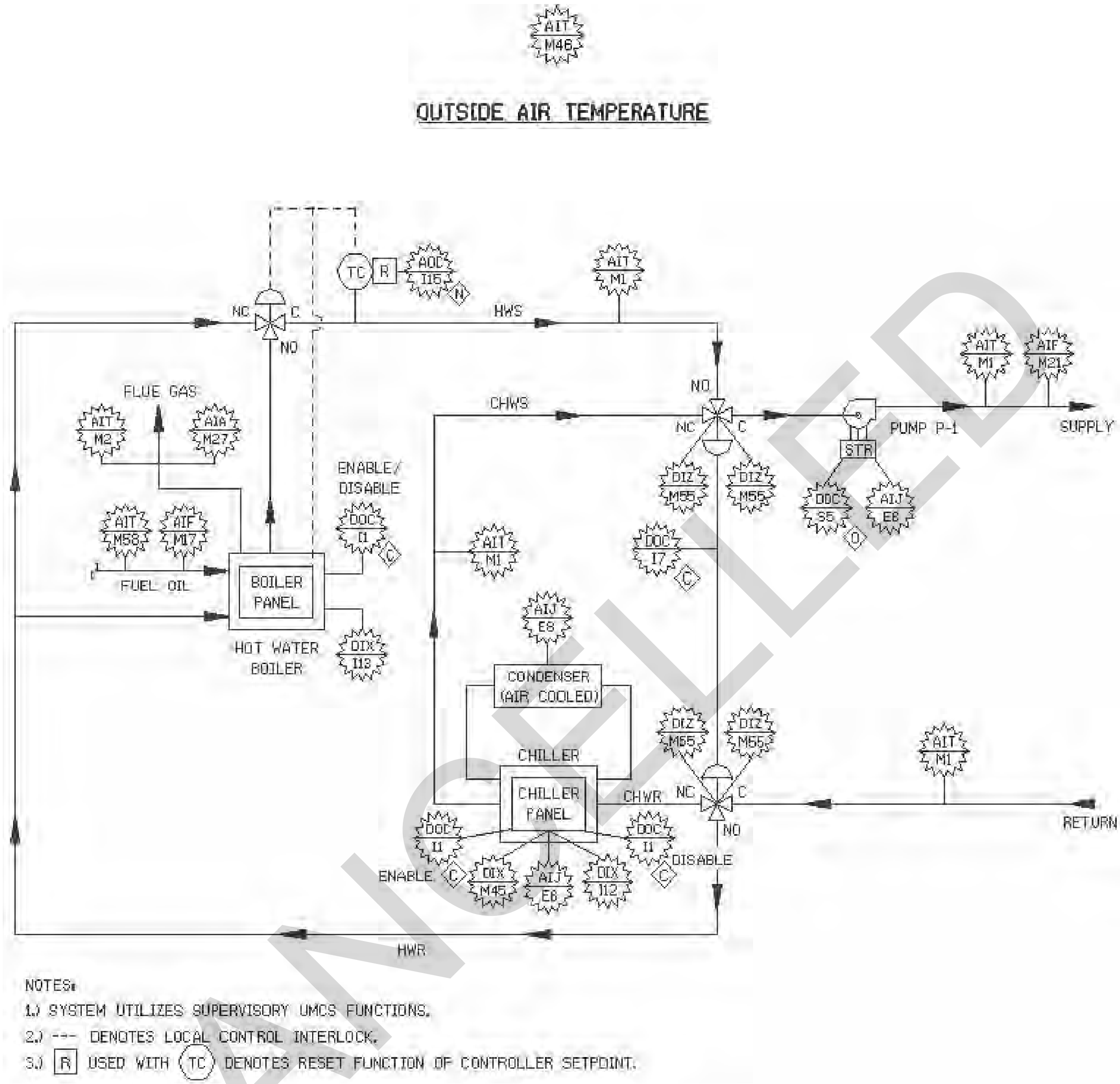


Figure 9-8. Dual Temperature System with Hot Water Boiler and Air-Cooled Chiller.

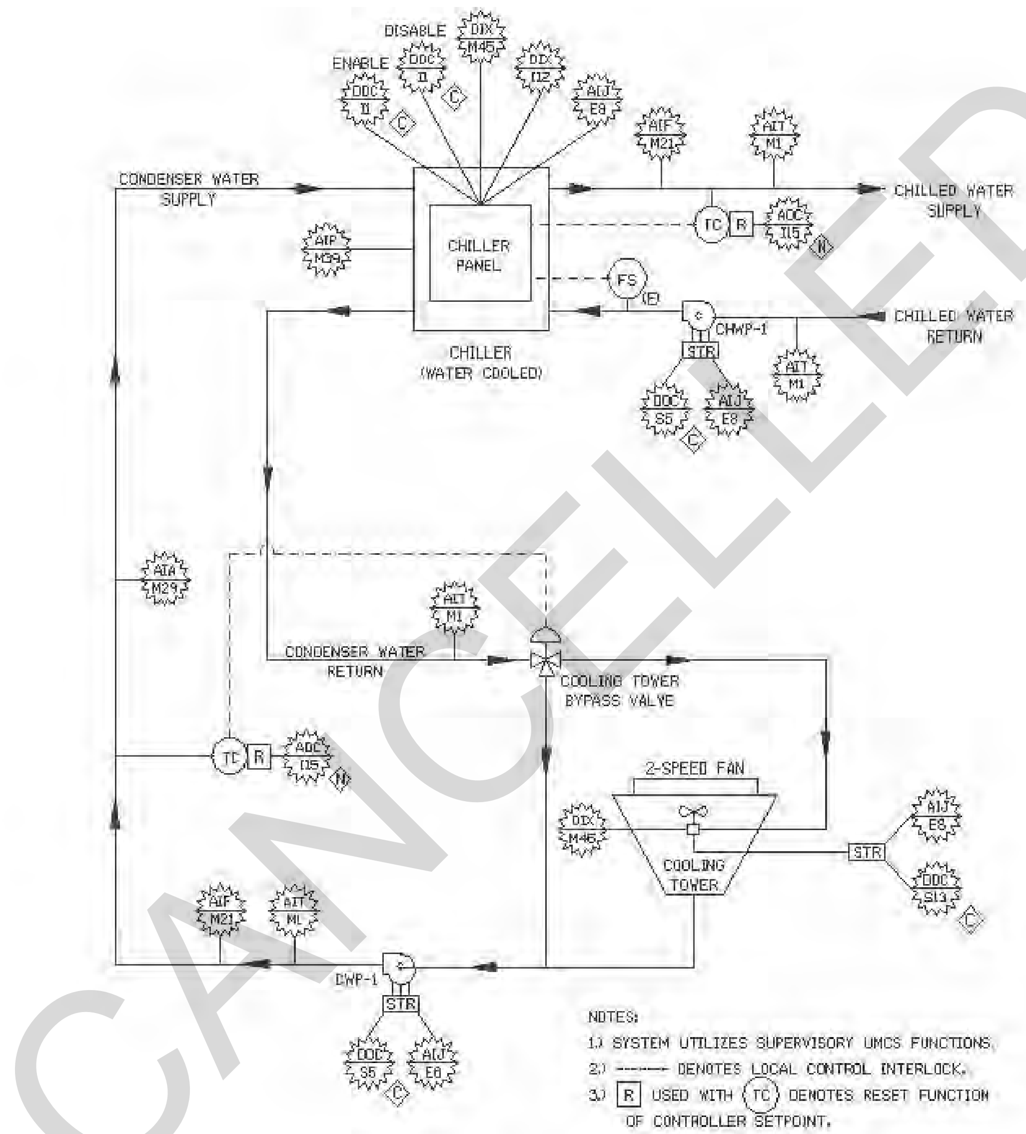


Figure 9-9. Water-Cooled Chiller.

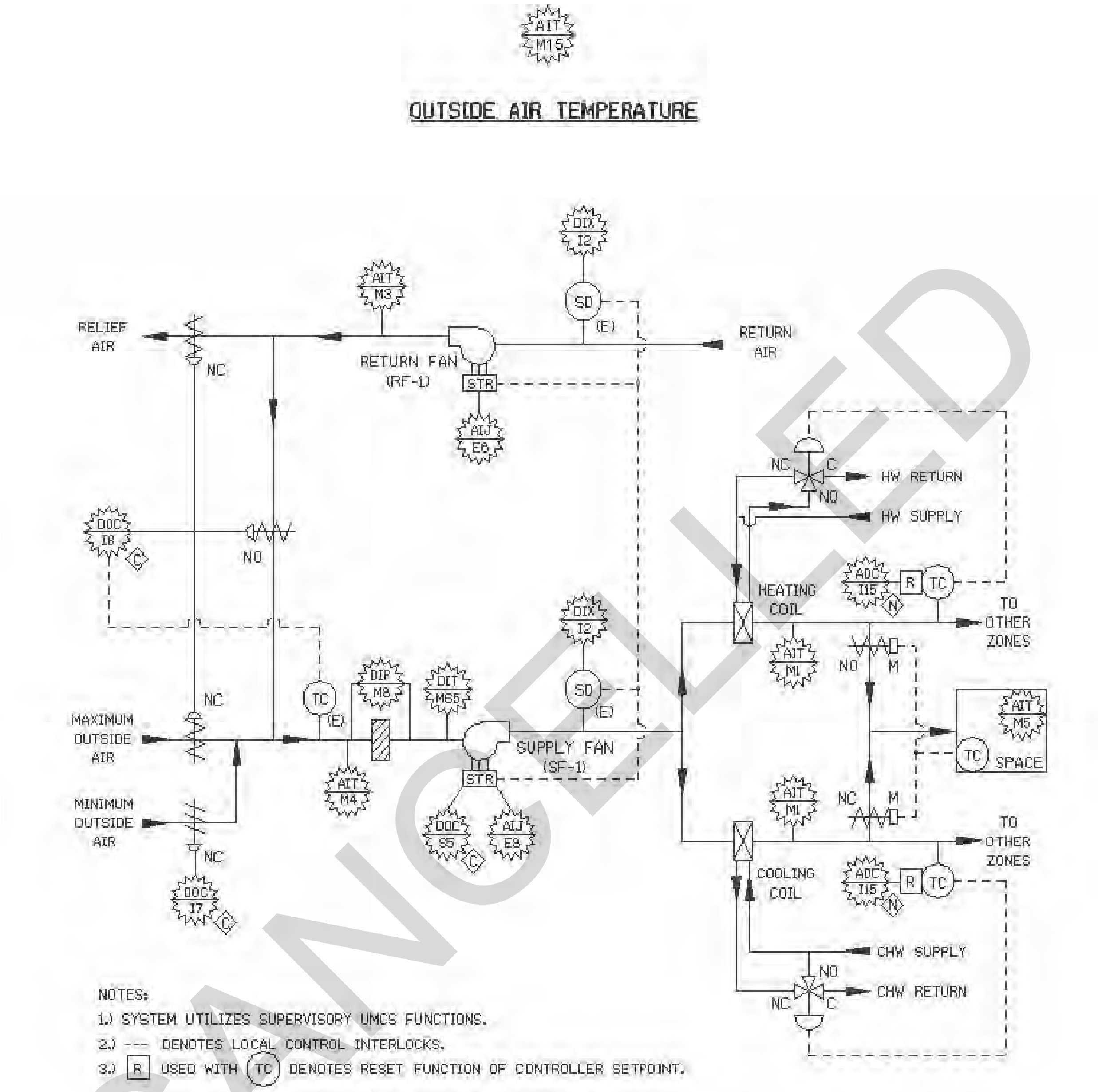


Figure 9-10. Multi-Zone Air Handling System w/Hot Water and Chilled Water Coils.

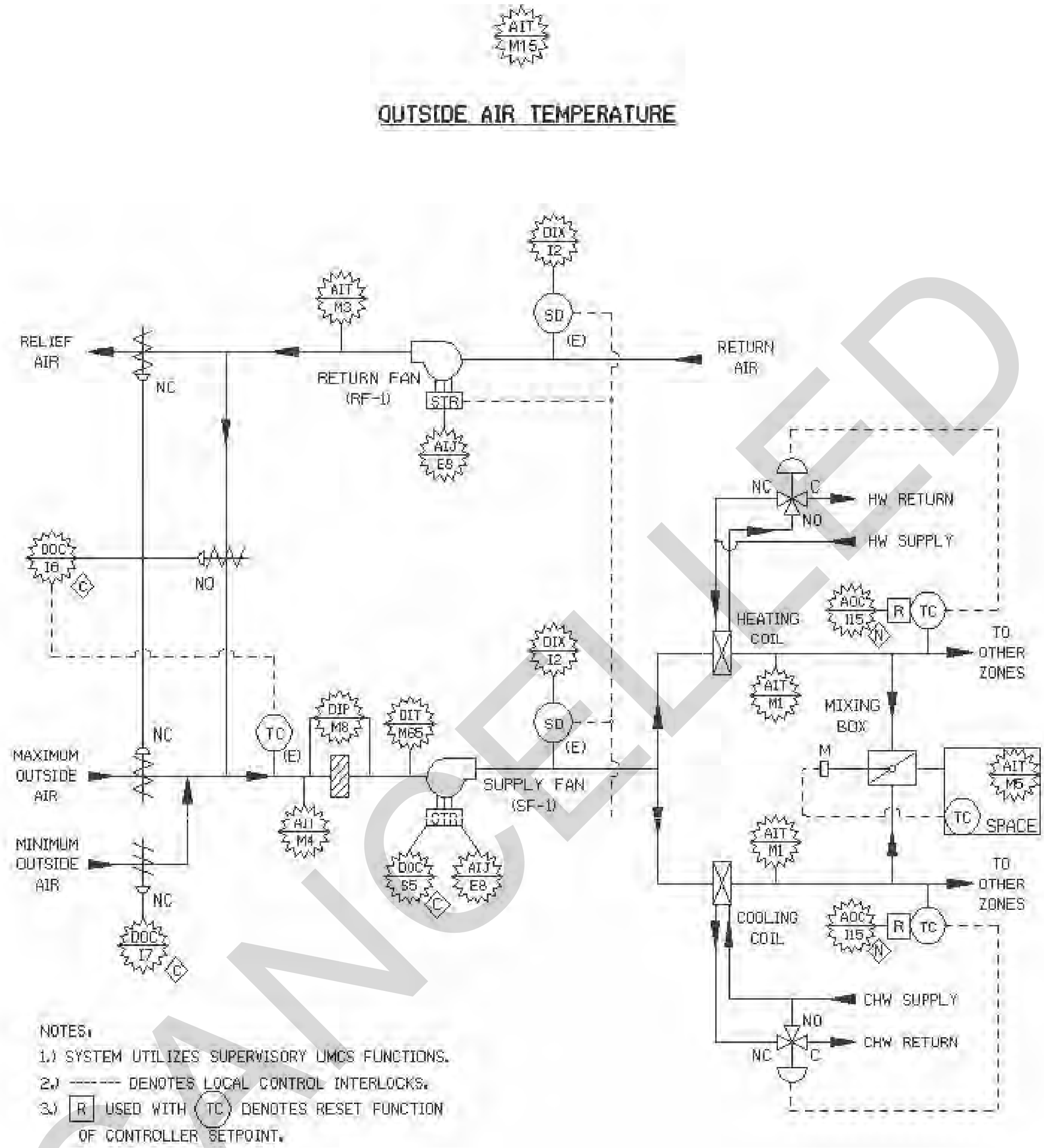
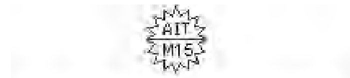


Figure 9-11. Dual Duct Air Handling System with Hot Water and Chilled Water Coils.



OUTSIDE AIR TEMPERATURE

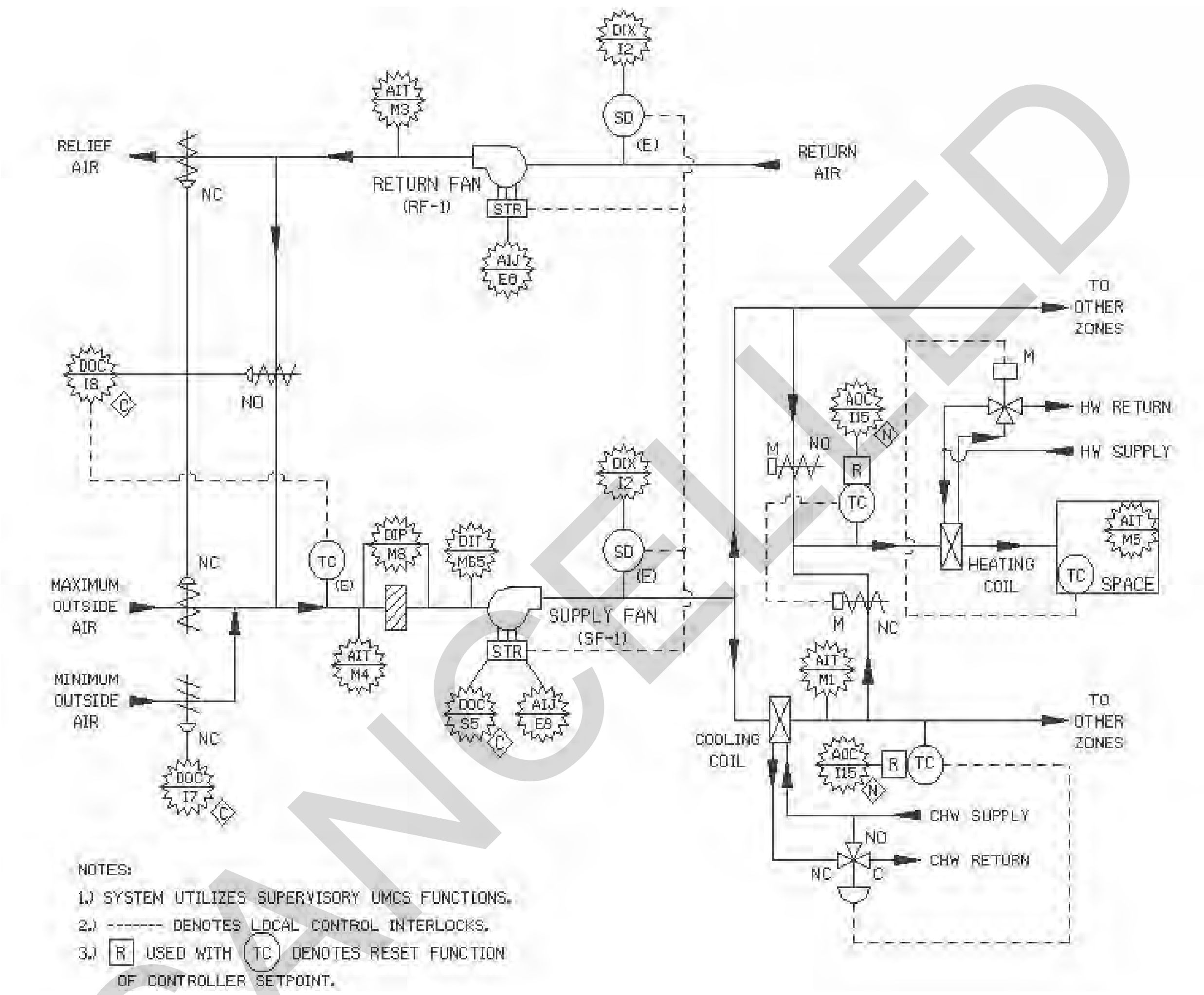
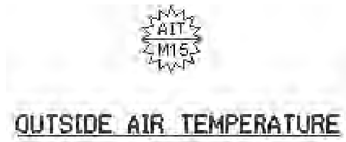


Figure 9-12. Bypass Multi-Zone Air Handling System with Hot Water and Chilled Water Coils.



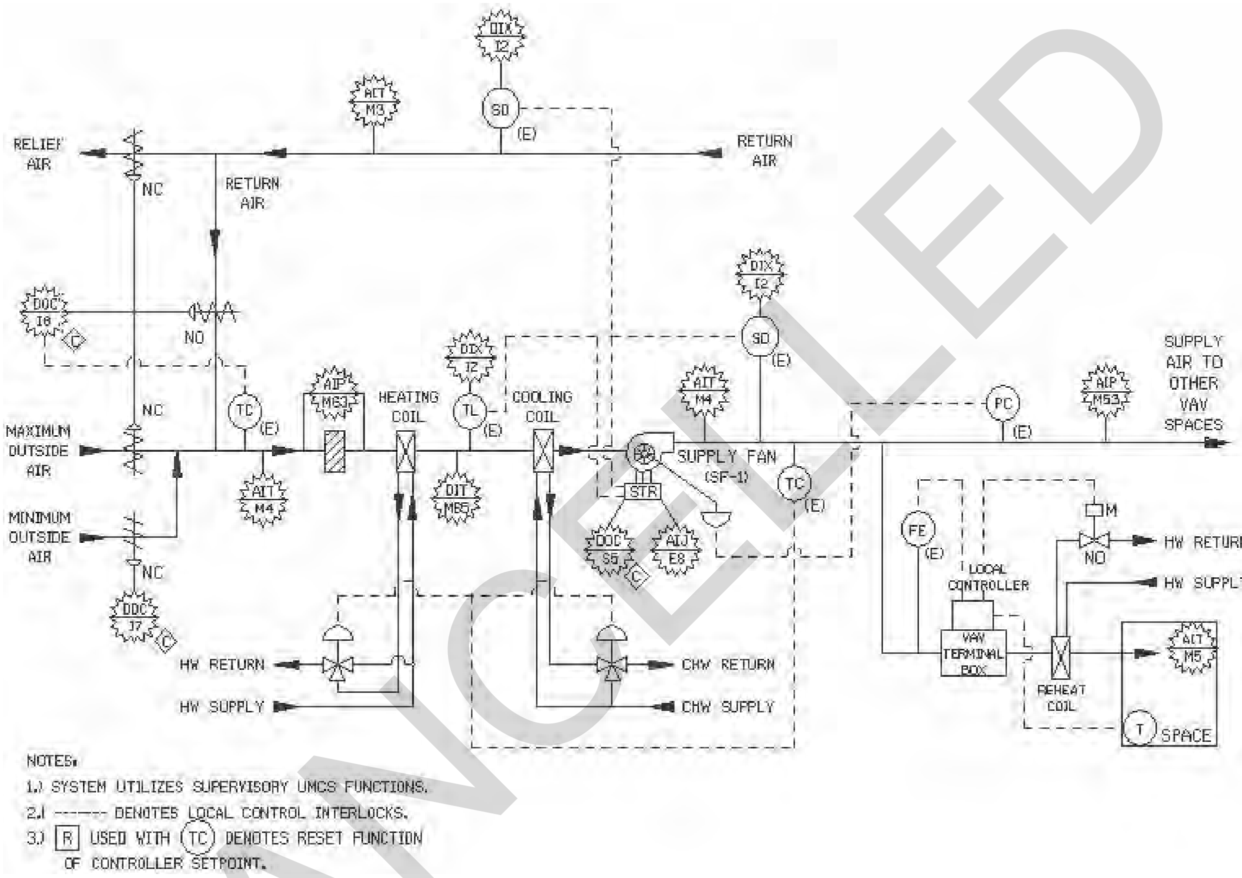
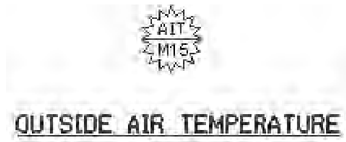


Figure 9-13. VAV Air Handling System with Hot Water and Chilled Water Coils.



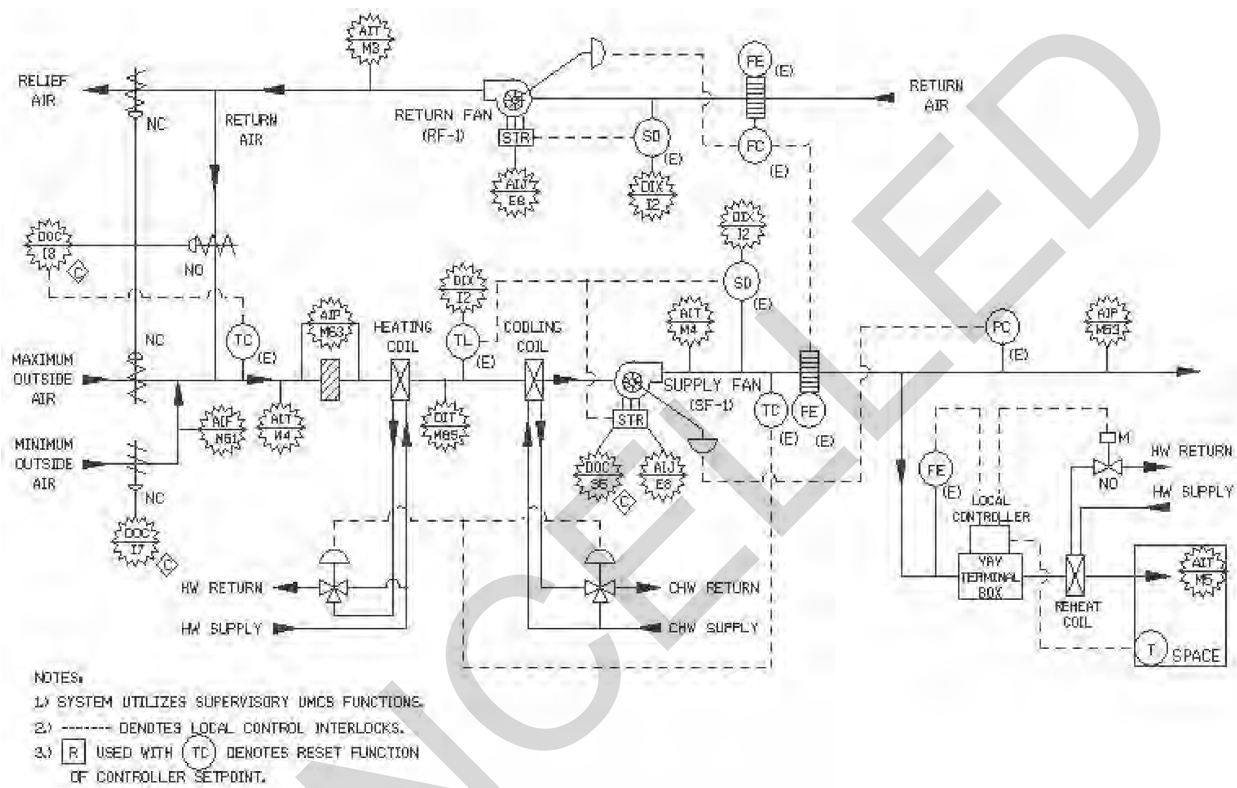


Figure 9-14. VAV Air Handling System with Return Air Fan and Hot Water/Chilled Water Coils.

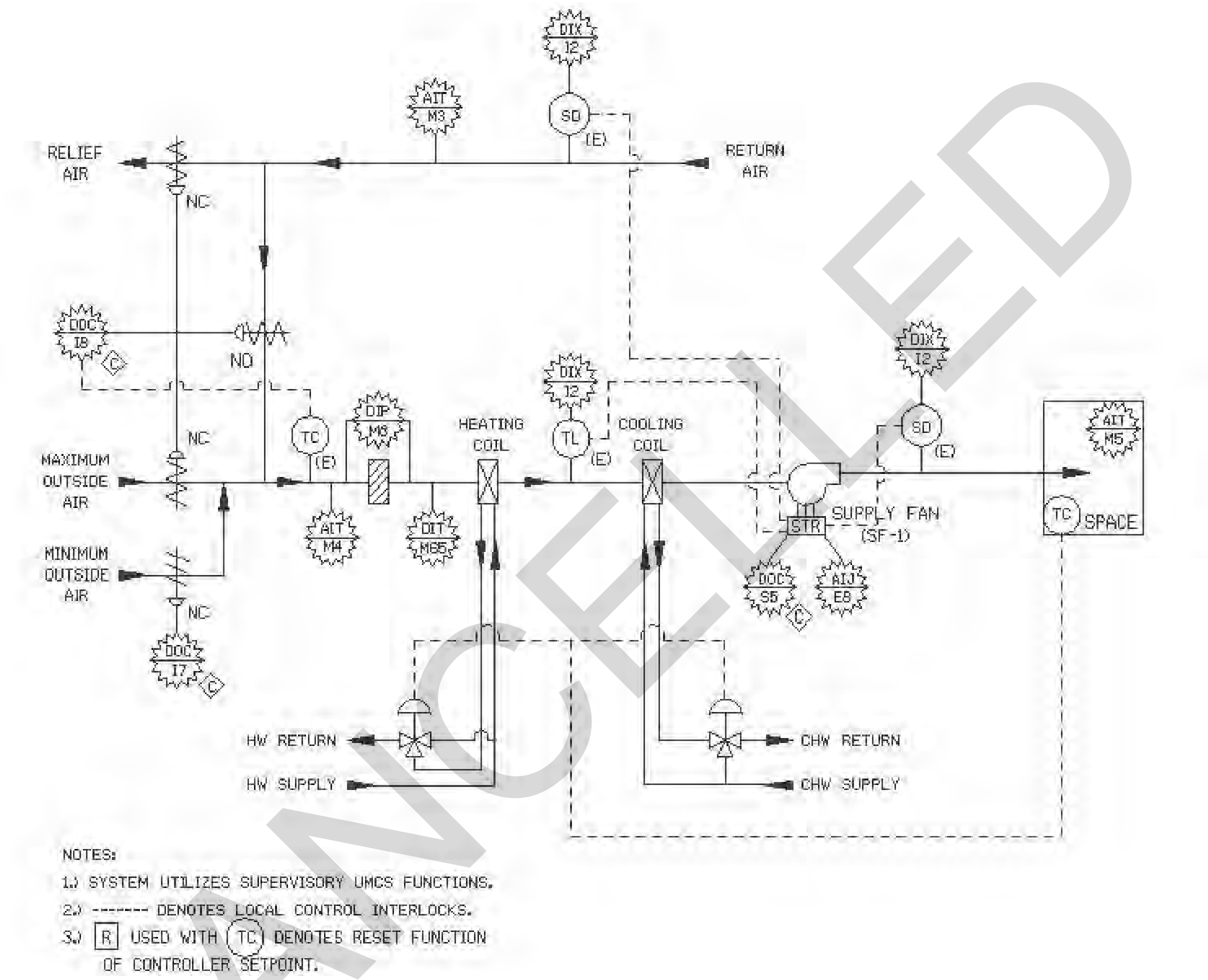


Figure 9-15. Single Zone Air Handling System with Hot Water and Chilled Water Coils.

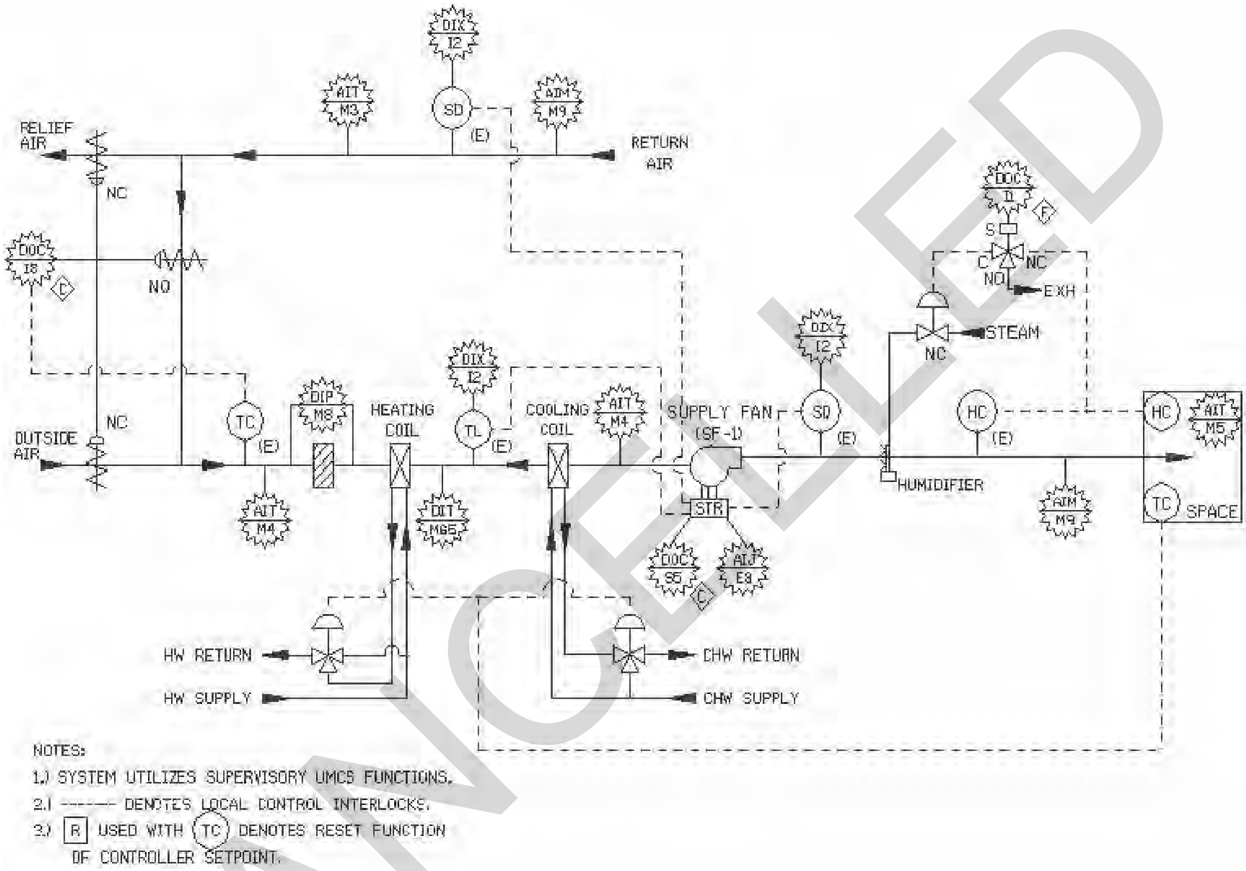
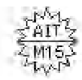


Figure 9-16. Single Zone Air Handling System with Humidification.



OUTSIDE AIR TEMPERATURE

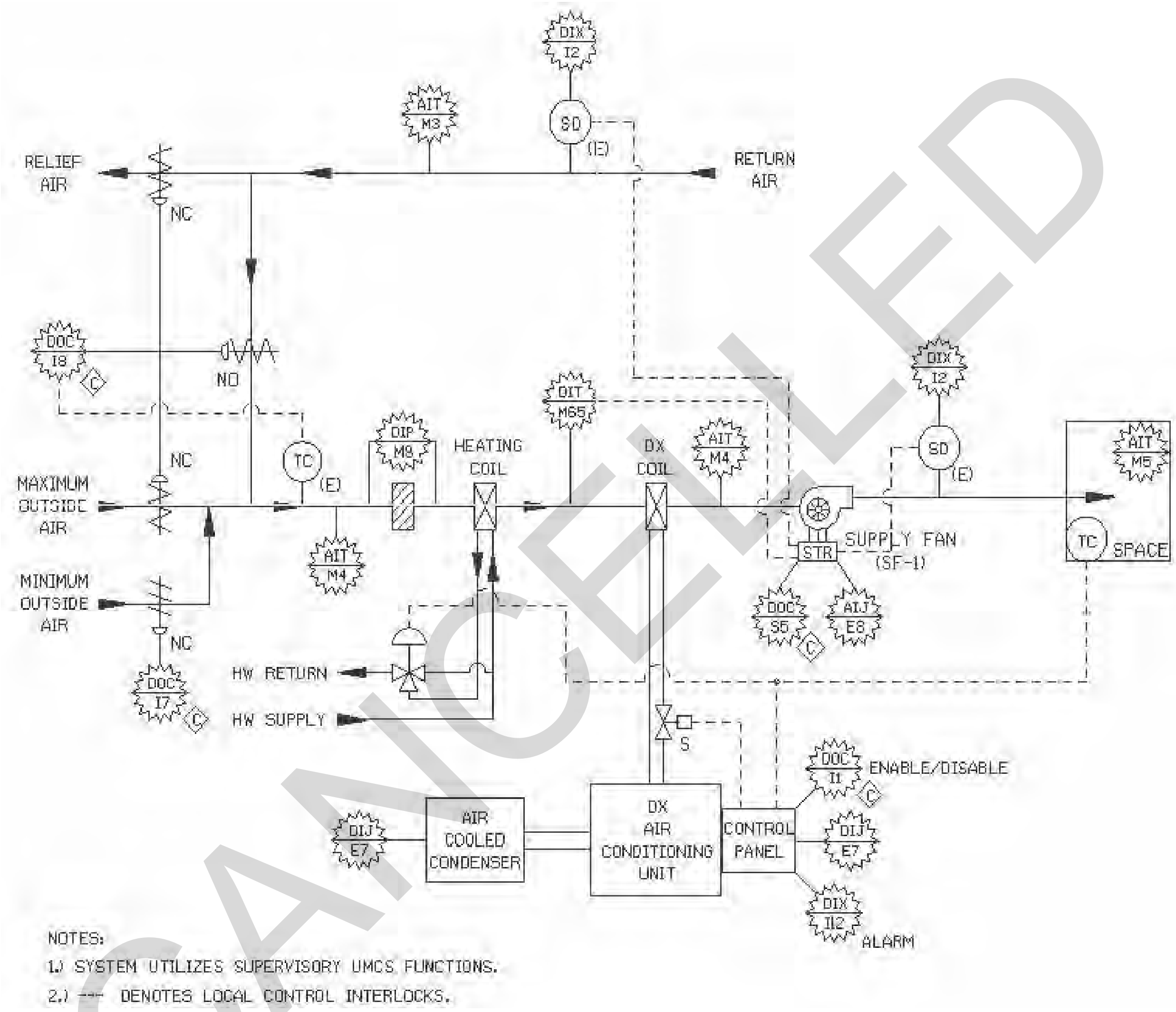
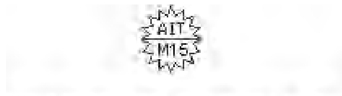


Figure 9-17. Single Zone Air Handling System with Hot Water and DX Refrigeration Coils.



OUTSIDE AIR TEMPERATURE

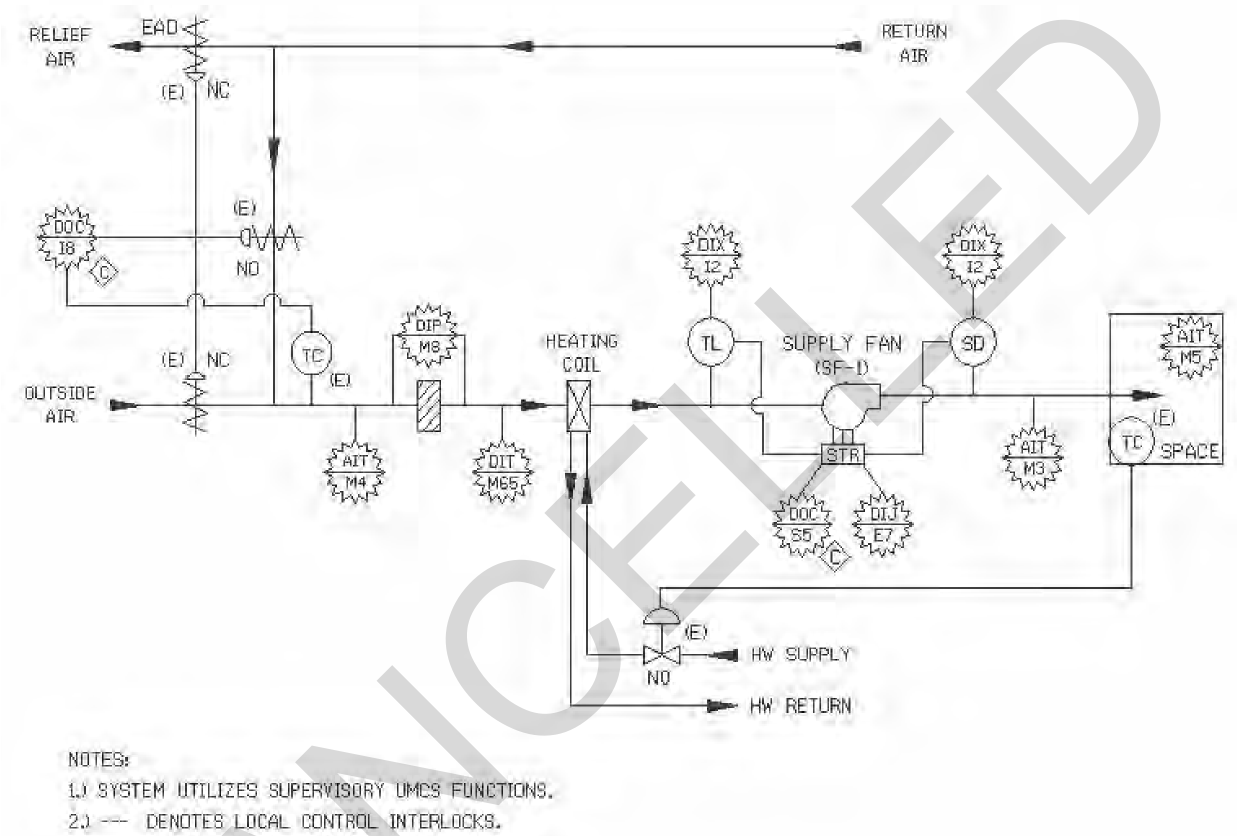
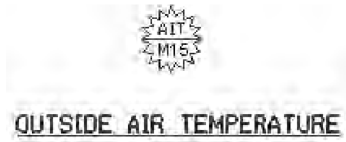


Figure 9-18. Heating and Ventilating System.



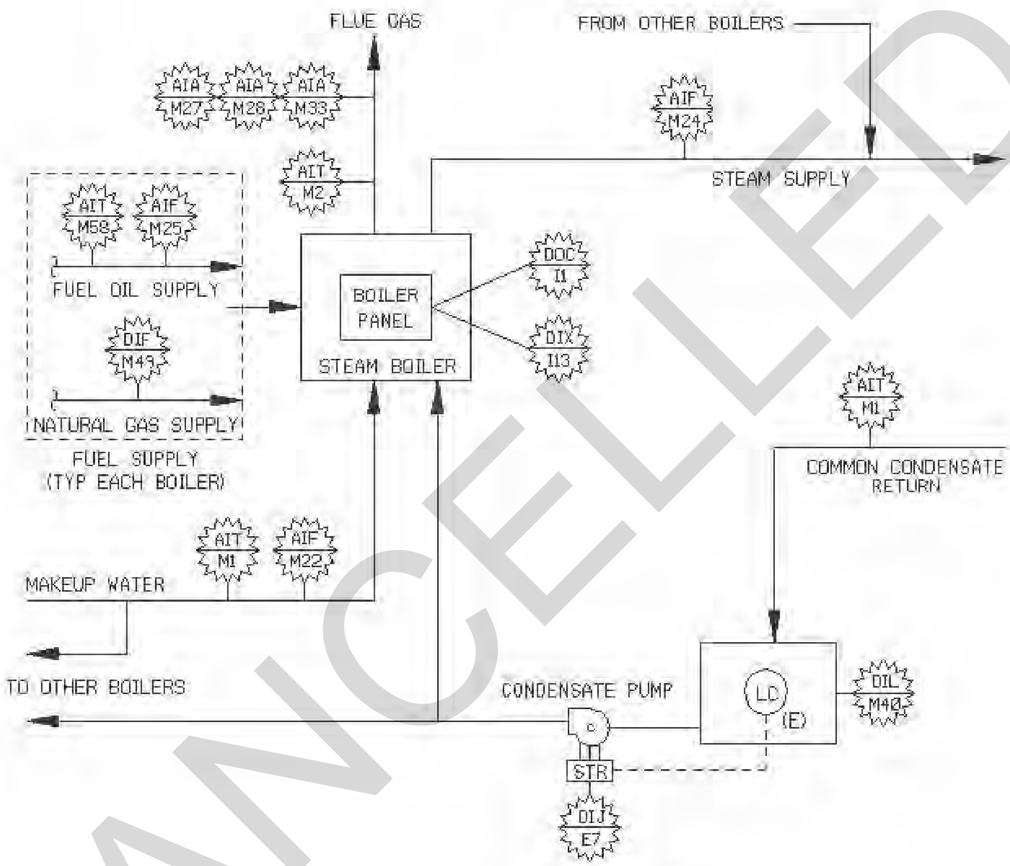
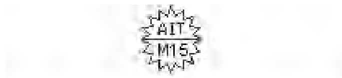


Figure 9-19. Steam Boilers.



OUTSIDE AIR TEMPERATURE

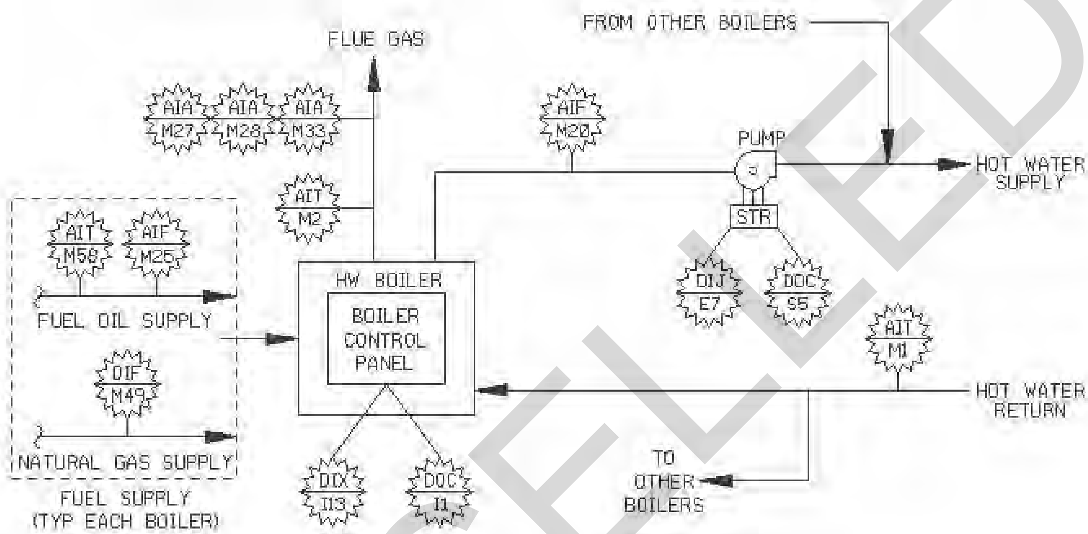


Figure 9-20. Hot Water Boilers.

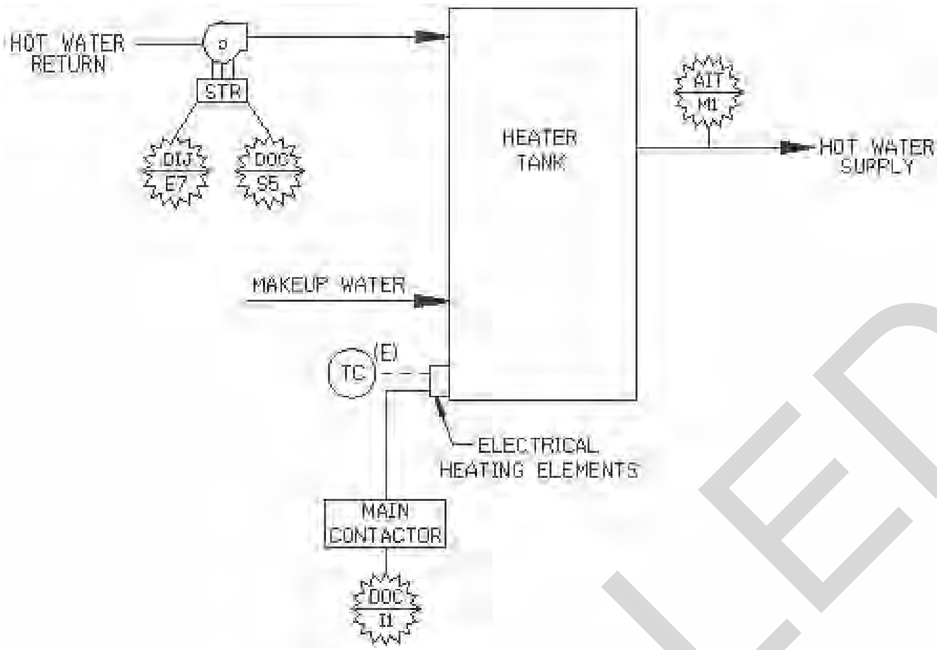


Figure 9-21. Electric Domestic Hot Water System.

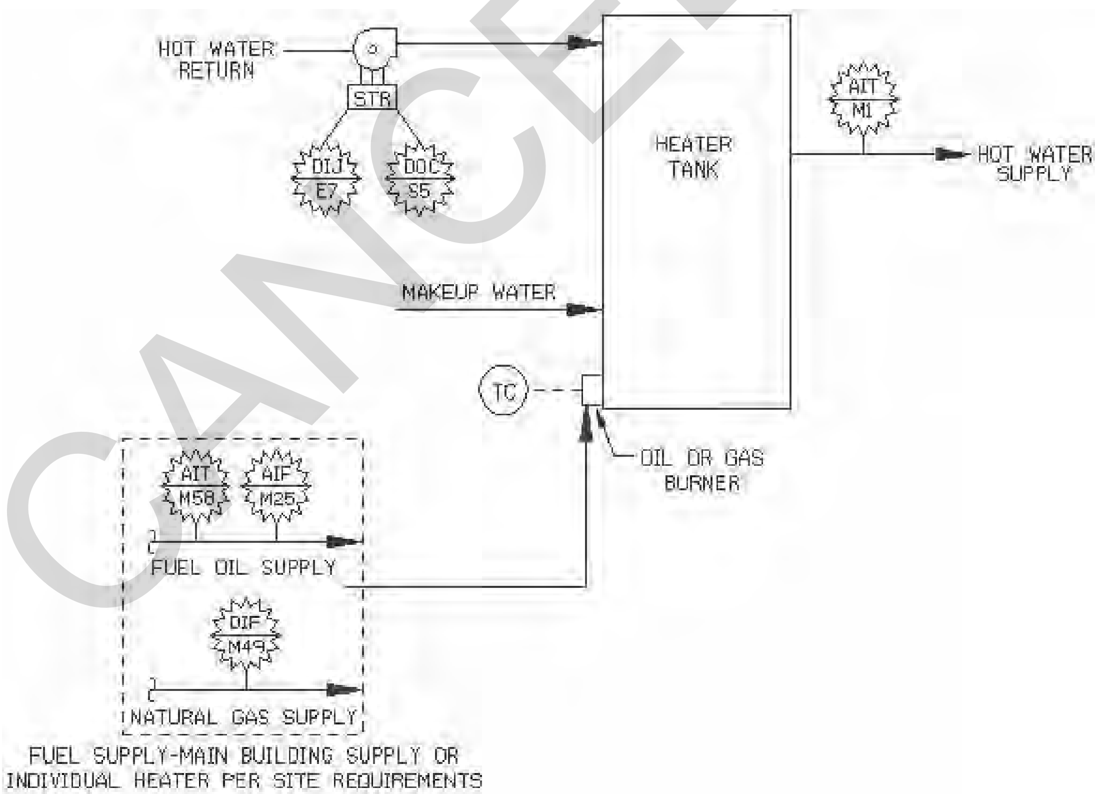


Figure 9-22. Oil/Gas Domestic Hot Water System.

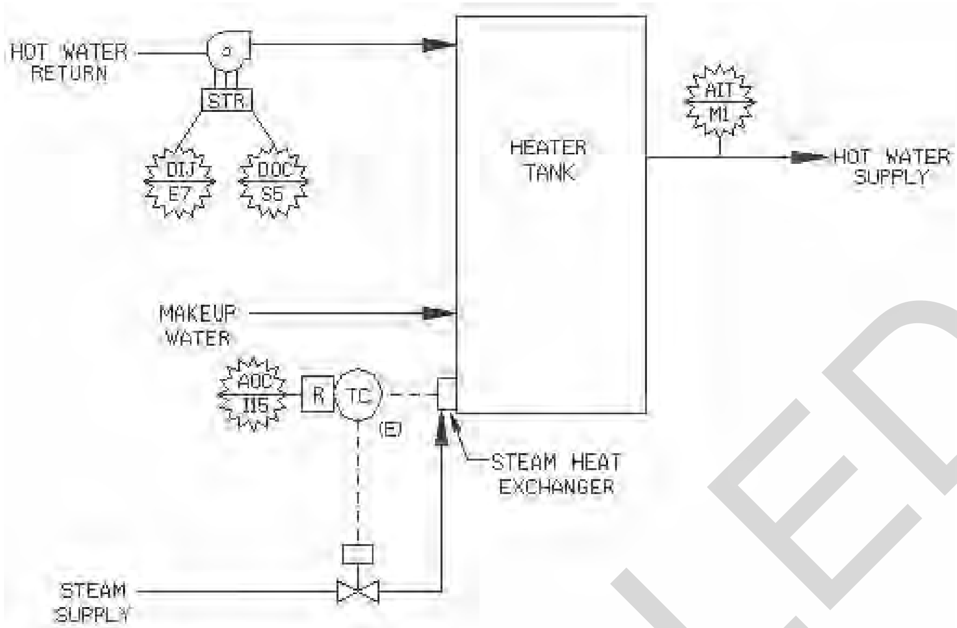


Figure 9-23. Steam Domestic Hot Water System.

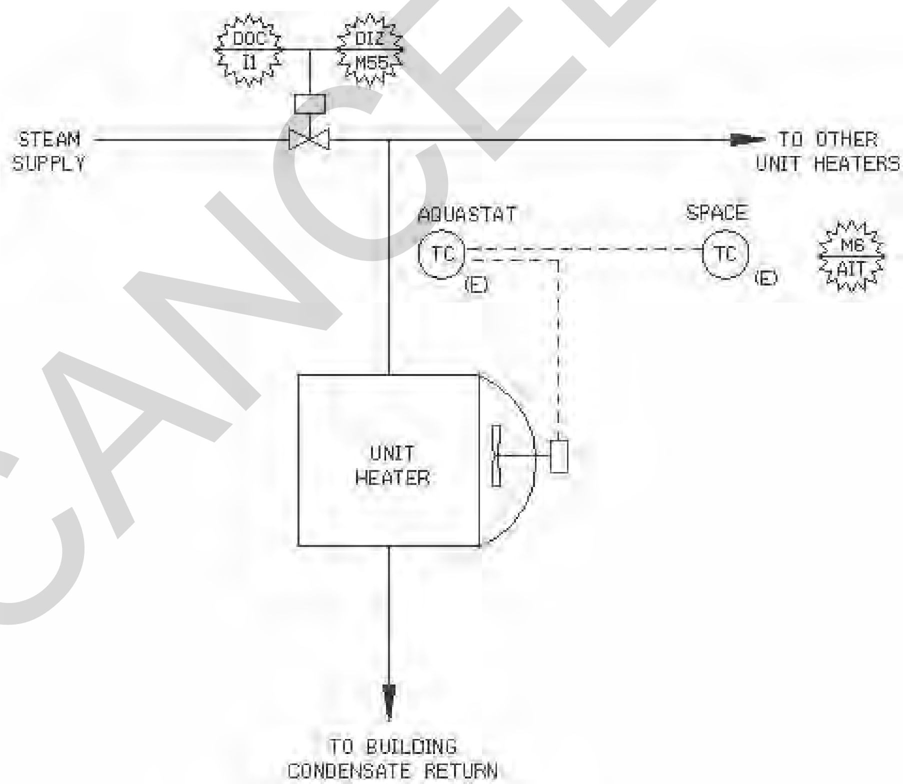


Figure 9-24. Steam Unit Heaters.

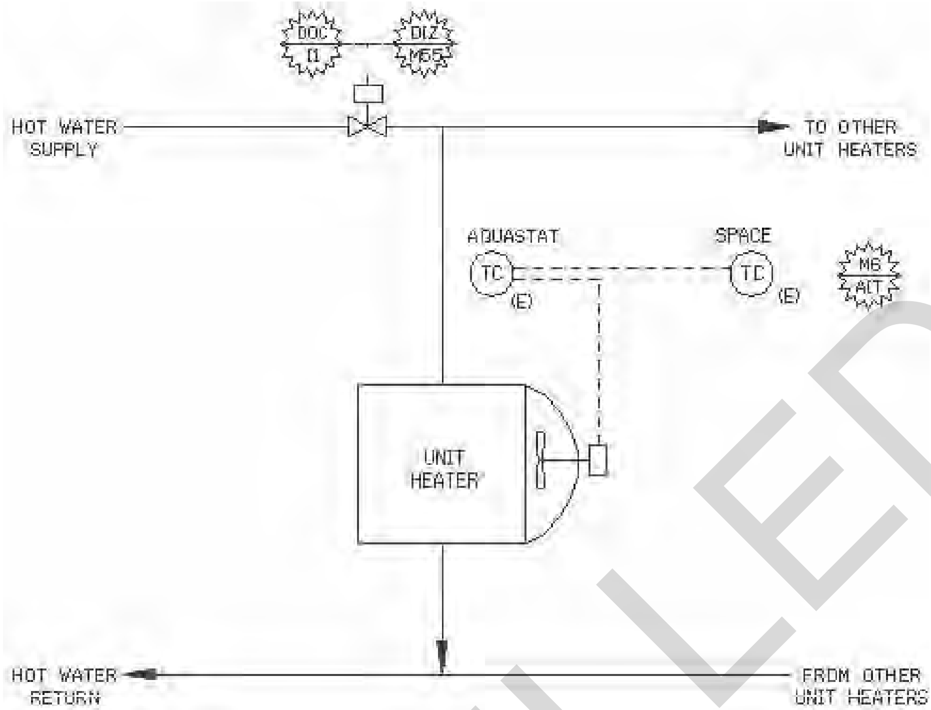


Figure 9-25. Hot Water Unit Heaters.

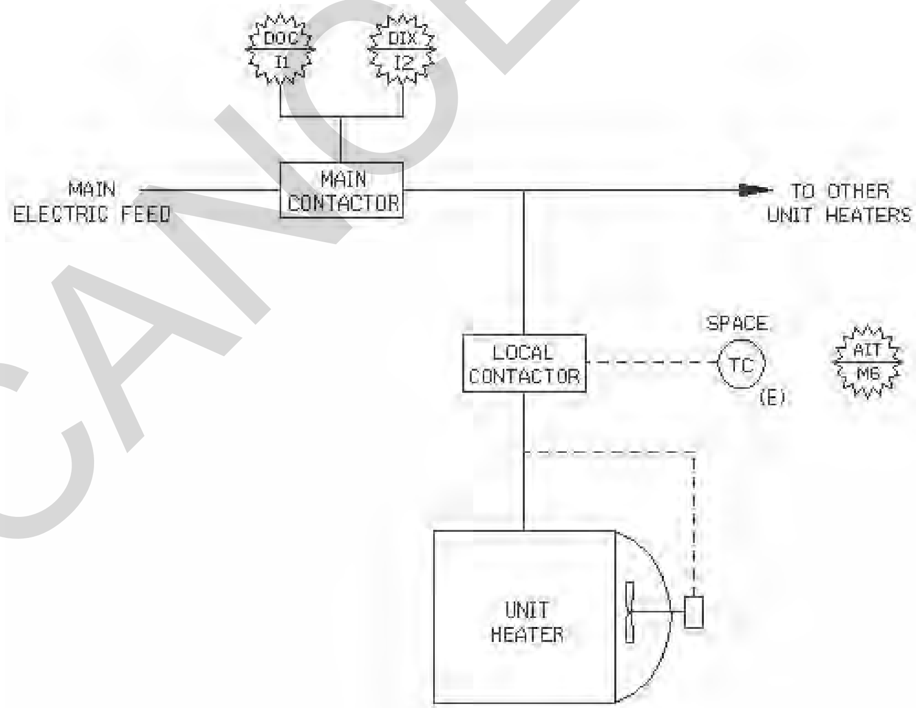


Figure 9-26. Electric Unit Heaters.

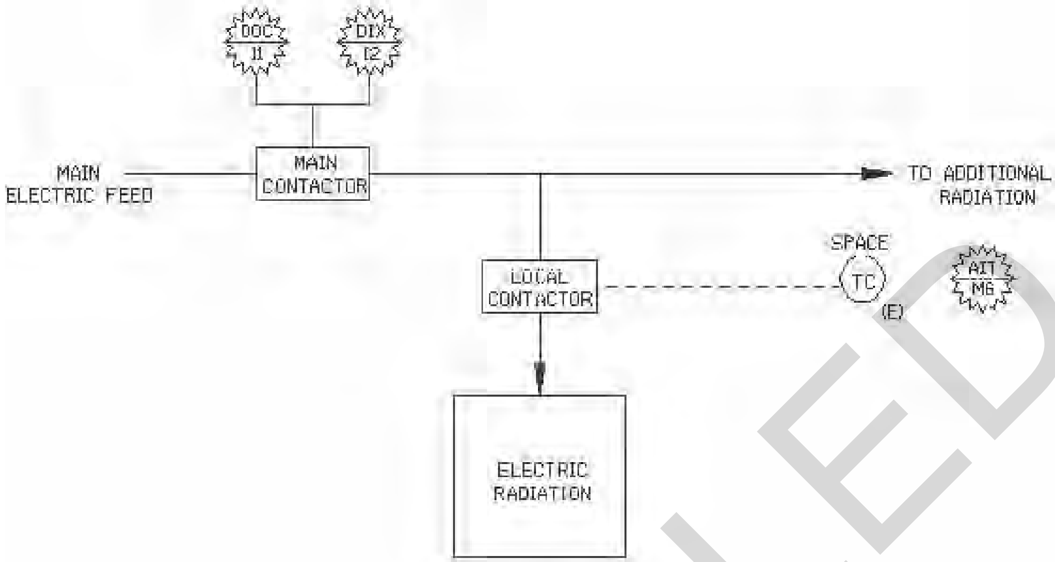


Figure 9-27. Electric Radiation.

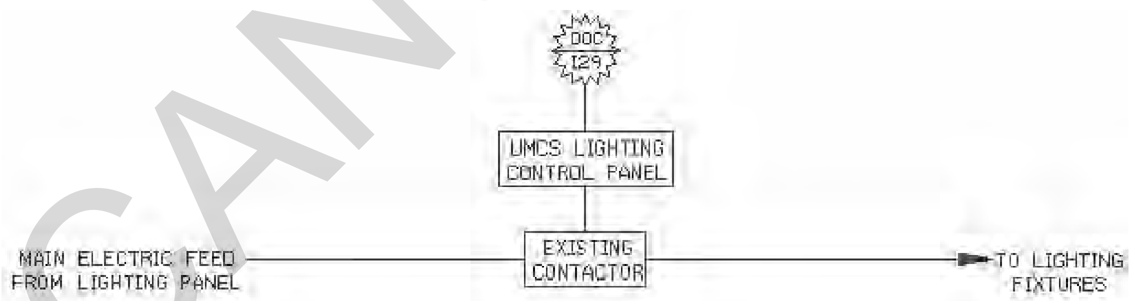


Figure 9-28. Lighting Control.

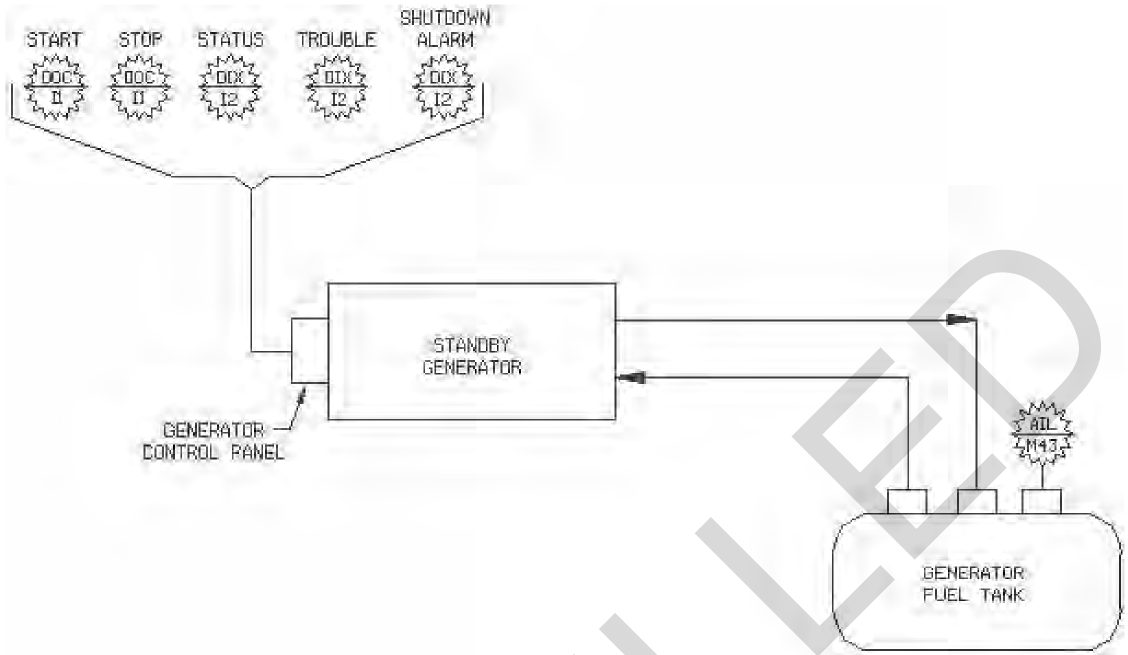


Figure 9-29. Standby Generator System.

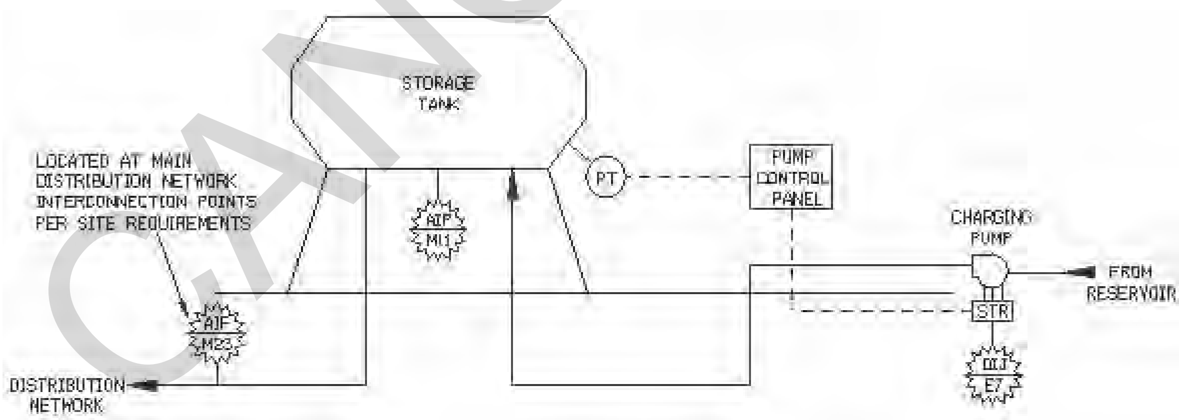


Figure 9-30. Water Storage and Distribution System.

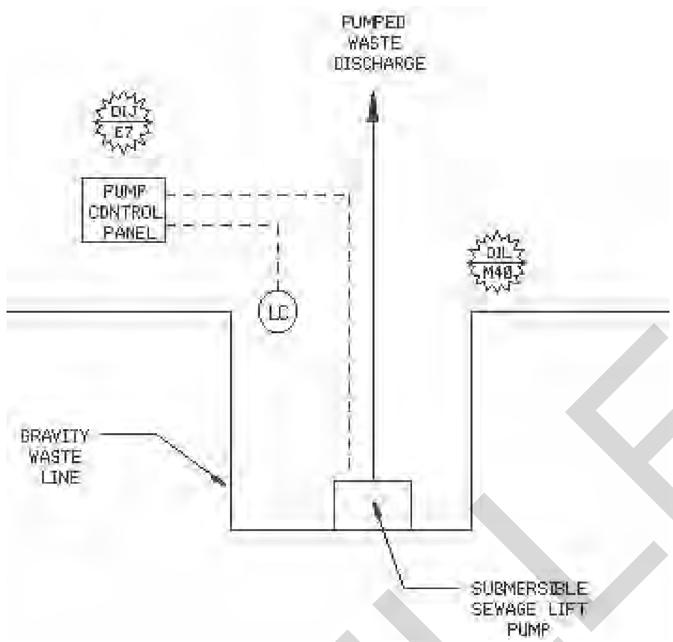


Figure 9-31. Sewage Lift System.

Table 9-1. Database Table for Steam/HW Converter and Primary/Secondary Heating System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
PRIMARY HW SUPPLY TEMP					SEE RESET SCH.		SP +/- 5 DEG.F	
PRIMARY HW RETURN TEMP							XX DEG.F	
PRIMARY SYSTEM FLOW							XX GPM (LOW)	
SECONDARY HW SUPPLY TEMP							XXX DEG. F	
SECONDARY HW RETURN TEMP							XXX DEG. F	
STEAM PRESSURE							XX PSI	

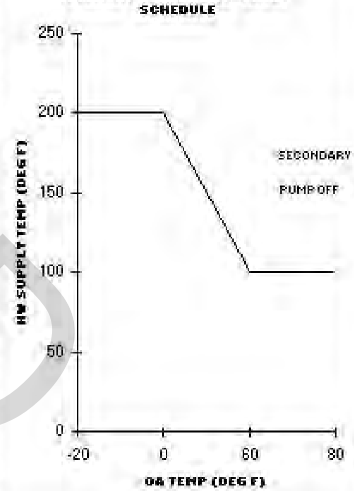
SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	X

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

PRIMARY SUPPLY TEMP RESET SCHEDULE



OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-2	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-2. Database Table for Hot Water Boiler and Primary/Secondary Heating System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
PRIMARY HW SUPPLY TEMP					SEE RESET SCH		SP +/- 5 DEG.F	
PRIMARY HW RETURN TEMP					XX GPM		XX DEG.F	
PRIMARY SYSTEM FLOW							XX GPM (LOW)	
SECONDARY HW SUPPLY TEMP							XXX DEG.F	
SECONDARY HW RETURN TEMP							XXX DEG.F	
FLUE GAS TEMP							XX DEG.F	
FLUE GAS O2							XX%O2	
FUEL FLOW							XX GPM (LOW)	
FUEL TEMP							XX DEG.F	

OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-2	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
HW BOILER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	X
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	X

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

PRIMARY HW SUPPLY TEMP RESET SCHEDULE

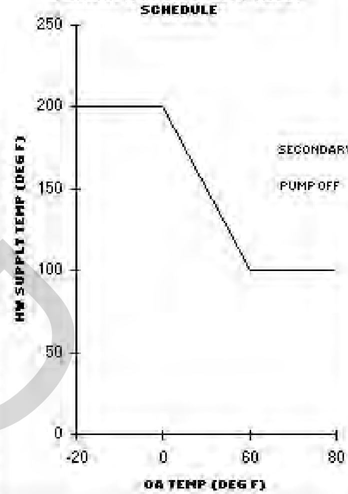


Table 9-3. Database Table for Hot Water Boiler with Constant Volume Circulating Loop and Primary/Secondary Heating System.

INSTALLATION: SITE NAME | AREA: | BLDG: | LOCATION: | ALARM DELAY ON STARTUP: ##

SYSTEM OPERATING PARAMETERS

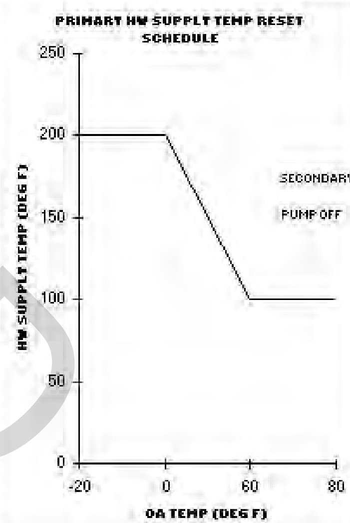
PARAMETERS	SUMMER DEFAULT OCCUPIED SETPOINT	SUMMER DEFAULT UNOCCUPIED SETPOINT	SUMMER ALARM LIMIT SETTINGS	SUMMER DEMAND LIMIT SETPOINT	WINTER DEFAULT OCCUPIED SETPOINT	WINTER DEFAULT UNOCCUPIED SETPOINT	WINTER ALARM LIMIT SETTINGS	WINTER DEMAND LIMIT SETPOINT
PRIMARY HW SUPPLY TEMP					SEE RESET SCH		SP +/- 5 DEG.F	
PRIMARY HW RETURN TEMP							## DEG.F	
PRIMARY SYSTEM FLOW							## GPM (LOW)	
SECONDARY HW SUPPLY TEMP							### DEG.F	
SECONDARY HW RETURN TEMP							### DEG.F	
FLUE GAS TEMP							## DEG.F	
FLUE GAS O2							## % O2	
FUEL FLOW							## GPM (LOW)	
FUEL TEMP							## DEG.F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	X
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	X

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS



OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	SUMMER OCCUPIED CYCLE 1	SUMMER OCCUPIED CYCLE 2	WINTER OCCUPIED CYCLE 1	WINTER OCCUPIED CYCLE 2
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-2	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-3	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
HW BOILER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-4. Database Table for High Temperature HW/HW Converter and Primary/Secondary Heating System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
PRIMARY HW SUPPLY TEMP					SEE RESET SCH.		SP +/- 5 DEG.F	
PRIMARY HW RETURN TEMP							XX DEG. F	
PRIMARY SYSTEM FLOW					160 DEG.F		XX GPM (LOW)	
SECONDARY HW SUPPLY TEMP.							SP +/- 5 DEG.F	
SECONDARY HW RETURN TEMP							XXX DEG. F	
HIGH TEMP HW SUPPLY							XX DEG. F	

OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-2	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	X

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

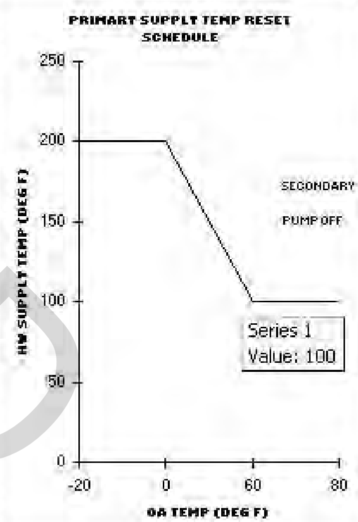


Table 9-5. Database Table for Steam HW/Converter with Dual Temperature Distribution System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX					
	SYSTEM OPERATING PARAMETERS									
PARAMETERS	COOLING				HEATING				SELECTED APPLICATION PROGRAMS	
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	SCHEDULED START/STOP	X
									OPTIMUM START/STOP	X
									ECONOMIZER	
									VENTILATION/RECIRCULATION	
HW SUPPLY TEMP	SEE RESET SCH.		SP +/- 5 DEG. F		SEE RESET SCH.		SP +/- 5 DEG. F		HOT DECK/COLD DECK TEMPERATURE RESET	
									REHEAT COIL RESET	
SUPPLY TEMP			XX DEG. F				XX DEG. F		BOILER MONITORING & CONTROL	
									CHILLER SELECTION	
RETURN TEMP			XX DEG. F				XX DEG. F		CHILLED WATER TEMPERATURE RESET	
									CONDENSER WATER TEMPERATURE RESET	
SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)		HOT WATER OA RESET	X
STEAM PRESSURE			XX PSI				XX PSI			
									REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS	
									DEMAND LIMITING	
									SUMMER STEP 1	
									SUMMER STEP 2	
									SUMMER STEP 3	
									WINTER STEP 1	
									WINTER STEP 2	
									ADDITIONAL SETTINGS	

OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

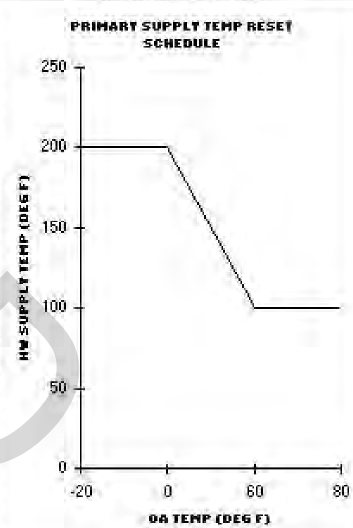
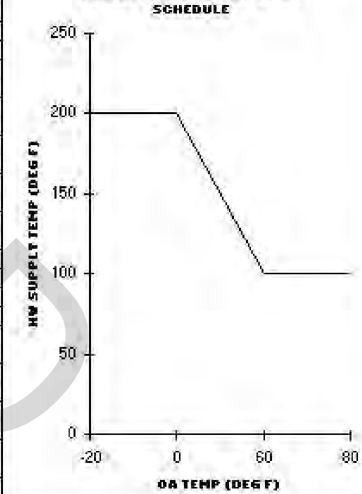


Table 9-6. Database Table for High Temperature HW/HW Converter with Dual Temperature Distribution System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
HW SUPPLY TEMP	SEE RESET SCH.		SP +/- 5 DEG.F		SEE RESET SCH.		SP +/- 5 DEG.F	
SUPPLY TEMP			XX DEG.F				XX DEG.F	
RETURN TEMP			XX DEG.F				XX DEG.F	
SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)	
HIGH TEMP. HW SUPPLY			XX DEG.F				XX DEG.F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	X
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS



OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

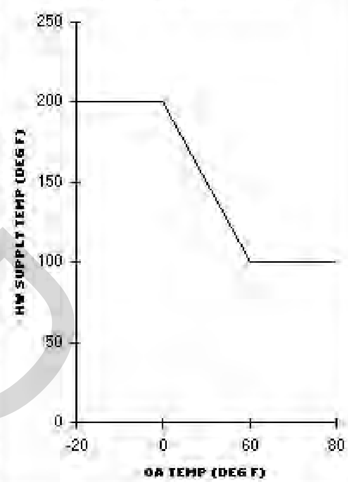
EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-7. Database Table For Dual Temperature System with Constant Volume Hot Water Circulating Loop And Air-Cooled Chiller.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	**COOLING**				**HEATING**			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
HW SUPPLY TEMP	SEE RESET SCH.		SP +/- 5 DEG. F		SEE RESET SCH.		SP +/- 5 DEG. F	
SUPPLY TEMP			XX DEG. F				XX DEG. F	
RETURN TEMP			XX DEG. F				XX DEG. F	
SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)	
FLUE GAS TEMP			XX DEG. F				XX DEG. F	
FLUE GAS O2			XX % O2				XX % O2	
FUEL FLOW			XX GPM				XX GPM (LOW)	
FUEL TEMP			XX DEG. F				XX DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	X
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	
ADDITIONAL SETTINGS	

SUPPLY TEMP RESET SCHEDULE



OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
PUMP P-2	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
HW BOILER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
CHILLER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-8. Database Table for Dual Temperature System with Hot Water Boiler and Air Cooled Chiller

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
HW SUPPLY TEMP	SEE RESET SCH.		SP +/- 5 DEG. F		SEE RESET SCH.		SP +/- 5 DEG. F	
SUPPLY TEMP			XX DEG. F				XX DEG. F	
RETURN TEMP			XX DEG. F				XX DEG. F	
SYSTEM FLOW			XX GPM (LOW)				XX GPM (LOW)	
FLUE GAS TEMP			XX DEG. F				XX DEG. F	
FLUE GAS O2			XX % O2				XX % O2	
FUEL FLOW			XX GPM				XX GPM (LOW)	
FUEL TEMP			XX DEG. F				XX DEG. F	

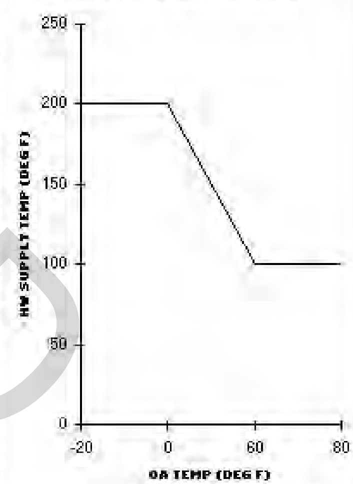
SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	X

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

SUPPLY TEMP RESET SCHEDULE



OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
PUMP P-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
HW BOILER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
CHILLER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-9. Database Table For Water-Cooled Chiller.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
CHWS TEMPERATURE	XX DEG.F		SP (+/-) 0.5 DEG.F	XX DEG.F				
CHWR TEMPERATURE			XXX DEG.F					
CWS TEMPERATURE	XX DEG.F		SP (+/-) 2 DEG.F					
CWR TEMPERATURE			XXX DEG.F					
CHWS FLOW			XXX GPM					
CWS FLOW			XXX GPM					
CWS PH LEVEL			6 PH/8 PH					

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	X
CONDENSER WATER TEMPERATURE RESET	X
HOT WATER OA RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	
ADDITIONAL SETTINGS	

OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
CHILLER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
COOLING TOWER	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
CHW PUMP	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
CW PUMP	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-10. Database Table For Multi-Zone Air Handling System w/Hot Water and Chilled Water Coils.

INSTALLATION: SITE NAME | **AREA:** | **BLDG:** | **LOCATION:** | **ALARM DELAY ON STARTUP: XX**

SYSTEM OPERATING PARAMETERS

PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG. F	
HOT DECK TEMP	PER RESET SCH.		SP (+/-) 2 DEG. F		PER RESET SCH.		SP (+/-) 2 DEG. F	
COLD DECK TEMP	PER RESET SCH.		SP (+/-) 2 DEG. F		PER RESET SCH.		SP (+/-) 2 DEG. F	
ZONE SPACE TEMP			XX DEG. F	XX DEG. F			XX DEG. F	XX DEG. F
FILTER			XX" WC				XX" WC	
LOW TEMP DEVICE			XX DEG. F				XX DEG. F	

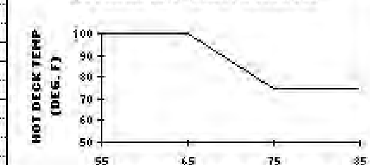
SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	X
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS

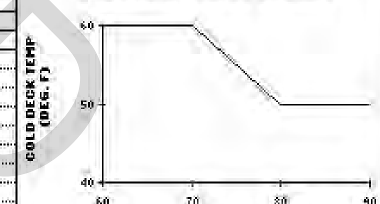
DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	

ADDITIONAL SETTINGS

HOT DECK TEMP RESET SCHEDULE



COLD DECK TEMP RESET SCHEDULE



OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
RETURN FAN RF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-11. Database Table For Dual Duct Air Handling System
With Hot Water and Chilled Water Coils

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG. F	
HOT DECK TEMP	PER RESET SCH.		SP (+/-) 2 DEG. F		PER RESET SCH.		SP (+/-) 2 DEG. F	
COLD DECK TEMP	PER RESET SCH.		SP (+/-) 2 DEG. F		PER RESET SCH.		SP (+/-) 2 DEG. F	
ZONE SPACE TEMP		XX DEG. F	XX DEG. F	XX DEG. F		XX DEG. F	XX DEG. F	XX DEG. F
FILTER			XX" WC				XX" WC	
LOW TEMP DEVICE			XX DEG. F				XX DEG. F	

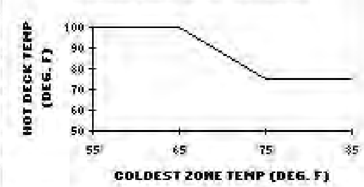
SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	X
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	

OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
RETURN FAN RF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

ADDITIONAL SETTINGS

HOT DECK TEMP RESET SCHEDULE



COLD DECK TEMP RESET SCHEDULE

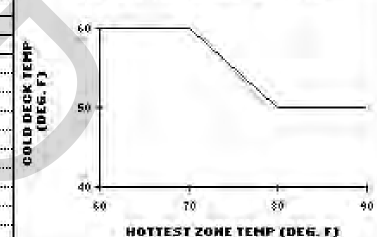


Table 9-12. Database Table For Bypass Multi-Zone Air Handling System with Hot Water and Chilled Water Coils

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX				
	SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING				
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG. F		
COLD DECK TEMP	PER RESET SCH		SP (+/-) 2 DEG. F		PER RESET SCH		SP (+/-) 2 DEG. F		
ZONE SPACE TEMP			XX DEG. F	XX DEG. F			XX DEG. F	XX DEG. F	
FILTER			XX" W.C.				XX" W.C.		
LOW TEMP DEVICE			XX DEG. F				XX DEG. F		

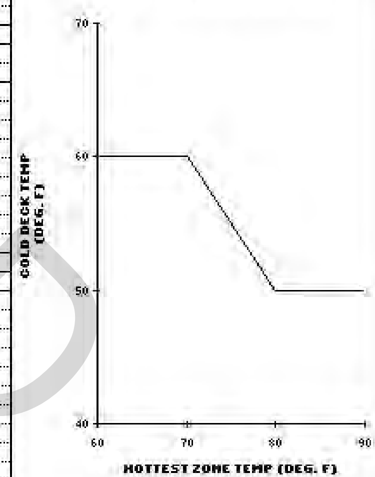
SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	X
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	
WINTER STEP 2	

ADDITIONAL SETTINGS

COLD DECK TEMP RESET SCHEDULE



OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
RETURN FAN RF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-13. Database Table For VAV Air Handling System with Hot Water and Chilled Water Coils

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
SUPPLY AIR TEMP			55 DEG.F				XX DEG.F	
MIXED AIR TEMP	PER SEQUENCE		SP(+/-)2 DEG.F		PER SEQUENCE		SP(+/-)2 DEG.F	
SPACE TEMP			XX DEG.F	XX DEG.F			XX DEG.F	XX DEG.F
FILTER			XX"WC				XX"WC	
SUPPLY AIR STATIC PRESS.			SYSTEM SPECIFIC				SYSTEM SPECIFIC	
LOW TEMP DEVICE			XX DEG.F				XX DEG.F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	X
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	
ADDITIONAL SETTINGS	

OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-14. Database Table For VAV Air Handling System with Return Air Fan and Hot Water/Chilled Water Coils

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
SUPPLY AIR TEMP			XX DEG.F				XX DEG.F	
MIXED AIR TEMP	PER SEQUENCE		SP(+/-)2 DEG.F		PER SEQUENCE		SP(+/-)2 DEG.F	
SPACE TEMP			XX DEG.F	XX DEG.F			XX DEG.F	XX DEG.F
FILTER			XX" WC				XX" WC	
SUPPLY AIR STATIC PRESS.			SYSTEM SPECIFIC				SYSTEM SPECIFIC	
LOW TEMP DEVICE			XX DEG.F				XX DEG.F	
RETURN FAN FLOW			SUPPLY CFM (-) MIN OA CFM				SUPPLY CFM (-) MIN OA CFM	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	X
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	
ADDITIONAL SETTINGS	

OCCUPANCY SCHEDULE				
DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE				
EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC
RETURN FAN RF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-15. Database Table For Single Zone Air Handling System with Hot Water and Chilled Water Coils

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG F	
SPACE TEMP			XX DEG. F	XX DEG. F			XX DEG. F	XX DEG. F
FILTER			XX" WC				XX" WC	
LOW TEMP DEVICE			XX DEG. F				XX DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	

ADDITIONAL SETTINGS

OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-16. Database Table For Single Zone Air Handling System with Humidification.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:	ALARM DELAY ON STARTUP: XX

SYSTEM OPERATING PARAMETERS

PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG. F	
RETURN AIR HUMIDITY (RH)			XX RH				XX RH	
DISCHARGE HUMIDITY (RH)			XX RH				XX RH	
SPACE TEMP			XX DEG.F	XX DEG.F			XX DEG.F	XX DEG. F
FILTER			XX" WC				XX" WC	
LOW TEMP DEVICE			XX DEG. F				XX DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	

REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS

DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	

ADDITIONAL SETTINGS

OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-17. Database Table For Single Zone Air Handling System with Hot Water And DX Refrigeration Coils.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:		ALARM DELAY ON STARTUP: XX			
	SYSTEM OPERATING PARAMETERS							
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETTINGS	ALARM LIMIT SETPOINT	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP	PER SEQUENCE		SP (+/-) 2 DEG. F		PER SEQUENCE		SP (+/-) 2 DEG F	
SPACE TEMP			XX DEG. F	XX DEG. F			XX DEG. F	XX DEG. F
FILTER			XX" WC				XX" WC	
LOW TEMP DEVICE			XX DEG. F				XX DEG. F	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	X
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	X
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	
ADDITIONAL SETTINGS	

OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SF-1	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

Table 9-18. Database Table Heating And Ventilating System.

INSTALLATION: SITE NAME	AREA:	BLDG:	LOCATION:	ALARM DELAY ON STARTUP: XX				
SYSTEM OPERATING PARAMETERS								
PARAMETERS	COOLING				HEATING			
	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT	DEFAULT OCCUPIED SETPOINT	DEFAULT UNOCCUPIED SETPOINT	ALARM LIMIT SETTINGS	DEMAND LIMIT SETPOINT
MIXED AIR TEMP					PER SEQUENCE		SP(+/-)2 DEG. F	
SPACE TEMP							XX DEG. F (LO)	
SUPPLY TEMP							XX DEG. F	
LOW TEMP DEVICE							XX DEG. F	
FILTER							XX" WC	

SELECTED APPLICATION PROGRAMS	
SCHEDULED START/STOP	X
OPTIMUM START/STOP	X
ECONOMIZER	
VENTILATION/RECIRCULATION	X
HOT DECK/COLD DECK TEMPERATURE RESET	
REHEAT COIL RESET	
BOILER MONITORING & CONTROL	
CHILLER SELECTION	
CHILLED WATER TEMPERATURE RESET	
CONDENSER WATER TEMPERATURE RESET	
HOT WATER OA RESET	
REFER TO SEQUENCE OF OPERATIONS FOR ADDITIONAL SOFTWARE, SETTING AND OPERATIONAL REQUIREMENTS	
DEMAND LIMITING	
SUMMER STEP 1	
SUMMER STEP 2	
SUMMER STEP 3	
WINTER STEP 1	X
WINTER STEP 2	
ADDITIONAL SETTINGS	

OCCUPANCY SCHEDULE

DAY OF WEEK/ HOLIDAY	OCCUPIED PERIOD 1	OCCUPIED PERIOD 2	OCCUPIED PERIOD 3	OCCUPIED PERIOD 4
SUNDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
MONDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
TUESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
WEDNESDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
THURSDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
FRIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
SATURDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC
HOLIDAY	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC	SITE SPECIFIC

EQUIPMENT SCHEDULE

EQUIPMENT NAME	CAPACITY	MOTOR HP	MANUFACTURER	MODEL/SERIES
SUPPLY FAN (SF-1)	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC	SYSTEM SPECIFIC

CHAPTER 10

DATA TRANSMISSION SYSTEMS

1. UMCS DATA TRANSMISSION TOPOLOGIES.

a. UMCS data transmission networks are defined as peer-to-peer networks where all nodes (island station computer, workstations and field equipment panels) have the same level of control over the communications and can control their own activities. In the UMCS, peer-to-peer network data is stored in many locations (distributed processing) and the island station computer takes the role of a server. UMCS network topology describes the physical layout of the data transmission system. UMCS data transmission system topologies include the following.

(1) Point-to-point is a dedicated connection between two devices.

(2) Bus topology is a form of multinode local area network (LAN) data transmission system. In a bus network all the devices connect directly to the same media by means of connectors in a daisy chain configuration. Bus LANs include token-passing LANs and ethernet LANs which utilize carrier sense multiple access/collision detection.

(3) Star topology is a configuration in which the UMCS island station computer or a communications hub connects radially to multiple field equipment panels. Star topologies include token ring, where the ring is internal to a multistation access unit, and hub ethernet, which is also called 10 Base-T.

(4) Hybrid topologies (combination bus and star) are used in an arcnet network, which is a token-passing network.

b. The UMCS data transmission system is also defined by the data transmission media used. Guided or physical media consists of fiber optics, wireline and coaxial cable. Unguided media consists of one-way radio frequency (RF) or two-way RF packet transmissions.

c. The selection of UMCS data transmission system topology will be based on the size of the system. Arcnet-based networks are limited to 256 nodes. Ethernet-based networks can be extended over 1000 nodes based on addressing capabilities, but the practical number is much lower because the collision detection nature of ethernet will limit network performance as the network size grows. The use of 10 Base-T hubs and multiple network segments can improve ethernet performance.

d. Data transmission between smart field panels and remote terminal units, universal programmable controllers or unitary controllers typically uses a bus topology.

e. Network interconnection devices, including hubs, bridges and routers, extend or interconnect networks or network segments.

(1) Active or passive hubs provide a central location for the connection of cables from network devices such as field equipment panels, workstations, and other hubs. Active hubs regenerate signals between devices connected to them. Passive hubs pass the signals from one port to the next without signal conditioning or regeneration.

(2) Bridges provide a communication path between two or more network segments. Bridges enable devices on one network segment to communicate with devices on another network segment. Bridges allow only those packets destined for the other network segment to be passed.

(3) Routers connect network segments (or different networks using identical protocols) of different media types. Routers are the basis for large internetworks made up of smaller networks each with its own logical identity. Routers direct packets between networks using the most efficient route based on packet type, destination and available network resources.

2. FIBER OPTICS.

a. Fiber optics uses the wideband properties of light traveling through transparent fibers. Fiber optics is a reliable communications media best suited for point-to-point high speed data transmission. Fiber optics is immune to radio frequency electromagnetic interference, and does not produce electromagnetic radiation emission; hence, fiber optics can be used in secure areas.

b. Fiber optic cable consists of small fiber cores encased in a thin, light-reflective plastic or glass jacket referred to as the cladding. The cladding is enclosed by a thicker plastic or teflon jacket. A light source at one end of the cable introduces coded light pulses into the fiber. The light source may be a laser diode or a light-emitting diode (LED). The light pulses are transmitted through the fiber to a photo diode at the other end, which receives the light pulses and converts them to electrical signals. Fiber optic cables (but not fiber optic equipment) can be installed in explosive and flammable environments. Fiber optic cables can tolerate severe weather conditions and can be immersed in many fluids with appropriate jackets. The bandwidth of this media is virtually unlimited, and extremely high data transmission rates can be obtained. The signal attenuation of high quality fiber optic cable is very low. The type of fiber optic cable typically used for UMCS data transmission is multimode fiber with 62.5 -micron fiber diameter. When the data transmission system interfaces with existing government furnished networks, however, the designer will evaluate the specific fiber required for interface or extension.

c. The use of fiber optics in a data transmission system requires that equipment be provided to encode, decode and regenerate digital data into the fiber optic media. Typical fiber optic equipment includes the following.

(1) Fiber optic modems allow full duplex, asynchronous, point-to-point communications. Fiber optic transmitter and receiver modules which convert electrical digital signals into optical signals are an integral part of fiber optic modems.

(2) Fiber optic repeaters extend the range of the fiber optic data transmission. A repeater is a signal regenerator used at specified distances to restore signals to their proper level and quality. Repeaters can be simplex (containing one transmitter and one receiver module) or duplex (containing two transmitters and two receiver modules). Repeaters are required for distances between data transmission equipment of 1 to 2 miles.

(3) Fiber optic transceivers convert signals between fiber optics and other UMCS communication media. One type of fiber optic transceiver converts an ethernet 10 Base-T (wireline) signal to a 10 Base FL (fiber optic) signal.

(4) Fiber optic drop/repeaters combine the features of fiber optic repeaters with fiber optic LAN transceivers in a multidrop bus topology.

(5) Fiber optic active star units (or fiber optic switched hubs) extend a fiber optic bus topology into a multi-segment star topology.

d. The use of fiber optics equipment and connectors will introduce optical signal losses/gains that must be accounted for during the design. Optical flux budget/gain will be calculated during UMCS data transmission system design.

3. WIRELINES.

a. Wirelines are twisted pairs that consist of two solid copper insulated conductors twisted and shielded together to minimize interference by unwanted signals.

b. Twisted shielded pairs carry information over a wide range of speeds depending on line characteristics. To maintain a particular data transmission rate, the line bandwidth, time delay, or the signal to noise ratio may require adjustment by conditioning the line. Twisted pairs are permanently hardwired lines between the equipment sending and receiving data. The nominal bandwidth of unconditioned twisted pairs is between 300 and 3000 Hz. For each Hz of available bandwidth, 2 bps may be transmitted. Data transmission in unconditioned twisted pairs, in most cases, is limited to a speed of 9600 bps or less. Hardwired twisted pairs must be conditioned by the supplier in order to obtain operating speeds up to 19.2 Kbps. Data transmission between field equipment panels is by means of twisted pairs connecting line drivers operating at a speed selected by the system.

c. To implement a wireline data transmission system, it is necessary to encode the data for transmission over the media using modems or line drivers.

d. The modem is a device which performs encoding and decoding of digital data by modulation and demodulation. The most commonly used format is frequency shift keying (FSK) of digital data into a series of "marks" and "spaces" represented by two audio tones. Modems are provided with sharply tuned filters which eliminate interference outside the normal pass band of the "marks" and "spaces" audio tones. Modems for UMCS operate at a speed up to 9600 bps using V.42 error correction and V.42 bis data compression.

e. A line driver is a hardware device which supplies sufficient output power to transmit digital signals over miles with balanced lines, such as between field equipment panels. The line driver output is a low power output transistor. Optical isolators are used as protection devices in the line driver output. Line drivers for UMCS operate at 9600 bps.

4. 10 BASE-T. 10 Base-T is an ethernet physical star topology with a data transmission speed of 10 Mb/s, utilizing wirelines with a maximum segment length of 100 meters. The segment length can be extended to 150 meters when 10 Base-T transceivers are used. 10 Base-T hubs typically have up to 12 ports. They are stackable to provide expansion of the number of ports. 10 Base-T hubs are selected with ports for attachment to fiber optic or coaxial cable LANs, and connect to UMCS workstations or other computers through network interface cards.

5. COAXIAL CABLE.

a. Coaxial cable is used as a communication media in some central station or island station LANs. Its use is typically limited to within a single building because of its susceptibility to electromagnetic interference.

b. Thick coaxial cable (10 Base-5 ethernet cable) is a 0.4 inch diameter cable that requires transceivers at nodes and has a distance limitation of 500 meters. The ends of a thick coaxial cable LAN are terminated using N-series terminators. Thick coaxial cable ethernet LANs will support a maximum of 100 nodes per segment.

c. Thin coaxial cable (10 Base-2 ethernet cable) is a 0.2 inch diameter cable that does not require transceivers at nodes and has a distance limitation of 186 meters between nodes. The ends of a thin coaxial cable LAN are terminated using BNC terminators. Thin coaxial cable LANs support a maximum of 30 nodes per segment.

d. Coaxial cable shieldings are grounded at one end.

6. RADIO FREQUENCY (RF).

a. Modulated RF data transmission systems can be used for UMCS with the installation of radio receivers and transmitters (a combination receiver/transmitter is referred to as an RF transceiver). The data signal enters a transmitter terminal where it modulates the RF carrier wave. After traveling through through the communication media, the modulated RF carrier enters a receiver terminal where it is amplified and demodulated back into the original data signal. Modems must be provided at each receiver/transmitter location. Frequency modulation is used instead of amplitude modulation because it is not susceptible to amplitude related interference.

b. RF systems can be effectively used for two-way communication between the island station and field equipment panels where other communication media is not available or suitable for the application. One-way RF systems can be effectively used to control loads at remote locations such as for unitary heaters in warehouses and in family housing applications. The use of RF will be coordinated with the communications officer to avoid interference with other existing or planned facility RF systems.

7. PACKET RADIO.

a. Packet radio is a two-way data transmission method utilizing a protocol similar to the CCITT X.25 protocol used for packet data transmission over wirelines. Using this protocol, data can be transmitted either on a single frequency dedicated for data transmission or on existing voice channels (although not simultaneously with voice transmission). Networks can be established on a polling or report-by-exception basis, or a combination of both.

b. Equipment required at each communication node for a packet radio data transmission system include a packet modem and controller designed to be used with a radio, and an RF transceiver. The RF transceiver, packet modem and controller may be separate or may be integrated into a single device.

8. GOVERNMENT-FURNISHED DATA TRANSMISSION SYSTEMS. For large installations, a substantial portion of the cost of a UMCS is related to the physical installation of data transmission media (wirelines or fiber optics). Depending on the extent, condition and availability of government-owned communications infrastructure on an installation, the cost of the UMCS may be reduced through the use of government-furnished data transmission systems. Coordination with the communications officer is required to verify the reliability of the existing data transmission systems. The designer will determine and show in the design the characteristics and extent of government-furnished transmission systems as well as extensions, interfaces and equipment to be provided by the contractor to provide an operable system.

CHAPTER 11

EQUIPMENT MODIFICATIONS

1. MODIFICATION GUIDELINES. UMCS implementation requires modifications to mechanical and electrical systems and their associated instrumentation and controls. Interface to mechanical and electrical systems will require coordination with manufacturer's operating recommendations and site associated equipment/systems operating constraints.

2. INSTRUMENTATION AND CONTROLS. Existing local controls will be removed and replaced with the application of DDC. For supervisory control applications existing local control system equipment will be shown to include modifications required for interfacing with the UMCS. Except for existing time clocks, the existing local loop control system must remain and perform as originally designed for UMCS supervisory control applications. It will be necessary to indicate replacement of controllers to provide capability for remote control point adjustment. The local loop controls will be interfaced so they will operate in a predetermined manner upon UMCS failure. New sensors dedicated for UMCS use must be shown as new rather than reusing existing sensors. When interfacing the field equipment, all existing indicating devices such as gauges and thermometers will be shown as remaining in service for direct digital control applications. The local controller will be replaced but the existing final control element (valve/damper) will operate as originally designed.

3. LOCAL CONTROLLERS UNDER SUPERVISORY CONTROL.

a. Existing local control systems using sensor, controller, and actuator require a controller with CPA port for remote control point adjustment. This will necessitate the replacement of the existing controller without CPA by a new controller with CPA. The CPA will be reset from an analog output.

b. Single input CPA controller. Single input CPA controllers permit remote changing of control points by varying the CPA port value. CPA port value variation must be plus or minus 10 percent of primary sensor span. The controller must include an adjustable setpoint, adjustable gain (proportional band) with field selectable direct or reverse acting action. The controller inputs and outputs must have internal or external gauges for calibration of input and output signals.

c. Two input controllers. Two input controllers permit remote changing of control points by varying the second port input value. Effect of the secondary sensor on the setpoint is adjustable as a percentage of the secondary sensor span, usually 33 to 100 percent of primary sensor span. The controller must include an adjustable set point, adjustable gain (proportional band) with field selectable direct or reverse acting action. The controller inputs and outputs must have internal and external gauges for calibration of input and output signals.

4. CONTROLLER INTERFACES.

a. Typical controller interfaces are shown in Appendix B .

b. A two-position pneumatic override incorporates a three-way solenoid to switch the signal to a predetermined UMCS signal. The UMCS control signal value depends on the operation required and the equipment being controlled. The existing control signal will operate the device being controlled during field equipment panel failure. The UMCS control diagrams (Chapters 8 and 9) will define the failure mode. The electrical equivalent to the two position pneumatic override is accomplished with a relay with Form C contacts.

c. A three mode pneumatic override control incorporates two 3-way EP valves controlled from the field equipment panel electrical output. The operation of the solenoids allows either for the dampers to be under local control of the mixed air controller or for override to allow for 100 percent outside air supply or minimum outside air supply.

d. Transducers are used for changing pneumatic signals to electric signals and vice versa or for changing a current signal to a voltage signal. Transducers are used in conjunction with sensors and controllers. Electric to pneumatic transducers can be used to convert field equipment panel electrical output signals to pneumatic signal inputs to a local pneumatic control loop or to a pneumatic actuator. Pneumatic to electric transducers can be used to convert local loop pneumatic signals to electric signals inputs to the field equipment panel.

e. A local loop pneumatic controller must be retrofitted with a CPA port for supervisory control. The operation of a local loop 3 to 13 psi air signal on a CPA changes the setpoint plus or minus 10 percent (the percentage will vary depending on the manufacturer of the controller). The UMCS will drive a transducer to change the setpoint from the high to the low (or low to high) setting.

f. The designer will determine the failure mode of operation for each CPA point. In order to fail to high, low, or local loop control, main air is fed through a pressure reducing station to produce fixed pressure input to the three-way EP valve. A similar arrangement will use a Form C relay in lieu of a 3-way solenoid. If the required failure mode is to remain in the last command state, the 3-way EP valve or Form C relay is eliminated and the transducer (on UMCS failure) remains at the last command position.

g. The local electric controllers will have the same functions as the pneumatic controllers described above.

5. TIME CLOCKS. The implementation of UMCS time dependent control programs requires elimination of existing time clocks. The existing time clock start/stop contacts are replaced with start/stop contacts operated from the field equipment panel.

6. SINGLE LOOP DIGITAL CONTROLLERS. Existing single loop digital controllers may have to be replaced with controllers having an EIA 485 serial interface with adjustable data transmission rates up to 19.2 Kbps in order to interface with the UMCS. The controller will provide the UMCS with process values, setpoints, alarms and controller status (local-off-auto) and will allow the UMCS to perform remote controller setpoint adjustment.

7. INSTRUMENT AIR SUPPLY.

a. Existing instrument air supplies must be checked for water and oil contamination. If contamination is present the affected pneumatic lines must be replaced and tested prior to UMCS operation. All other devices in the local control loop that have been contaminated must be replaced.

b. The instrumentation air compressor must be oil free. Duplex air compressors are recommended.

c. The instrumentation air supply must have an air drier. Filtration must be provided before and after the air dryer.

d. Air filters must be installed with bypass and isolation valves to permit filter replacement without instrument air supply disruption.

e. Pressure switches must be installed for all major supply air branches to detect loss of air supply.

f. Air drying and filtration at buildings must be provided when instrument air enters a building from an outdoor distribution system.

g. The designer must evaluate the cost effectiveness of replacing a damaged instrumentation air system versus replacement of pneumatic control devices with electric devices (e.g. actuators, controllers).

8. ELECTRICAL EQUIPMENT.

a. Existing equipment being connected to the UMCS will require the installation of disconnect switches or locking starters within sight of the controlled equipment as required by NFPA 70.

b. Spare electrical circuits may be locally available to supply power to UMCS equipment. If these circuits do not exist, or are inadequate for the intended service, new panels or circuit breakers will be required.

9. SUBSTATIONS. Selection and installation of current and voltage transducers for UMCS must be coordinated with the facility and with the equipment manufacturer. Placement of transformer winding temperature sensors must also be coordinated with the manufacturer.

10. SWITCHGEAR. UMCS can monitor the status of electrical distribution switchgear equipment such as:

a. Circuit breakers.

b. Breaker over current trip relays.

c. Tie breaker.

If there are no spare contacts in the switchgear monitoring relays, interposing relays must be provided. Interposing relay kits must be obtained from the original breaker manufacturer. The UMCS will not perform switchgear control functions. These functions may be provided by a Supervisory Control and Data Acquisition (SCADA) system.

11. EMERGENCY GENERATOR. The remote start/stop of emergency generators must be coordinated and reviewed with the installation electrical engineer and with the generator manufacturer. The UMCS will monitor generator status and common alarms either from available contacts at the generator control panel or by means of interposing relays in series with existing control panel status and alarm indicating lights. Generator main fuel storage and day tank level sensors may have to be replaced for the measurements to be monitored by UMCS.

12. MOTOR STARTERS. Starter control circuits must be modified for UMCS interfacing. Typically, existing momentary type starters require parallel starting contacts and series stop contacts, while starters with on/off and hand-off-auto (HOA) switches will require maintained contacts in series with the local automatic control device. Start/stop switches will be replaced with HOA switches. New starter control circuits interfaced with a UMCS for controlling equipment from the UMCS are shown in Appendix B. Since a push-button control circuit requires magnetically operated contacts for momentary operation, latching relays cannot be used. During field equipment panel failure, the controlled equipment remains in the last commanded state. No definitive failure mode can be designed with push-button control circuits. The HOA and start-stop selector control circuits allow magnetically held relays or latching relays to be used for contact operation, depending on the required failure mode. Latching relays will be used when the design requires equipment to remain in the last commanded state during a field equipment panel failure. Magnetically held, normally open relays will be used when the required failure mode is off (or an open circuit), and magnetically held, normally closed relays will be used when the required failure mode is on (or a closed circuit). The design requires definition of the failure mode during a field equipment panel failure for all types of starter circuits. Magnetically held or latching relays will be selected to provide the required failure mode operation. A magnetically held relay requires one DO to control it, while a latching relay requires two DOs to control it.

13. MECHANICAL EQUIPMENT.

a. Piping systems which require addition of flow measuring devices will have pump characteristics verified to determine that any additional pressure drops will not affect the system performance.

b. New valves required to implement UMCS application programs will include installation of any isolation valves needed to provide for valve maintenance and service. Valves for UMCS include chilled water valves, hot water valves, and steam valves. Two position valves installed in steam lines will be provided with bypass lines or other means to keep sufficient heat in the piping to prevent thermal shock when the valves are reopened. Operators installed on steam line valves will have the capability for manual operation, such as a handwheel. Pumps will be added and piping modified to zone particular areas for night setback and summer-winter operation, depending on the site specific requirements. For example, domestic hot water pumps would continue to operate during the summer while space heating pumps would be shutdown.

14. CHILLERS.

a. Chiller enable/disable and multiple chiller selection by UMCS must be coordinated with the installation following the chiller manufacturer's guidelines and system specific operating constraints.

b. The implementation of UMCS applications such as chiller water temperature reset and condenser water temperature reset require interfacing with existing controllers which may need to be replaced to provide the CPA function.

c. Monitoring of chiller operating parameters can be accomplished either by interfacing with an existing control panel (via a communication interface or a hardwired interface) or by adding specific UMCS sensors (such as refrigerant pressures). The sensor selection will be made after consulting with the chiller manufacturer. In some cases it may be more practical to install a new chiller control panel provided by the chiller manufacturer than to install UMCS specific sensors.

d. All chiller installations must have refrigerant-specific leak detection monitoring systems that also provide local and visual indication and alarm. The UMCS designer must coordinate with the installation in the selection of the appropriate leak detection system taking into consideration planned phasing out of existing refrigerants and their replacement.

15. BOILERS.

a. Boiler enable/disable (either automatic or manual based on UMCS program outputs) and multiple boiler selection must be coordinated with the installation for the specific needs of the boiler installation and safety codes. Some installations will not allow remote start of boilers.

b. Control of boiler bypass control valves must be coordinated with the boiler manufacturer for reduced flow operation limits.

c. Monitoring of boiler operating parameters can be accomplished by either interfacing with an existing control panel or by adding interposing relays in series with existing boiler monitoring panel annunciator lights for common or specific alarm conditions.

d. Selection and installation of boiler specific flue gas analytical instrumentation must be coordinated with the boiler manufacturer.

16. HVAC.

a. Air handling systems to which the economizer program is applicable must have 100 percent OA intake and relief air capabilities. New OA intakes will be provided for systems which do not have the capability to handle the 100 percent OA flow. New return and relief air fans will also be required to pull the air back from occupied spaces. The cost of HVAC equipment modifications will be compared with the cost savings from the economizer program to determine if the economizer program is cost effective.

b. New HVAC systems may be needed to separate a continuously operating area from an area requiring night setback capability.

c. VAV boxes installed in air distribution ductwork modulate air flow to conditioned spaces, through positioning of an air valve or damper, to control space temperature. In addition to air flow modulation, VAV boxes may include reheat coils and induction fans. Stand-alone VAV boxes are generally equipped with pneumatic or electronic controllers which are interfaced to pneumatic space thermostats or electronic space temperature sensors. If the stand-alone VAV box controls are in poor operating condition, replacement of the controls with box-mounted unitary controllers interfaced to electronic space temperature sensors may provide cost savings and operational benefits. The unitary controllers would be networked together and interfaced to a smart field panel, allowing centralized monitoring, alarm reporting, and setpoint adjustment through the UMCS. The designer will include in the design drawings the location of each new unitary controller and associated temperature sensor. For projects requiring the replacement or addition of VAV boxes, it is often less costly to have the unitary controllers furnished by the UMCS supplier and mounted to the VAV boxes at the VAV box supplier's factory, rather than install the unitary controllers at the construction site.

17. NEW BUILDING PREPARATION. New buildings which must be prepared for UMCS will be designed following current guidelines. The guidelines shall be verified for the following requirements:

a. Installation of UMCS sensors, including wiring from these sensors to a data terminal cabinet.

b. Provision of HOA switches at equipment electrical starters for future UMCS start/stop interface through the auto switch position. HOA switches will be provided with auxiliary contacts for UMCS monitoring.

c. Provision of auxiliary contacts for monitoring of equipment status and common alarm contacts from local control panels.

CHAPTER 12

PROJECT IMPLEMENTATION

1. SEQUENCE OF EVENTS.

a. The sequence of events necessary to implement a UMCS is described, but will vary depending on the project complexity and scheduling.

b. The sequence of events is divided into several categories.

(1) Viability Survey.

(2) Information collection.

(3) Buildings and systems selection.

(4) Design kickoff meeting.

(5) Design survey.

(6) UMCS design.

(7) Savings calculation.

(8) Cost Estimates.

(9) DD form 1391 validation.

(10) Preparation of contract documents.

2. VIABILITY SURVEY. The using facility is responsible for the initial list of buildings and systems to be considered as candidates for inclusion in a UMCS. Site specific experience and available utility records are used in determining which buildings and systems offer the largest potential energy savings. This initial investigation determines which of the buildings are included as candidates in the project, based on current guidelines relating to payback period, energy saved per dollar of investment, and other factors. A viability survey is performed to confirm the applicability of the candidate buildings for UMCS. This viability survey is performed in sufficient detail for preparation of a DD form 1391 and supporting documentation or other funding documents, as appropriate. Specific requirements for performing the viability survey are at Appendix C.

3. INFORMATION COLLECTION FOR DESIGN. A necessary task in the implementation of a UMCS is to retrieve pertinent information related to the buildings and systems which are candidates for inclusion in the project. The information to be retrieved includes the following:

a. As-built design and/or shop record drawings for the buildings and systems preselected by the facility engineer. The record drawings will be verified by comparing them to actual conditions in the field during the design survey.

b. Equipment lists and schedules as a source in identifying large energy users. Equipment lists for the various buildings and systems may be available, separate from the as-built record drawings. All equipment considered for inclusion in the UMCS will be field checked during the design survey to ensure that the equipment is still being used.

c. Utility records that provide energy consumption and cost data. Large energy users can be identified if records are available for separate areas of the facility, individual buildings, or systems.

d. Buildings or systems which are scheduled for shutdown or demolition will be identified by the site facility engineer and will not be included in the project.

e. Occupancy schedules for buildings and individual areas within buildings, and equipment operating schedules. These schedules provide information which will be used in design, and will aid in identifying operating changes resulting in energy savings.

f. Building data and details of wall sections will be used to calculate the building heat loss and heat gain.

g. Data communication media type, routing, installation costs, site specific conditions, maintenance costs, and use will be coordinated with the facility communications office.

4. BUILDINGS AND SYSTEMS SELECTION.

a. Selection of buildings and systems is required for confirmation of energy savings to be included in the validation of the DD form 1391 or other funding documentation.

b. The list of selected buildings should include those buildings and systems which have appropriate savings from energy, labor, or cost avoidance.

c. Buildings will be subdivided to identify quantities and types of systems with their associated occupancy schedules, equipment operating schedules, and other required operating parameters. A detailed survey is required to verify all information retrieved.

d. Hospitals will be carefully evaluated prior to inclusion into a UMCS. Functions such as demand limiting may not be possible for building systems in the hospital environment.

5. DESIGN SURVEY. Specific requirements for performing the design survey are at Appendix D.

a. One of the first activities which will take place is a design kickoff meeting with the following personnel in attendance. This design kickoff meeting will cover the scope of the project, expected problem areas, scheduling of survey and other work required at the site, and identification of all organizations to be contacted during the design process.

(1) Government design representative.

(2) Architect-engineer design representative (where applicable).

(3) Facility engineer representative.

(4) Communications office.

(5) Operations personnel (including future UMCS operators).

b. The design survey will include the following tasks:

(1) Verify information retrieved.

(2) Determine buildings and system operating schedules.

(3) Identify any equipment not documented.

(4) Record equipment nameplate data.

(5) Determine the location of the Central Station and Island Station.

(6) Determine need for intercommunications between UMCS field equipment panel locations and Central Station/Island Station.

(7) Identify potential locations for field equipment panels, power line conditioners, and data transmission equipment.

(8) Determine routing of data transmission cables.

(9) Locate and identify sources of power for UMCS equipment.

(10) Perform a preliminary selection of applications programs.

(11) Identify standard details for the installation of UMCS instrumentation and control devices, and prepare sketches of any unique situations.

(12) Identify standard details for the installation of mechanical and electrical modifications, and prepare sketches of any unique situations.

(13) Determine the location of utility meters and UMCS interface requirements.

c. Detailed information will be gathered and tabulated during the survey. The principal items are:

(1) Method of operation and schedule for each item of equipment.

(2) Occupancy schedule for each area/zone the equipment serves.

(3) Sources and type of heating for each building.

(4) Sources and type of cooling for each building.

(5) Data necessary to calculate heat loss of each building.

(6) Data necessary to calculate heat gain of each building.

(7) Type and horsepower of air handling equipment.

(8) Size and type of outside air, return air, and relief dampers.

(9) Number and physical location of zones served by each air handling unit.

(10) Number, type, horsepower, and locations of mechanical equipment, such as pumps and motors.

(11) Location, type, and sequence of existing controls for each system.

(12) Location and type of existing starters for each piece of equipment.

(13) Location and type of existing local loop controllers.

(14) Location and type of available electric power for UMCS.

(15) Repair and replacement of existing devices, such as local loop controllers, and inoperable devices.

d. Survey sheets. Survey sheets included in Appendix D, or similar survey sheets will be used to collect the necessary information for calculating savings and costs to implement a UMCS.

6. APPLICATIONS PROGRAM SELECTION. Applications programs will be selected for each system from the survey data. A summary of applications programs discussed in Chapter 7 that can be applied to mechanical and electrical systems can be seen in Table 12-1 at the end of this chapter.

a. Other applications to be considered for specific systems include the following:

(1) Heating/Cooling operation monitoring.

(2) Variable air volume control.

(3) Air distribution terminal unit control.

(4) Hot water distribution.

(5) Domestic hot water generator control.

(6) Site water distribution.

(7) Lighting control.

(8) Water treatment system monitoring.

(9) Sewage system control.

(10) Cold/Ice storage systems control.

(11) Heating recovery boiler efficiency monitoring.

(12) Gas turbine generator efficiency monitoring.

(13) Cogeneration unit efficiency monitoring.

7. REPAIR AND REPLACEMENT (EXISTING EQUIPMENT). Equipment and accessories required to provide building environmental conditions or process support must be in good operating condition. During UMCS operation, existing local loop control equipment (for supervisory control implementation) and actuators must be operational in order for the UMCS to perform its necessary functions. Furthermore, during UMCS failure, the existing local loop controls must continue to function (for supervisory control). The existing control devices that must be repaired or replaced as determined by visual inspection and operational check will be noted during the survey. The cost to perform this work will be estimated for each building for future use in determining budget contingencies and operating and maintenance budget requirements.

8. IDENTIFICATION OF EQUIPMENT MODIFICATIONS.

a. The implementation of UMCS requires mechanical and electrical equipment modifications. The modifications will be identified during the survey in sufficient detail to estimate their cost.

b. The cost of the mechanical and electrical modifications required for each building will be determined and used in preparing the cost estimate.

9. I/O POINT SELECTION ESTIMATE. The control diagrams for each system described in chapters 8 and 9 provide the starting point from which to determine the required number of points for each system. The number of I/O points, and associated UMCS instrumentation and controls costs for each system, will be identified and used in preparing the cost estimate.

10. SYSTEM CONFIGURATION.

a. The total number of I/O points estimated for all systems establishes a starting point for determining the relative size of the UMCS. System hardware configuration will follow the guidelines established in Chapters 3 and 4. The number of field equipment panels will be determined by:

(1) The number of I/O points per system.

(2) The maximum number of I/O points per field equipment panel.

b. User requirements will be evaluated to determine the need for Central/Island Station backup operation or the need for operator workstations in multiple locations. The final system configuration to be documented in the contract drawings and specifications will be determined as part of the design process.

c. Once the configuration of the UMCS has been established, the location of the Central Station and Island Stations will be determined. The location of the Central Station and Island Stations is influenced by the location of the physical plant operating personnel, availability of communication media, available space and power, and future applications. The Central Station and Island Stations will not be located in close proximity to large electrical loads, rotating machinery or other sources of vibration, or in dirty air environments.

d. After the locations of the Central Station and Island Stations have been established, the placement and minimum required quantity of field equipment panels and the data transmission system requirements and routing will be determined.

11. DATA COMMUNICATION CONSIDERATIONS. The data transmission equipment selection and communication media layout will be coordinated with the communications office for review and comments in accordance with the guidelines described in Chapter 10. The data transmission system configuration will be clearly defined in the contract documents. Data transmission system installation and maintenance costs, coordinated with the communications office, will be used in preparing the cost estimate. The selection of the data transmission system will be based on a life-cycle cost analysis of data transmission system types using current cost data for their installation and maintenance. The topology of the data transmission system and the detailed layout will be based on the guidelines presented in Chapter 10.

12. INTERCOMMUNICATIONS. The designer will determine whether the facility operating personnel require an intercommunication system in conjunction with the UMCS. Hand held FM transceivers may, in many cases, be used as an intercom system. An intercommunication system will require a dedicated pair of wirelines or optical fibers from the Central Station/Island Station to each intercom station in addition to all other communication media. It may also require the multiplexing of audio communications onto the UMCS communication media.

13. FIELD HARDWARE LOCATION. The location of field equipment panels will be determined in accordance with the following guidelines:

a. Field equipment panel locations will be outside the equipment rooms, where practicable, and selected such that the ambient conditions are between 50 degrees F and 90 degrees F and 10 to 85 percent relative humidity. Field equipment panels located in areas exceeding these ranges will have enclosures with heating or cooling devices to provide the proper environmental conditions.

b. Field equipment panels will be located within close proximity to equipment rooms in order to minimize field wiring.

14. EQUIPMENT MODIFICATIONS.

a. Implementation of UMCS in existing facilities requires that modifications to the mechanical and electrical equipment (including controls and instrumentation) be shown in accordance with the requirements of Chapter 11. Sketches made during the design survey will identify the following items:

(1) Ductwork additions or changes.

(2) Piping additions or changes.

(3) Additional fans or pumps, as required.

(4) Disconnect switches.

(5) Electric service changes or new service requirements.

(6) Locations of new sensing lines, thermowells, and other instrumentation.

(7) Starter control stations.

b. Field data will be detailed enough to be used for the cost estimate, as well as for preparation of design and contract documents for those buildings and systems selected for UMCS. The field data will identify existing equipment that will remain, be removed, or replaced with new equipment.

15. ENERGY SAVINGS.

a. Using the applications programs selected for each system, calculations will be performed to obtain the difference between present energy consumption and future energy consumption.

b. The method of calculating energy savings for each application program will be in accordance with current guidelines.

c. The energy savings will be converted to equivalent MBTUs (MJoules) for use in the economic analysis.

d. Energy savings for the applications programs selected for each system will be entered in Table 12-2 at the end of this chapter.

e. Electrical demand savings will be calculated in accordance with current guidelines and entered in Table 12-2 at the end of this chapter.

16. COST AVOIDANCE. Undetected failure of equipment and systems often results in significant cost to an installation. Examples include the cost of food spoilage following an undetected failure of a refrigerated storage locker, excessive water and sewer utility costs following the undetected rupture of a water distribution main, or the cost of repairing water and other damage to an unoccupied building following failure of its freeze-protection heating systems. Some UMCS functions can result in cost avoidance by providing rapid detection of equipment failures or other abnormal conditions. The expected value of cost avoidance is site-specific and will be reviewed with the installation. UMCS applications which should be evaluated for cost avoidance benefits include the following. Cost avoidance savings will be entered in Table 12-2 at the end of this chapter.

a. Monitoring cold storage warehouses

b. Monitoring refrigeration units.

c. Monitoring water distribution systems.

d. Monitoring electrical systems.

e. Monitoring fuel tanks.

f. Monitoring waste oil tanks.

g. Monitoring air compressors.

h. Monitoring water storage tank levels.

i. Monitoring sewage lift stations.

j. Monitoring building temperatures.

17. COST SAVINGS. Many facilities and their mechanical/electrical systems and utility operations require periodic operational adjustments, recording of data or verification of status. The labor costs associated with these operations, if performed manually, can be significant. Examples include seasonal HVAC system changeover, electric, gas or water meter reading, and equipment status checks. Some UMCS functions can result in labor cost savings by automating the operational adjustments, data recording or status verification. The expected value of labor cost savings is site-specific and will be reviewed with the installation. UMCS applications which should be evaluated for labor cost savings include the following. Cost savings will be entered in Table 12-2 at the end of this chapter.

a. Monitoring HVAC system filters.

b. Monitoring fuel oil tank levels.

c. Monitoring chiller or cooling tower vibration switches.

d. Monitoring building alarms.

e. Providing heating-cooling operation switch over.

f. Monitoring utility consumption and demand.

18. COST ESTIMATES. The cost estimate necessary to prepare an economic analysis can proceed after the designer has completed information collection and the design survey, identified the data transmission system type to be used, located the Central Station/Island Stations, identified equipment modifications, selected applications programs, compiled I/O point estimates, and arrived at a UMCS configuration. The cost estimate will be summarized in Table 12-3 at the end of this chapter..

19. ECONOMIC ANALYSIS. The economic analysis will be performed for validation of the DD form 1391. The following tasks will be performed for each system in each building to develop the data required in Table 12-4 at the end of this chapter for the entire UMCS:

a. Identification of fixed costs common to all building is based on the UMCS configuration. The fixed costs include all the Central Station and Island Station equipment; field hardware, operating system and command software; applications software; Central Station/Island Station construction (when applicable); training; documentation; and maintenance and service (for the first year). The UMCS fixed costs will be entered in Table 12-4 at the end of this chapter.

b. Identification of the fixed costs in each building: field equipment panel and data transmission system installation costs, and associated maintenance and service costs for the first year. These items will be entered in Table 12-4 at the end of this chapter.

c. Identification of maintenance costs for UMCS related equipment provided as part of the project. The costs for each building will be entered in Table 12-4 for use in determining the savings to investment ratio (SIR).

d. Identification of the following first costs for each system in each building: I/O point functions hardware, instrumentation and controls, modifications of existing mechanical and electrical equipment, and the associated maintenance costs for the first year.

e. Determination of the building or system ranking will be based on current guidelines (i.e., ranking based on SIR) for the source of funding used for the project.

f. Determination of the project SIR or other payback requirements will be based on current guidelines. If the entire UMCS does not meet these guidelines, buildings or systems with the lowest ratios will be deleted. There may also be special cases where certain buildings are added to the UMCS even though the ratios are below acceptable levels. In either case, a new determination based on the revised project configuration will then be made to verify conformance with current guidelines. This may result in revisions to the DD form 1391 reflecting changes to the project cost or scope.

20. DD FORM 1391 VALIDATION. The list of buildings and systems selected during the UMCS design survey will be used by the designer to validate or amend the DD form 1391. The preliminary selection of buildings for inclusion in an UMCS in the preparation of the DD form 1391 has been based on energy and economic analysis for all systems in a building. The final design selection of systems for inclusion in UMCS will be based on an analysis for individual systems within a building. Contract documents prepared by the designer will be based on the buildings and systems included in the validated or amended DD form 1391. A written description of changes to the scope or cost of the project will be required in order to revise the DD form 1391 for final submittal.

21. CENTRAL STATION AND ISLAND STATIONS.

a. The Central Station and Island Station rooms will have sufficient space to accommodate the UMCS computers, peripherals, associated equipment and accessories. All free standing equipment will have at least 36 inches front and rear clearance for maintenance purposes. Figure 12-1 at the end of this chapter illustrates a typical Central Station or Island Station layout. The final room size, architectural, and structural requirements will be tailored to the quantity and type of equipment to be specified in the final design. Central stations and/or Island Stations may benefit from raised floors for UMCS wiring distribution.

b. The electrical power service will be designed to furnish sufficient capacity to handle all the UMCS equipment, including any additional air conditioning and lighting. An uninterruptible power supply will be required for all Central Station and Island Station UMCS equipment in accordance with the requirements of Chapter 2. A typical Central Station electrical single line diagram is shown in Figure 12-2 at the end of this chapter.

c. Lighting design including size and placement of windows will be carefully planned. The Central Station or Island Station equipment room will have a lighting level of approximately 50 footcandles with task lighting as required. Lighting design shall consider and plan for elimination of workstation monitor screen glare problems.

d. The HVAC system for the Central Station/Island Station equipment room will be designed to provide year round occupied and unoccupied environmental conditions of 68 to 78 degrees F, 30 to 60 percent relative humidity. The sizing of the HVAC equipment will be based on the number of occupants, lighting load, and heat rejection of the UMCS equipment. The designer will consider use of an independent HVAC system if the Central/Island Station equipment room requires 24 hour occupancy and the building in which it is located does not.

22. INSTRUMENTATION AND CONTROLS.

a. When sensors are to be located outdoors, suitable instrument shelters or sun shields will be used, as applicable, to protect against wind, rain, solar effects, and radiation from nearby structures. For installations in the northern hemisphere, mounting of sun shields on the southerly exposure of a building will be avoided.

b. Current sensing relays may be used for motor status feedback, where constant motor running horsepower allows the relay to be set for approximately fifty percent of full load. Current transducers will be used for variable speed or variable load motor status feedback, and may be applied to other large loads where precise energy consumption measurements are required.

c. Switches for UMCS use will have the following characteristics and be applied as follows:

(1) Differential pressure switches may be used for monitoring and alarming air filter loading on constant volume air systems. Differential pressure sensors will be considered for variable volume air systems.

(2) Pressure switches must have adjustable settings, and be selected to have the switch setting in the middle half of the device's range.

(3) Temperature switches meeting the accuracy requirements may be used in lieu of temperature sensors where an analog readout is not required.

d. Selection of flow sensors will include consideration of accuracy, rangeability, and physical installation requirements. The designer will perform the appropriate calculations as described in TM 5-815-3, HVAC Control Systems. Flow sensors will be applied as follows:

(1) The required accuracy of a measurement will be determined based on the intended use of the flow information by the UMCS. Flow measurement of compressible fluids such as steam will be compensated by temperature and pressure measurements when high accuracy is required.

(2) Rangeability is the ratio of the maximum to minimum flows over which the flow sensor maintains the specific accuracy. The required rangeability of a flow sensor will be determined based on the anticipated variations in process flow conditions, such as seasonal variations in steam and chilled water flow.

(3) The physical installation of liquid flow sensors requires minimum straight runs of pipe both upstream and downstream of the sensor, which vary depending on the specific sensor type and whether or not straightening vanes are installed. The designer will consider these requirements in the selection and location of flow sensors. In general, the longest straight run of pipe available will be selected, with consideration of maintenance access and clearance requirements for hot-tap tools (where applicable).

(4) There may be a significant pressure drop across head type flow sensors (orifices, flow nozzles, venturi tubes) and volumetric displacement type flow sensors. The designer will consider the impact of flow sensor pressure drop on system operation. Detailed application and installation requirements for the use of head-type primary flow measuring devices, and the secondary measuring elements (differential pressure transmitter), are described in the ASME publication "Fluid Meters, Their Theory and Application".

(5) Turbine flow sensors provide excellent accuracy and rangeability and will be considered for clean chilled water and hot water flow measurements. However, turbine meter heads are susceptible to damage from suspended solids in dirty liquids or from slugs of condensate in steam systems. Insertion turbine flow sensors are installed using hot-tap methods without shutting down the process system.

(6) Vortex shedding flow meters provide excellent accuracy and rangeability and will be considered for steam flow measurements. Insertion vortex shedding flow sensors are installed using hot-tap methods without shutting down the process system.

(7) Annular pitot tube flow sensors provide good accuracy and will be considered for chilled water, hot water and steam measurements not requiring the accuracy and rangeability of a turbine or vortex shedding flow sensor. Insertion annular pitot tube flow sensors are installed using hot-tap methods without shutting down the process system.

(8) Positive displacement flow sensors will be considered for domestic water, fuel oil, and pumped condensate flow measurements.

(9) The physical installation of air flow sensors requires minimum straight runs of duct similar to the requirements for liquid flow sensors. In existing duct installations where the required straight runs can not be maintained, installation of air flow measurement stations in the fan inlet will be considered.

e. Metering on the incoming electric service requires a set of pulsing contacts for consumption and demand measurements. Whenever local metering for individual buildings or selected equipment is required, current and potential transformers connected to watt transducers, or meters with pulse contacts, will be installed at each location.

f. UMCS control devices, including relays, transducers, and electropneumatic devices will be applied as described in Chapter 5.

23. WIRING REQUIREMENTS.

a. All wiring will be in accordance with TM5-811-2, Electrical Design, Interior Electrical Systems. Low voltage wiring in mechanical rooms and plenums and where exposed to physical damage will be in conduit for protection against physical damage. Low voltage wiring in concealed spaces other than plenums, where it is not subject to physical damage, does not have to be run in conduit where permitted by installation criteria.

b. Electrical disconnect means for UMCS controlled devices as required by NFPA 70 will be provided when there is not a disconnect within sight of the device location.

c. All existing safety interlocks will remain in place.

24. TRANSIENT PROTECTION.

a. The UMCS electrical power supply, data transmission system, and input/output functions must be protected against transients as described in Chapter 2.

25. DRAWINGS. The drawings for a complete UMCS design will include all the requirements in the A/E scope of services. The drawings must include the following:

a. Alterations or additions required to create the Central Station/Island Station equipment room and provide the proper environmental conditions. A physical layout of the Central Station/Island Station equipment room is required, showing the UMCS computers, workstations, peripherals, accessories, and storage space. Power sources, uninterruptible power supply, HVAC, lighting, and fire protection will be shown in detail.

b. System configuration block diagram for the selected UMCS showing all Central Station equipment , Island Station equipment and field equipment panels.

c. Installation drawings for Central Station equipment, Island Station equipment, and field equipment.

d. Data transmission system configuration. Each data transmission circuit will be clearly shown. The A/E will include details for each of the installation methods and locations, both indoors and outdoors.

e. Site-specific control and monitoring schematic diagrams for each type of system being connected to the UMCS with all sensor locations identified. Existing control devices being reused or replaced will be shown as existing devices.

f. UMCS interface control diagrams showing all interface devices such as relays, controllers, and sensors between existing equipment and new UMCS field equipment.

g. The sequence of operation (including any necessary interlocks), database tables, building layout, and control schematic diagrams for each system to be interfaced to UMCS.

h. Floor plans for each building showing the location of all UMCS equipment, mechanical and electrical systems, instruments, and controls. The mechanical/electrical systems will be shown in sufficient detail to make the equipment arrangement clear. Sources of electrical power will be shown and noted as existing or new. Location of existing controls will be shown, including any item to be altered or replaced. The location of field equipment panels and data transmission cable terminations will be shown.

i. Equipment data, operating schedules and expected operating ranges.

j. Database tables with parameters such as the heating/cooling, occupied/unoccupied operating and alarm setpoints, and all other parameters required for the contractor to complete the entry of data.

k. For flow and BTU calculations, system operating pressure, maximum and minimum temperatures and flows, maximum allowable pressure drop for sensor elements, location of sensors, and size of existing piping.

l. Building occupancy and equipment start-stop times including heating and cooling switch over schedules.

m. Details for mounting each type of sensing and control device by the specific icon used. Temperature sensors in ducts will be shown with the sensitive portion of the element installed in the center of the duct cross section or located to sense the average temperature. Where necessary for installation or service, access doors will be provided. Room sensors will be shown securely mounted to the wall as shown in the applicable installation detail. Where located on exterior walls or walls adjacent to unheated spaces, 1/4 inch insulating blocks will be shown. OA sensors will be shown suitably shielded. Care will be taken to avoid locating OA sensors near exhaust or relief openings. Temperature sensors in small diameter pipes will be mounted in piping elbows so that the entire element is in the normal fluid flow. Stand off tees will not be used. Where sensor wells restrict fluid flow significantly, pipe sizes will be increased to avoid restriction. Wells will be located where there is flow during all cycles of equipment operation. Pressure sensing elements in pipes and pressure vessels will include pulsation dampeners and siphons if required to protect the sensor from pulsations or extreme temperatures.

n. Required modifications to the existing mechanical and electrical equipment for implementing the various programs (i.e. installation of disconnecting means, contactors, ductwork, piping, fan, pumps, and controllers). Sensors installed on insulated pipes or ducts will accommodate the additional insulating material thickness.

o. Identifications for each system or system component requiring nameplate or equipment tags to be furnished by the UMCS contractor.

p. Routing of data transmission cables.

26. SPECIFICATIONS. The specifications required for a complete UMCS design will include CEGS 16935, all other appropriate CEGSs, and all requirements in the A/E Scope of Work.

27. CONSTRUCTION PERIOD. A typical UMCS construction period requires completion of numerous interdependent activities including meetings, submittals, equipment installation and testing. The timely

completion of the project requires that the contractor have sufficient technical UMCS personnel to complete the tasks within the designated schedule and that the Government perform its functions in a timely manner. The length of a construction period for a typical UMCS from notice to proceed to system acceptance is estimated to be: 320 days (base effort) plus (0.18 calendar days times the number of points) plus (1.75 calendar days times the number of smart field panels).

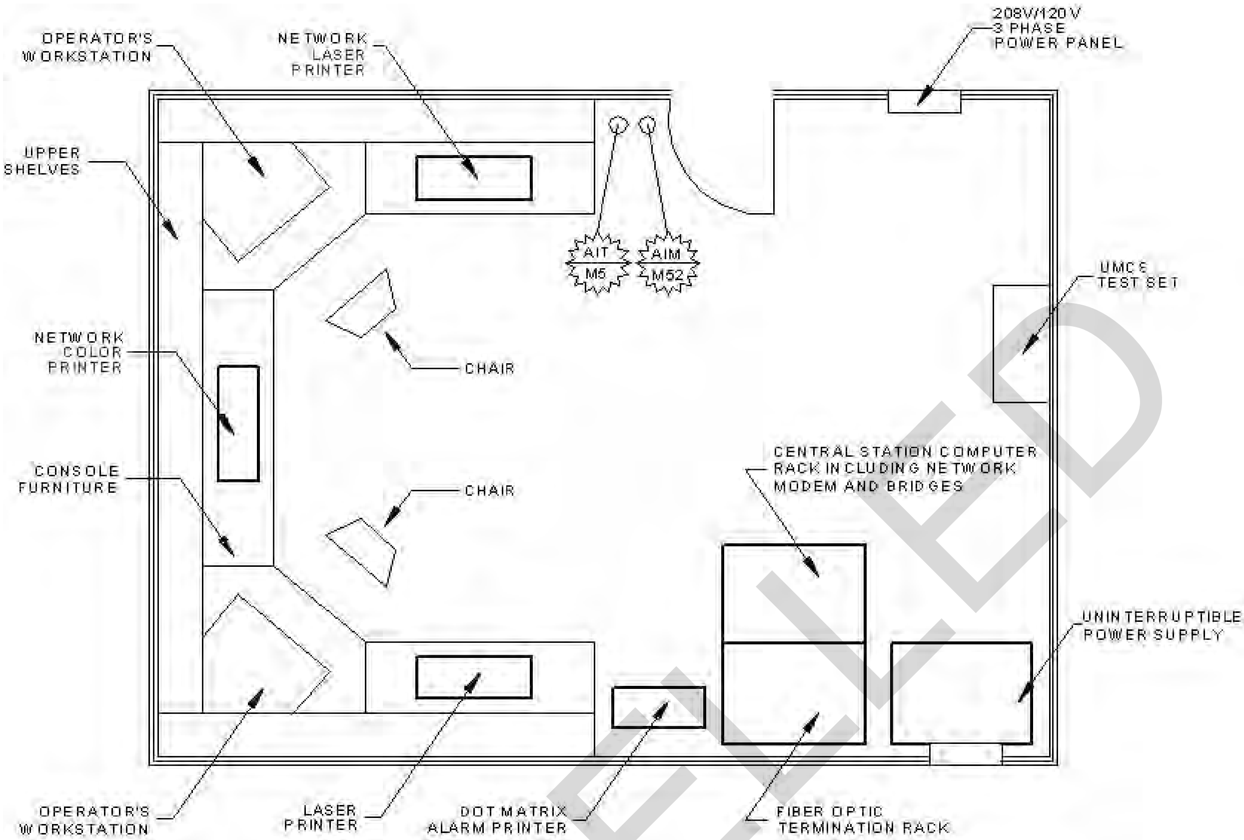


Figure 12-1. Typical Central Station or Island Station Equipment Room.

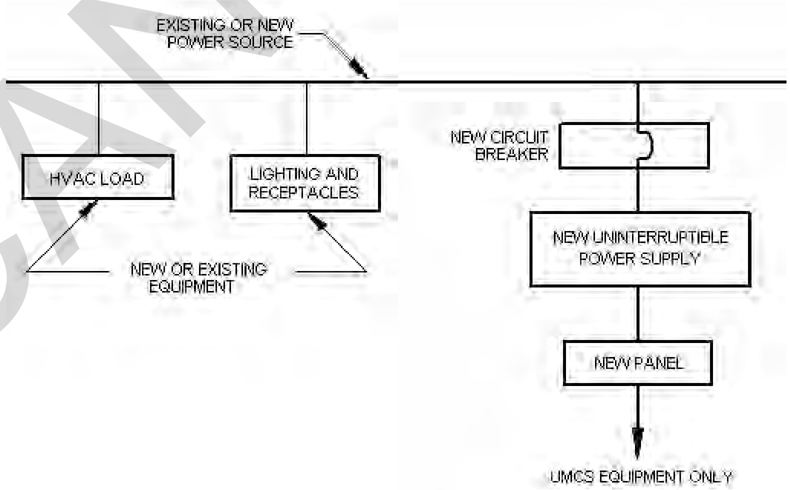


Figure 12-2. Typical Electrical Single-Line Diagram.

Table 12-1. Summary of Applications Programs.

HVAC SYSTEM TYPE	Scheduled Start/Stop	Optimum Start/Stop	Economizer	Ventilation/Recirculation	Hot Deck/Cold Deck Temp Reset	Reheat Coil Reset	Steam Boiler Selection	Hot Water Boiler Selection	Boiler Monitoring & Control	Chiller Selection	Chilled Water Temp Reset	Condenser Water Temp Reset	Hot Water OA Reset	Demand Limiting
1. Single Zone AHU	X	X	X	X										X
2. Terminal Reheat AHU	X	X	X	X		X								X
3. Variable Volume AHU	X	X	X	X										X
4. Multi-Zone AHU	X	X	X	X	X									X
5. Single Zone DX-A/C	X	X	X	X										X
6. Multi-Zone DX-A/C	X	X	X		X									X
7. Two Pipe Fan Coil Unit	X	X												X
8. Four Pipe Fan Coil Unit	X	X												X
9. Heating Ventilating Unit	X	X												X
10. Steam Unit Heater														
11. Electric Unit Heater	X	X												X
12. Electric Radiation	X	X												X
13. Hot Water Radiation	X	X												
14. Steam Boiler							X		X					
15. Hot Water Boiler								X	X				X	
16. Direct Fired Furnace	X	X		X										
17. Direct Fired Boiler	X	X		X										
18. Steam/HW Converter	X	X											X	
19. HTHW/HW Converter	X	X											X	X
20. Water-Cooled DX Compressor	X	X										X		X
21. Air-Cooled DX Compressor	X	X												X
22. Air-Cooled Chiller	X	X								X	X			X
23. Water-Cooled Chiller										X	X	X		X
24. Domestic HW Oil/Gas	X													
25. Domestic HW Electric	X													X

Table 12-2. UMCS Savings by Building.

Unit Costs	
Kwh	
Kw	
Steam per 1000#	
Fuel Oil	
Natural Gas	
Cost Savings	

UMCS SAVINGS BY BUILDING

Building Number	Electrical Savings in		Demand Savings in		Steam Savings in		Fuel Oil Savings in		Natural Gas Savings in		Cost Avoidance in	Cost Savings in		Total Savings in	
	Kwh	Dollars	Kw	Dollars	1000#	Dollars	Gallons	Dollars	1000 Cu Ft	Dollars	Dollars	Hours	Dollars	Dollars	MBTUH
TOTALS															

Table 12-3. Cost Estimate Summary by Building.

PRELIMINARY COST ESTIMATE SUMMARY BY BUILDING									
Building Number	Building Area (Square Feet)	Field Equipment Panels	Digital Outputs (DO)	Analog Outputs (AO)	Digital Inputs (DI)	Analog Inputs (AI)	Utility System Modifications	Data Transmission System	Common Costs	Total Cost
TOTALS									

Table 12-4. Systems Summary Economic Analysis Worksheet.

UTILITY MONITORING AND CONTROL SYSTEM (UMCS)
SUMMARY ECONOMIC ANALYSIS WORKSHEET

		Savings		First Costs					Priority		Recurring Costs		
											Maintenance		Rental
Building Number	Number of Points	MBTUH	Dollars	UMCS Hardware	Utility System Modification	Data Transmission System	Common Costs	Building Total Cost	SIR	Rank	UMCS	Data Transmission System	Data Transmission System
TOTALS													

CHAPTER 13

EXPANSION AND UPGRADE OF EXISTING EMCS

1. UPGRADE GUIDELINES.

a. An existing EMCS can be upgraded to state-of-the-art UMCS to provide additional operational benefits of current technology.

b. Existing EMCS sensors and controls may be reused as part of the system upgrade if they utilize standard instrumentation signals (4-20 mAdc, for example) and are determined to be in good condition. The sensor and control wiring up to and including the data terminal cabinet should also be evaluated for reuse. If the sensors and controls are not in good condition or do not utilize standard instrumentation signals, they should be replaced as part of the upgrade.

c. It may be possible to reuse existing field interface devices and multiplexers if these devices are fully operational and can be easily interfaced to a new central/island station. Reuse of existing field interface devices and multiplexers requires that the government execute licensing agreements that allow third party personnel to use copies of technical data and computer software of the existing system for interfacing the new central/island station with existing equipment at the particular military installation specified in the agreement.

2. EXPANSION GUIDELINES.

a. A system may be expanded where the central station EMCS equipment has sufficient spare capacity to absorb the additional points and software in the expansion project. If the addition of points and operating requirements of the expanded system exceeds the capability of the existing control station EMCS equipment, it will usually be necessary to upgrade the equipment to state-of-the-art UMCS. Expansion of existing systems requires that the Government execute licensing agreements that allow third party personnel to use copies of technical data and computer software of the existing system for interfacing new equipment with the existing equipment at the particular military installation specified in the agreement.

b. Replacement of the existing system is required when no licensing agreement exists for the existing system, when the existing systems functional capabilities cannot be increased or when sole source expansion is not feasible.

APPENDIX A

REFERENCES

GOVERNMENT PUBLICATIONS

Department of the Army Technical Manuals (TM)

TM 5-811-2	Electrical Design, Interior Electrical System
TM 5-815-3	Heating, Ventilating and Air Conditioning (HVAC) Control Systems

NON-GOVERNMENT PUBLICATIONS

American National Standards Institute (ANSI)
1430 Broadway, New York, NY 10018

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
1791 Tullie Circle, NE, Atlanta, GA 30329

ANSI/ASHRAE Standard 135	(1995) BACnet - A Data Communication Protocol for Building Automation and Control Networks.
ASHRAE	(1995) HVAC Applications Handbook
ASHRAE	(1992) HVAC Systems and Equipment Handbook

National Electrical Manufacturers Association (NEMA)
155 East 44th Street, New York, NY 10017

NEMA ICS 1	(1993) Industrial Control and Systems
NEMA MG-1	(1993) Motors and Generators
NEMA MG 10	(1993) Energy Management Guide for Selection and Use of Polyphase Motors

National Fire Protection Association (NFPA)
60 Batterymarch Street, Boston, MA 02110

NFPA 70	(1996) National Electrical Code

The American Society of Mechanical Engineers (ASME)
345 East 47th Street, New York, N.Y. 10017

ASTM	Report on Fluid Meters, Their Theory and Application

The Institute of Electrical and Electronics Engineers, Inc. (IEEE)
345 East 47th Street, New York, NY 10017

IEEE Standard 142 (1982) Recommended Practice for Grounding of Industrial and Commercial Power Systems

IEEE Standard 1100 (1992) Recommended Practice for Powering and Grounding Sensitive Electronic Equipment

APPENDIX B

SYMBOLS, ABBREVIATIONS, AND TYPICAL DETAILS

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PART 1. GENERAL INFORMATION

Table of Contents

Name of Drawing or Detail | Page

SYMBOLS

Symbol	Description
C	STARTER COIL/POWER CONTACTOR
CR	CONTROL RELAY
DP	DIFFERENTIAL PRESSURE SENSOR/SWITCH
F	FLOWMETER
FS	FLOW SWITCH
FZ	LOW TEMPERATURE DEVICE
H	HUMIDISTAT
HL	HIGH HUMIDITY LIMIT
L	LIMIT SWITCH
LC	LEVEL CONTROLLER
M	METER
MS	MANUAL SWITCH
PC	PRESSURE CONTROLLER
PZ	POSITION SWITCH
S	START/STOP INTERFACE
SD	SMOKE DETECTOR
SP	STATIC PRESSURE SENSOR/SWITCH
SPL	STATIC PRESSURE LIMIT
T	THERMOSTAT
TC	TEMPERATURE CONTROLLER
TH	HIGH TEMPERATURE DEVICE
TL	LOW TEMPERATURE CONTROLLER
P	PILOT LIGHT
	HAND VALVE
	2-WAY AIR OPERATED VALVE
M	2-WAY MOTOR OPERATED VALVE
	3-WAY AIR OPERATED VALVE
M	3-WAY MOTOR OPERATED VALVE
S	3-WAY SOLENOID OPERATED VALVE
	PRESSURE REDUCING VALVE
PRV	PRESSURE RELIEF VALVE
	DIRECTION OF FLOW
	PUMP OR FAN
	VAV FAN (SUPPLY, RETURN)
STR	MOTOR WITH STARTER
	RF ANTENNA

Symbol	Description
MC	MOTOR CONTROL CENTER
	COMBINATION STARTER/SAFETY SWITCH
	DISCONNECT/SAFETY SWITCH
	FILTER
	AIR FLOW MEASURING STATION
	COIL (CHILLED WATER, HOT WATER, STEAM)
	UNIT HEATER (SCHEMATIC)
	SUPPLY DUCT-UP
	SUPPLY DUCT-DOWN
	RETURN, EXHAUST DUCT-UP
	RETURN, EXHAUST DUCT-DOWN
	MANUAL DAMPER
M	MOTORIZED DAMPER
	PNEUMATIC DAMPER
	CHECK VALVE
ϕ	PHASE (ELECTRICAL)/DIAMETER
	FILLET WELD
	NOTE SYMBOL
	HUMIDIFIER
AHU 7	HVAC ZONE BOUNDARY
AIT M1	DENOTES STANDARD DETAIL CONNECTED TO A SMART FIELD PANEL OR REMOTE TERMINAL UNIT
AIT M1	DENOTES STANDARD DETAIL CONNECTED TO A UNITARY CONTROLLER OR UNIVERSAL PROGRAMMABLE CONTROLLER
I/O TYPE, I&C TYPE, AIX I3, T (E), 1, DETAIL NUMBER	EXISTING SENSOR/CONTROL
I/O TYPE, I&C TYPE, AOZ M5Ø, F, DETAIL NUMBER	TYPICAL OUTPUT

FAILURE MODE AS FOLLOWS:
F (CLOSED\OFF), O (OPEN/ON), C (LAST COMMAND)
H (HIGH), L (LOW), N (LOCAL CONTROL)

CANCELLED

ABBREVIATIONS

AAHE	AIR TO AIR HEAT EXCHANGER
AC	ALTERNATING CURRENT
A/C	AIR CONDITIONER
ACCU	AIR COOLED CONDENSING UNIT
AFF	ABOVE FINISHED FLOOR
AHU/AH	AIR HANDLING UNIT
AMP	AMPERE
ATC	AUTOMATIC TEMPERATURE CONTROLS
AWS	AMERICAN WELDING SOCIETY
BFW	BOILER FEED WATER
BLDG	BUILDING
BPA	BYPASS AIR
BPD	BYPASS DAMPER
BTU	BRITISH THERMAL UNIT
BTUH	BRITISH THERMAL UNITS PER HOUR
C	COMMON
C_	CONDUIT NUMBER
CB	CIRCUIT BREAKER
C/D	COLD DECK
CD	CONDENSATE DRAIN/RETURN
CFM	CUBIC FEET PER MINUTE
CH	CHILLER
CHW	CHILLED WATER
CHWP	CHILLED WATER PUMP
CHWR	CHILLED WATER RETURN
CHWS	CHILLED WATER SUPPLY
CKT	CIRCUIT
COND	CONDENSER/CONDENSATE
CP	COMPRESSOR
CT	CURRENT TRANSFORMER
CWP	CONDENSER WATER PUMP
CWR	CONDENSER WATER RETURN
CWS	CONDENSER WATER SUPPLY
DC	DIRECT CURRENT
DHW	DOMESTIC HOT WATER
DHWH	DOMESTIC HOT WATER HEATER
DP	DIFFERENTIAL PRESSURE
DPAH	DIFFERENTIAL PRESSURE ALARM HIGH
DPAL	DIFFERENTIAL PRESSURE ALARM LOW
DTW	DUAL TEMP WATER
DX	DIRECT EXPANSION
(E)	EXISTING
EA	EXHAUST AIR
EAD	EXHAUST AIR DAMPER
EAF	EXHAUST AIR FAN
ECU	EVAPORATIVE COOLING UNIT
EF	EXHAUST FAN
ELEC	ELECTRIC
EMS	ENERGY MANAGEMENT SYSTEM
EMCS	ENERGY MONITORING & CONTROL SYSTEM
EP	ELECTRIC TO PNEUMATIC SWITCH
EPNL	ELECTRIC PANEL
EXH	EXHAUST
FBPD	FACE & BYPASS DAMPER
FCU	FAN COIL UNIT
FD	FACE DAMPER
FEP	FIELD EQUIPMENT PANEL
FLA	FULL LOAD AMPS
FO	FIBER OPTICS
FODR	FO DROP/REPEATER
FOM	FO MODEM
FOR	FUEL OIL RETURN
FOS	FUEL OIL SUPPLY
G	GAS (NATURAL)
GAL	GALLONS
GND	GROUND
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
HAH	HUMIDITY ALARM HIGH
HAL	HUMIDITY ALARM LOW
H/D	HOT DECK
HGB	HOT GAS BYPASS
HOA	HAND OFF AUTO SELECTOR SWITCH
HP	HORSEPOWER
H/P	HEAT PUMP
HPS	HIGH PRESSURE STEAM
HTHW	HIGH TEMP HOT WATER
HTHWR	HIGH TEMP HOT WATER RETURN
HTHWS	HIGH TEMP HOT WATER SUPPLY
HTR	HEATER
HV	HEATING AND VENTILATING UNIT
HVAC	HEATING, VENTILATING & AIR CONDITIONING
HW	HOT WATER
HWB	HOT WATER BOILER
HWP	HOT WATER PUMP
HWS	HOT WATER SUPPLY
HWR	HOT WATER RETURN
IA	INSTRUMENT AIR
IG	ISOLATED GROUND
IP	CURRENT TO PNEUMATIC TRANSDUCER
LBS/HR	POUNDS PER HOUR
LFX	LAN FIBER OPTIC TRANSCEIVER
LP	LOW POINT
LPS	LOW PRESSURE STEAM
LPR	LOW PRESSURE RETURN
MA	MIXED AIR
MAX	MAXIMUM
MBH	ONE THOUSAND BTU PER HOUR
MCC	MOTOR CONTROL CENTER
MDP	MAIN DISTRIBUTION PANEL
MECH	MECHANICAL
MIN	MINIMUM OR MINUTES
MTR	MOTOR
MVD	MANUAL VOLUME DAMPER
MZ	MULTIZONE
MZAHU	MULTIZONE AIR HANDLING UNIT
MZD	MULTIZONE DAMPER
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
NPWC	NAVY PUBLIC WORKS CENTER
NTS	NOT TO SCALE
OA	OUTSIDE AIR
OAD	OUTSIDE AIR DAMPER
OCC	OCCUPIED
PAH	PRESSURE ALARM HIGH
PAL	PRESSURE ALARM LOW
P_	UTILITY POLE NUMBER
PE	PNEUMATIC/ELECTRIC SWITCH
PHC	PREHEAT COIL
PIR	PASSIVE INFRARED MOTION SENSOR
PLC	POWER LINE CONDITIONER
PNL	PANEL
PRV	PRESS. REDUCING VALVE/PRESS. RELIEF VALVE
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSIG	POUNDS PER SQUARE INCH GAUGE
PT	POTENTIAL TRANSFORMER
RA	RETURN AIR
RAD	RETURN AIR DAMPER
REF	RELIEF AIR FAN
RAR	RETURN AIR REGISTER
RCR	ROOM CAVITY RATIO
RAF/RF	RETURN AIR FAN
RHC	REHEAT COIL
RLA	RUNNING LOAD AMPS
RTD	RESISTANCE TEMPERATURE DETECTOR
SA	SUPPLY AIR
SAF	SUPPLY AIR FAN
SAR	SUPPLY AIR REGISTER
SLCP	HVAC SINGLE LOOP CONTROL PANEL
S/N	SOLID/NEUTRAL
SP	STATIC PRESSURE
S/S	START/STOP
STM	STEAM
STR	STARTER
SV	SOLENOID VALVE
SW	SWITCH
S-W	SUMMER-WINTER
SZ	SINGLE ZONE
SZAHU	SINGLE ZONE AIR HANDLING UNIT
SZD	SINGLE ZONE DAMPER
TAH	TEMPERATURE ALARM HIGH
TAL	TEMPERATURE ALARM LOW
TEMP	TEMPERATURE
T'STAT	THERMOSTAT
TYP	TYPICAL
UH	UNIT HEATER
UMCS	UTILITY MONITORING & CONTROL SYS
UNOCC	UNOCCUPIED
VAV	VARIABLE AIR VOLUME
VFD	VARIABLE FREQUENCY DRIVE
VSD	VARIABLE SPEED DRIVE
WB	WET BULB
WC	WATER COLUMN
WS	WATER SUPPLY
WTR	WATER
XDUCER	TRANSDUCER
XFMR	TRANSFORMER
XMTR	TRANSMITTER
Z	ZONE

ANALOG INPUT

Symbol	Description
AIA M28	ANALYZER, CARBON MONOXIDE
AIA M37	ANALYZER, CHLORINE (POOL WATER)
AIA M30	ANALYZER, CONDUCTIVITY
AIA M33	ANALYZER, NITROUS GASES (NOx)
AIA M27	ANALYZER, OXYGEN
AIA M32	ANALYZER, OXYGEN DEPLETION
AIA M29	ANALYZER, pH SENSOR
AIA M31	ANALYZER, REFRIGERANT LEAKAGE
AIA M35	ANALYZER, TOTAL DISSOLVED SOLIDS
AIA M34	ANALYZER, TURBIDITY
AIA M36	ANALYZER, WATER HARDNESS
AIF M51	AIR FLOW MEASURING STATION
AIF M18	FLOW METER, ORIFICE PLATE (DELTA-P)
AIF M21	FLOW METER, LIQUID (ANNULAR PITOT TUBE)
AIF M24	FLOW METER, STEAM (PIPE ABOVE)
AIF M25	FLOW METER, STEAM (PIPE BELOW)
AIF M22	FLOW METER, TURBINE
AIF M23	FLOW METER, TURBINE (INSERTION TYPE)
AIF M19	FLOW METER, ULTRASONIC
AIF M17	FLOW METER, VENTURI (DELTA-P)
AIF M20	FLOW METER, VORTEX SHEDDING
AIF M67	FLOW METER, VORTEX SHEDDING (INSERTION TYPE)
AIJ E8	CURRENT SENSING TRANSDUCER
AIJ E30	TRANSDUCER, CURRENT
AIJ E37	TRANSDUCER, NEW 3 PHASE CURRENT
AIJ E28	TRANSDUCER, PHASE ANGLE
AIJ E29	TRANSDUCER, POWER FACTOR
AIJ E31	TRANSDUCER, VOLTAGE
AIJ E38	TRANSDUCER, NEW 3 PHASE VOLTAGE
AIJ E24	TRANSDUCER, VAR (3 PHASE, 3 WIRE DELTA SYSTEM)
AIJ E23	TRANSDUCER, VAR (3 PHASE, 4 WIRE WYE SYSTEM)
AIJ E34	TRANSDUCER, WATT (SINGLE PHASE)

Symbol	Description
AIJ E35	TRANSDUCER, WATT HOUR (SINGLE PHASE)
AIJ E19	TRANSDUCER, WATT (3 PHASE, 4 WIRE WYE SYSTEM)
AIJ E20	TRANSDUCER, WATT HOUR (3 PHASE, 4 WIRE WYE SYSTEM)
AIJ E21	TRANSDUCER, WATT (3 PHASE, 3 WIRE DELTA SYSTEM)
AIJ E37	TRANSDUCER, NEW 3 PHASE CURRENT
AIJ E38	TRANSDUCER, NEW 3 PHASE VOLTAGE
AIJ E22	TRANSDUCER, WATT HOUR (3 PHASE, 3 WIRE DELTA SYSTEM)
AIL M42	LEVEL TRANSMITTER, BUBBLER TYPE
AIL M43	LEVEL TRANSMITTER, VENTED TANK
AIM M77	HUMIDITY SENSOR, CEILING MOUNT
AIM M9	HUMIDITY SENSOR, DUCT
AIM M52	HUMIDITY SENSOR, SPACE
AIM M47	INSTRUMENT SHELTER W/TEMPERATURE AND HUMIDITY SENSORS
AIM M38	DEW POINT SENSOR, COMPRESSED AIR
AIP M63	DIFFERENTIAL PRESSURE SENSOR, AIR FILTER
AIP M82	DIFFERENTIAL PRESSURE SENSOR, FAN
AIP M82	DIFFERENTIAL PRESSURE SENSOR, FAN
AIP M57	DIFFERENTIAL PRESSURE SENSOR, ROOM
AIP M82	DIFFERENTIAL PRESSURE SENSOR, FAN
AIP M74	DIFFERENTIAL PRESSURE TRANSMITTER (LIQUID)
AIP M11	PRESSURE TRANSMITTER, LIQUID
AIP M39	PRESSURE TRANSMITTER, REFRIGERANT
AIP M75	PRESSURE TRANSMITTER, STEAM
AIP M53	STATIC PRESSURE SENSOR, DUCT
AIP M78	STATIC PRESSURE SENSOR, ROOM
AIT M4	AVERAGING TEMPERATURE SENSOR, DUCT
AIT M76	TEMPERATURE SENSOR, CEILING MOUNT
AIT M85	TEMPERATURE SENSOR, COOLING TOWER BASIN
AIT M3	TEMPERATURE SENSOR, DUCT
AIT M71	TEMPERATURE SENSOR, FREEZER OR REFRIGERATOR
AIT M58	TEMPERATURE SENSOR, FUEL OIL (PIPE)
AIT M15	TEMPERATURE SENSOR, OUTDOOR (SUNSHIELD)

Symbol	Description
AIT M1	TEMPERATURE SENSOR, PIPE
AIT M2	TEMPERATURE SENSOR, LARGE PIPE
AIT M5	TEMPERATURE SENSOR, FINISHED SPACE
AIT M6	TEMPERATURE SENSOR, UNFINISHED SPACE
AIT M46	INSTRUMENT SHELTER W/TEMPERATURE SENSOR
AIX I3	ANALOG INPUT, SENSOR
AIX I16	AMBIENT LIGHT SENSOR
AIZ M16	POSITION INDICATION, DAMPER
AIZ M60	POSITION INDICATION, RISING STEM VALVE
AIZ M59	POSITION INDICATION, ROTARY VALVE

DIGITAL INPUT

Symbol	Description
DIA / M44	WATER QUALITY CONTROLLER
DIC / I32	LIGHTING CONTROL, PIR SENSOR (CEILING MOUNTED)
DIC / I33	LIGHTING CONTROL, PIR SENSOR (WALL MOUNTED)
DIF / M61	FLOW METER, EXISTING NATURAL GAS W/NEW PULSE INITIATOR (INDUSTRIAL)
DIF / M26	FLOW METER, EXISTING NATURAL GAS W/NEW PULSE INITIATOR (RESIDENTIAL)
DIF / M62	FLOW METER, NEW NATURAL GAS W/NEW PULSE INITIATOR (INDUSTRIAL)
DIF / M49	FLOW METER, NEW NATURAL GAS W/NEW PULSE INITIATOR (RESIDENTIAL)
DIJ / E7	CURRENT SENSING RELAY
DIJ / E13	ELECTRICAL METERING INSTALLATION (UNDER 600V)
DIJ / E36	POWER METER, EXISTING W/EXISTING KYZ CONTACTS
DIJ / E27	POWER METER, EXISTING W/EXISTING PULSE INITIATOR
DIJ / E1	POWER METER, EXISTING 2 WIRE SINGLE PHASE W/NEW PULSE INITIATOR (UNDER 600V)
DIJ / E3	POWER METER, EXISTING 3 PHASE W/NEW PULSE INITIATOR (OVER 600V)
DIJ / E2	POWER METER, EXISTING 3 PHASE W/NEW PULSE INITIATOR (UNDER 600V)
DIJ / E4	POWER METER, NEW 2 WIRE SINGLE PHASE W/NEW PULSE INITIATOR (UNDER 600V)
DIJ / E25	POWER METER, EXISTING 3 WIRE SINGLE PHASE W/NEW PULSE INITIATOR (UNDER 600V)
DIJ / E5	POWER METER, NEW 3 PHASE W/NEW PULSE INITIATOR (UNDER 600V)
DIJ / E26	POWER METER, NEW 3 WIRE SINGLE PHASE W/NEW PULSE INITIATOR (UNDER 600V)
DIJ / E6	POWER METER, NEW 3 PHASE W/NEW PULSE INITIATOR (OVER 600V)
DIL / M40	FLOAT SWITCH, POLE MOUNTED
DIL / M41	FLOAT SWITCH, SUSPENDED

Symbol	Description
DIM / M84	HIGH HUMIDITY SWITCH, DUCT
DIP / M8	DIFFERENTIAL PRESSURE SWITCH, AIR FILTER
DIP / M7	DIFFERENTIAL PRESSURE SWITCH, FAN AIR FLOW
DIP / M14	DIFFERENTIAL PRESSURE SWITCH, INSTRUMENT AIR FILTER
DIP / M10	DIFFERENTIAL PRESSURE SWITCH, PUMP STATUS
DIP / M64	DUCT STATIC PRESSURE SWITCH
DIP / M69	PRESSURE SWITCH, AIR LINE
DIP / M12	PRESSURE SWITCH, LIQUID
DIP / M48	PRESSURE SWITCH, REFRIGERANT
DIT / M65	LOW TEMPERATURE DEVICE, DUCT MOUNTED
DIX / I2	AUXILARY CONTACT, DIGITAL INPUT
DIX / I17	AUXILARY CONTACT (NEW PILOT RELAY), DIGITAL INPUT
DIX / I18	AUXILARY CONTACT, FIRE ALARM INTERFACE
DIX / I13	BOILER STATUS AND SAFETY ALARM DEVICES
DIX / S1	STATUS RELAY, PUMP (STARTER)
DIX / E9	TRANSFER SWITCH INTERFACE
DIX / M45	VIBRATION SWITCH
DIX / I12	CHILLER SAFETY ALARMS DEVICE
DIZ / M54	POSITION SWITCH, DAMPER
DIZ / M55	POSITION SWITCH, VALVE
DIZ / M70	POSITION SWITCH, DOOR

ANALOG OUTPUT

Symbol	Description
AOC / I4	ANALOG OUTPUT, ELECTRIC CONTROL DEVICE
AOC / I15	ANALOG OUTPUT, PNEUMATIC CONTROL DEVICE
AOC / M66	ANALOG OUTPUT, FAN PNEUMATIC INLET VANE OPERATOR
AOC / I14	ANALOG OUTPUT, PNEUMATIC ECONOMIZER CONTROL
AOC / M13	ANALOG OUTPUT, TERMINAL BOX CONTROLLER WITH REHEAT COIL VALVE
AOC / M80	ANALOG OUTPUT, TERMINAL BOX CONTROLLER WITHOUT REHEAT COIL VALVE
AOC / M81	ANALOG OUTPUT, TERMINAL REHEAT COIL VALVE CONTROLLER
AOC / M83	ANALOG OUTPUT, ZONE DAMPER CONTROL FOR MULTIZONE UNIT
AOZ / I11	ANALOG VALVE CONTROL W/MANUAL OVERRIDE
AOZ / M50	NEW THREE-WAY MIXING VALVE W/PNEUMATIC ACTUATOR
AOZ / M79	NEW THREE-WAY MIXING VALVE W/ELECTRIC ACTUATOR
AOZ / M56	VALVE ACTUATOR/POSITIONER W/TRANSDUCER

SYSTEM EQUIPMENT

Symbol	Description
S	SMART FIELD PANEL
R	REMOTE TERMINAL UNIT
U	UNITARY CONTROLLER
P	UNIVERSAL PROGRAMMABLE CONTROLLER

DIGITAL OUTPUT

Symbol	Description
DOC / I8	CONTROLLER, DAMPER, 3-MODE ECONOMIZER/VENT RECIRCULATION
DOC / I6	CONTROLLER, CENTRIFUGAL CHILLER (DEMAND LIMIT)
DOC / I5	CONTROLLER, RECIPROCATING CHILLER (DEMAND LIMIT)
DOC / I9	CONTROLLER, 4-MODE ECONOMIZER/VENT-RECIRCULATION
DOC / I1	CONTROL RELAY, DIGITAL OUTPUT
DOC / S4	CONTROL RELAY, DAMPER CONTROL (2-POSITION)
DOC / S7	CONTROL RELAY, DAMPER CONTROL W/FIRE ALARM OVERRIDE (2-POSITION)
DOC / S5	CONTROL RELAY, HOA SWITCH INTERFACE
DOC / S8	CONTROL RELAY, W/NEW HOA SWITCH INTERFACE TO PACKAGE UNIT
DOC / S6	CONTROL RELAY, HOA SWITCH (REPLACING PUSHBUTTON STATION)
DOC / S11	CONTROL RELAY, HOA SWITCH (REPLACING START/STOP STATION)
DOC / S10	CONTROL RELAY, INTERFACED TO EXISTING HOA SWITCH
DOC / S9	CONTROL RELAY, INTERFACED TO EXISTING HOA SWITCH (WITHOUT FEEDBACK)
DOC / S14	CONTROL RELAYS, W/NEW HOA AND 2-SPEED SWITCH INTERFACE
DOC / S15	CONTROL RELAYS, W/NEW HOA AND 2-SPEED SWITCH INTERFACE AND FIRE ALARM OVERRIDE INTERLOCK
DOC / I28	CONTROL RELAY AND LATCHING CONTACTOR W/EXISTING AUXILIARY CONTACT
DOC / I29	CONTROL RELAY AND LATCHING CONTACTOR W/NEW AUXILIARY CONTACT
DOC / I30	CONTROL RELAY AND LATCHING CONTACTOR FOR ONE LIGHTING CIRCUIT/FIXTURE W/AUXILIARY CONTACT
DOC / I31	CONTROL RELAY (24VDC) AND LATCHING CONTACTOR W/NEW AUXILIARY CONTACT
DOC / S3	CONTROL RELAY, THERMOSTAT
DOC / S13	CONTROL RELAYS, W/REPLACEMENT 3-POSITION, 2-SPEED CONTROL STATION
DOC / S2	RELAY, INTERLOCK
DOC / S12	SOLENOID VALVE CONTROL, LIQUID LINE
DOC / I7	SOLENOID VALVE, 3-WAY, 2-POSITION OVERRIDE
DOC / I35	VAV BOX, AREA CONTROL PANEL FIRE ALARM INTERFACE, DIGITAL OUTPUT
DOZ / I10	MOTORIZED VALVE CONTROL
DOZ / M68	VALVE, (2-POSITION) ACTUATOR W/SOLENOID VALVE

PART 2. COMMUNICATION DETAILS

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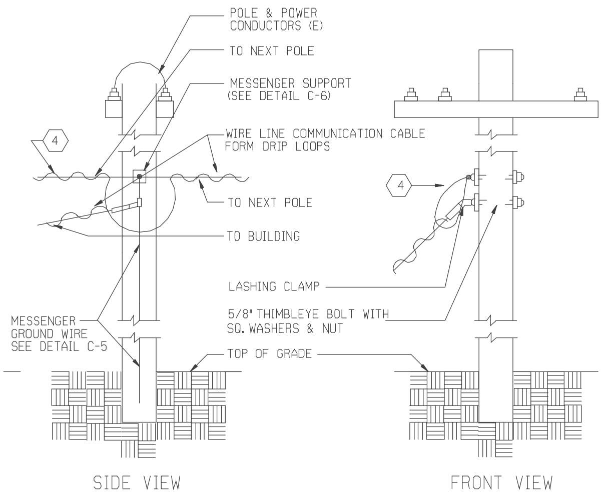
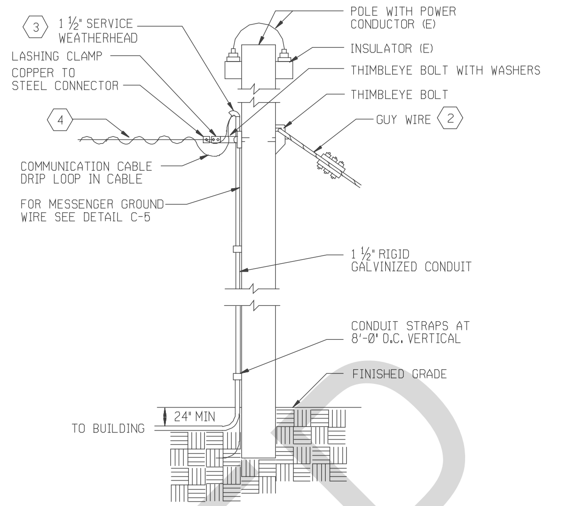


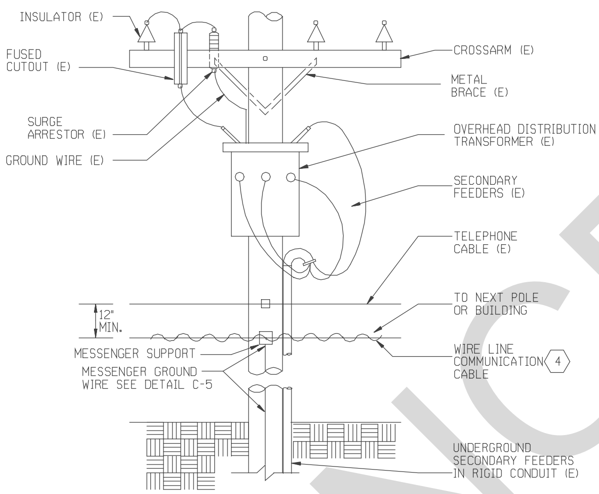
WIRE LINE COMMUNICATION CABLE INSTALLATION POLE

DETAIL C-1



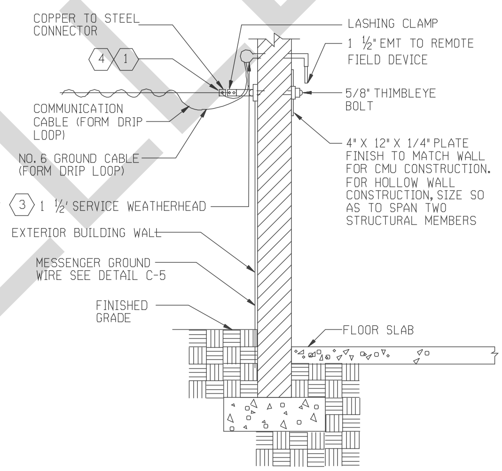
AERIAL/UNDERGROUND WIRE LINE CABLE INSTALLATION

DETAIL C-2



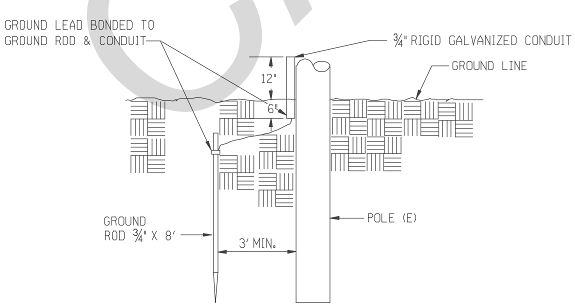
COMMUNICATION CABLE INSTALLATION ON POLE TRANSFORMER

DETAIL C-3



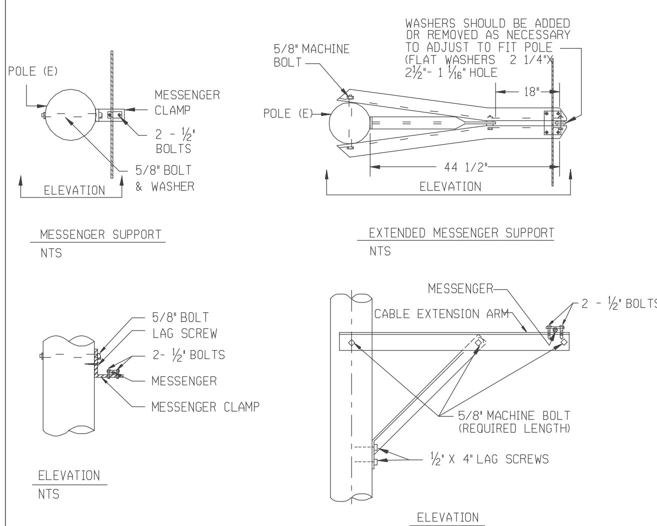
AERIAL WIRELINE CABLE ENTRANCE

DETAIL C-4



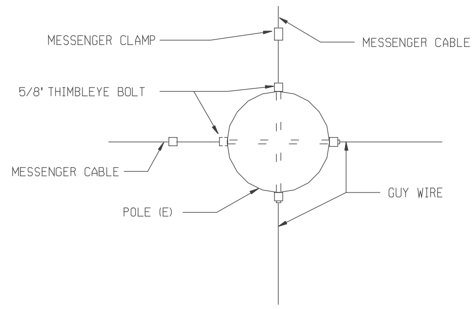
GROUND ROD CONNECTION

DETAIL C-5



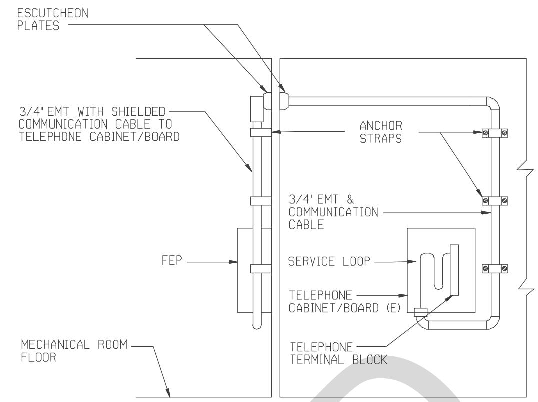
MESSENGER SUPPORT

DETAIL C-6



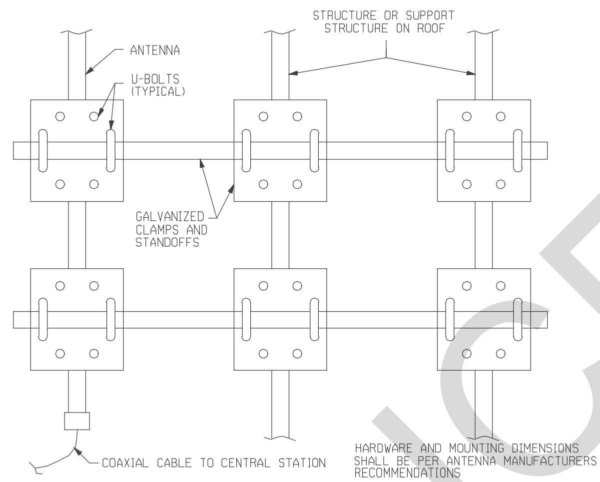
4 ANGLE POLE

DETAIL C-7



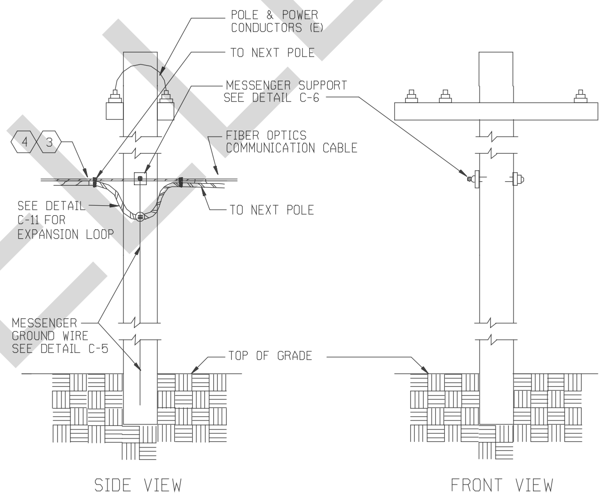
FEP COMMUNICATION CABLE CONNECTION
TO TELEPHONE CABINET/BOARD
(FOR UNFINISHED INTERIOR)

DETAIL C-8



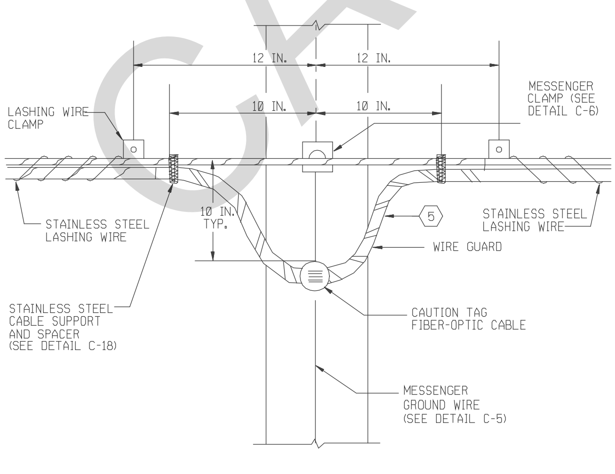
CENTRAL STATION ANTENNA INSTALLATION

DETAIL C-9



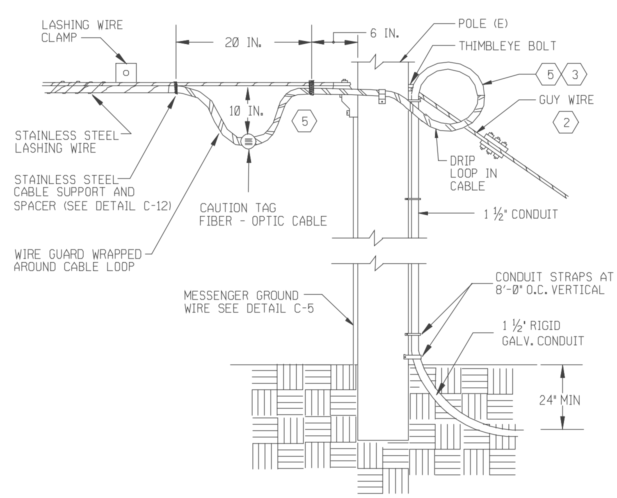
FIBER OPTIC COMMUNICATION
CABLE INSTALLATION POLE

DETAIL C-10



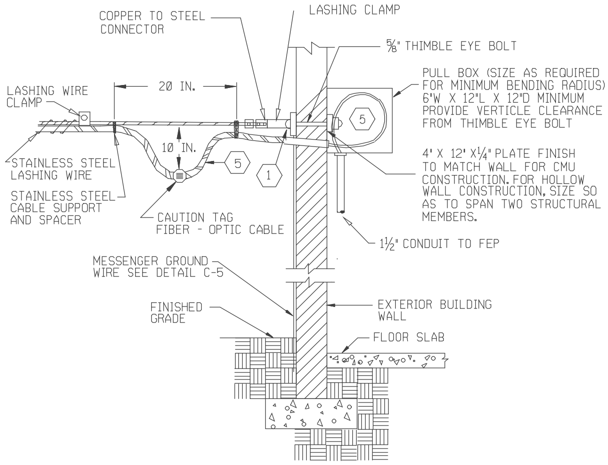
FIBER OPTIC CABLE EXPANSION

DETAIL C-11



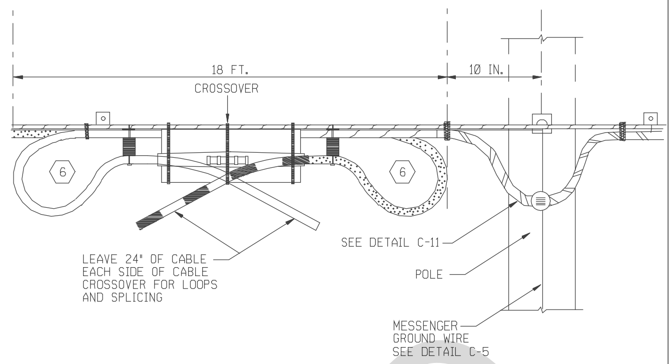
AERIAL/UNDERGROUND FIBER
OPTIC CABLE INSTALLATION

DETAIL C-12



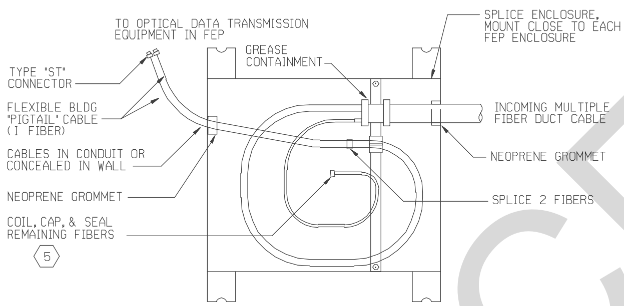
FIBER OPTIC AERIAL CABLE ENTRANCE

DETAIL C-13



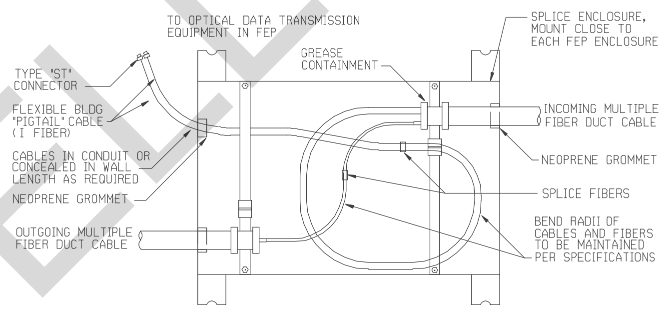
FIBER OPTIC AERIAL SPLICE CLOSURE INSTALLATION

DETAIL C-14



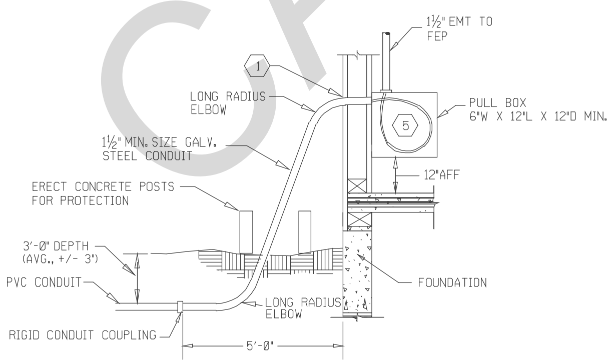
FIBER OPTIC CABLE SPLICING
(TERMINATION ENCLOSURE)

DETAIL C-15



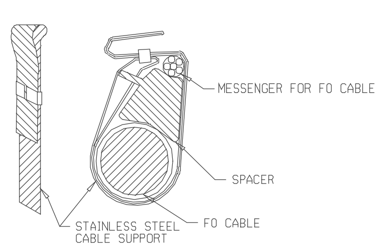
FIBER OPTIC CABLE PASS THROUGH SPLICING
(TERMINATION ENCLOSURE)

DETAIL C-16



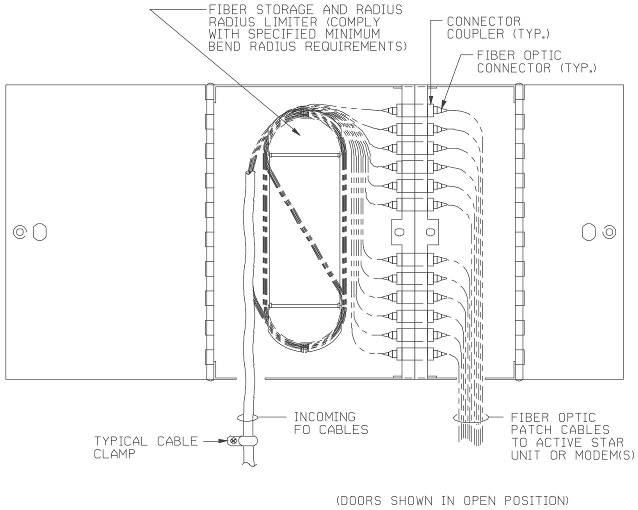
UNDERGROUND FIBER OPTIC CABLE ENTRANCE

DETAIL C-17



FIBER OPTIC CABLE SUPPORT AND SPACER

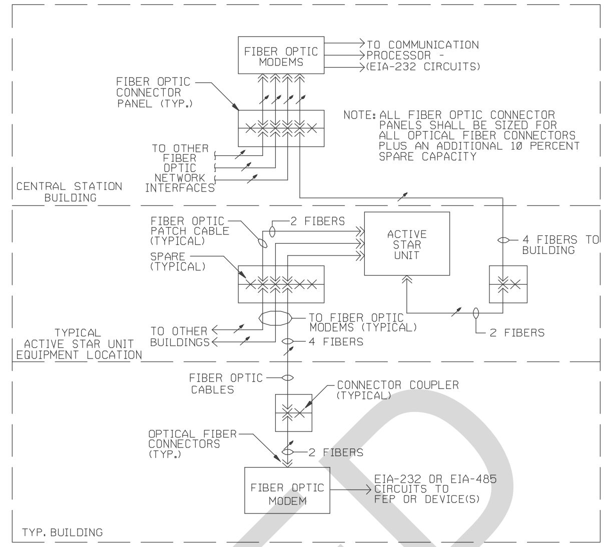
DETAIL C-18



TYPICAL FIBER OPTIC CONNECTOR PANEL

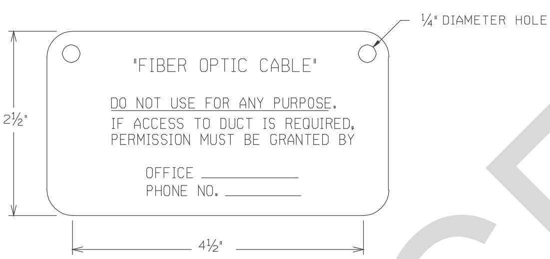
(ALSO REFERRED TO AS FIBER TERMINATION PANEL)

DETAIL C-19



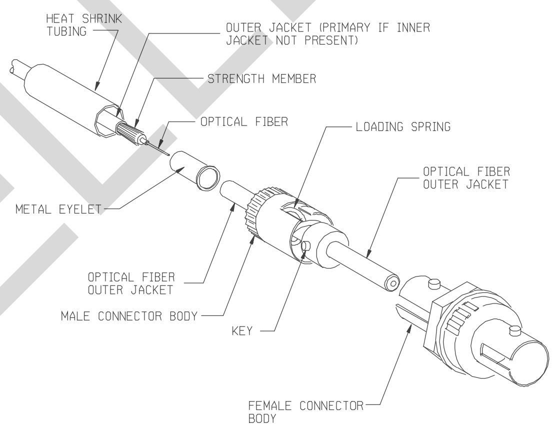
TYPICAL FIBER OPTIC DATA TRANSMISSION
CIRCUIT USING ACTIVE STAR TOPOLOGY

DETAIL C-20



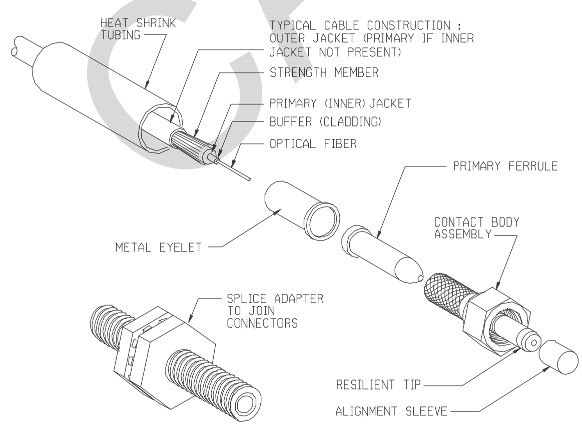
TYPICAL CABLE TAG

DETAIL C-21



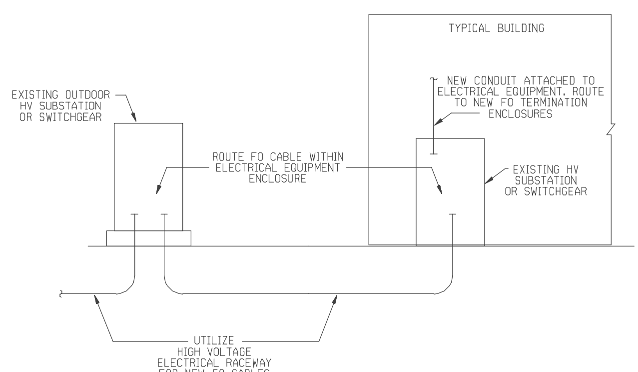
"ST" FIBER OPTIC CONNECTOR

DETAIL C-22



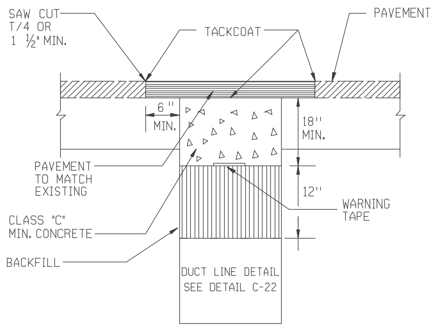
"SMA" FIBER OPTIC CONNECTOR

DETAIL C-23



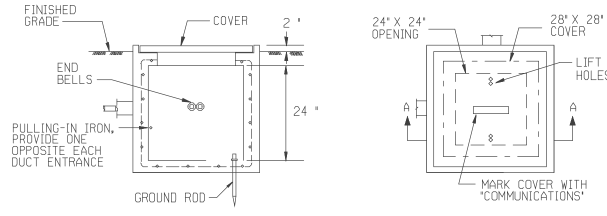
FIBER OPTIC CABLE BUILDING SERVICE
ENTRANCE IN ELECTRICAL RACEWAY

DETAIL C-24



REINFORCED DUCTS UNDER ASPHALT PAVEMENT

DETAIL C-25

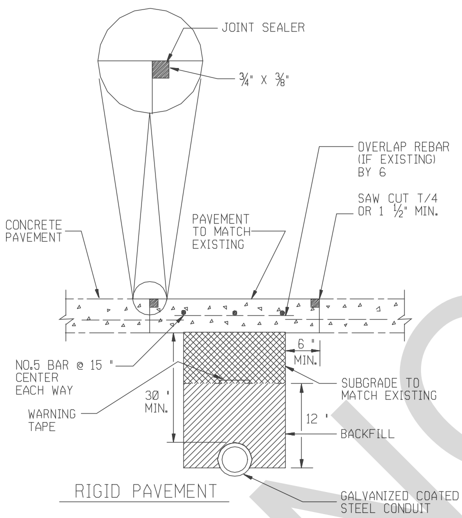


SECTION A-A

PLAN

COMMUNICATION HANDHOLE ⟨7⟩

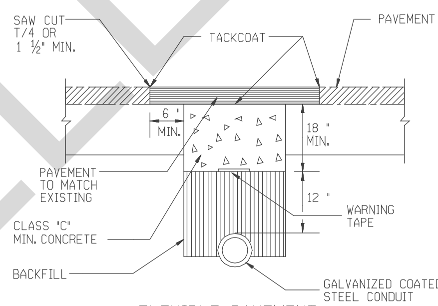
DETAIL C-26



RIGID PAVEMENT

PAVEMENT REPLACEMENT

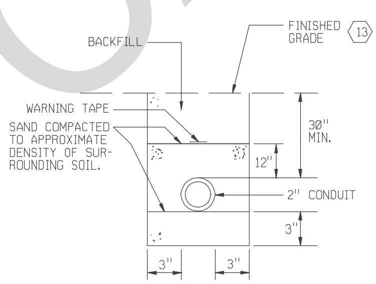
DETAIL C-27



FLEXIBLE PAVEMENT

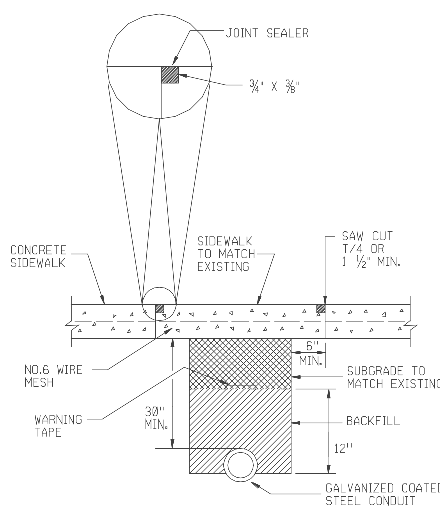
PAVEMENT REPLACEMENT

DETAIL C-28



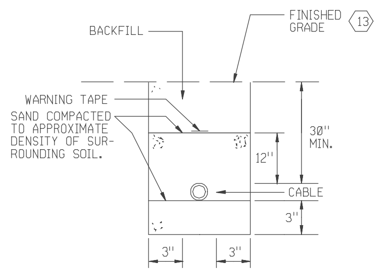
CONDUIT BURIED UNDER UNPAVED GRADE

DETAIL C-29



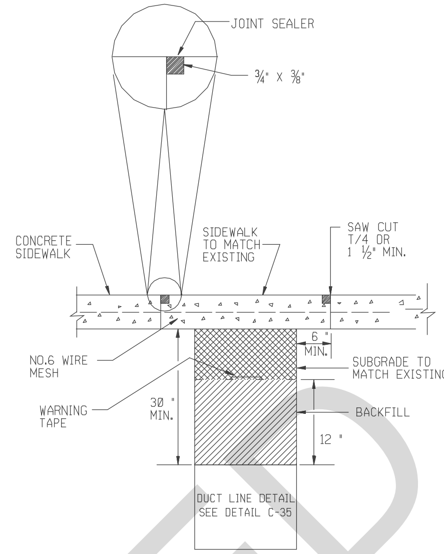
CONDUIT BURIED UNDER SIDEWALK

DETAIL C-30



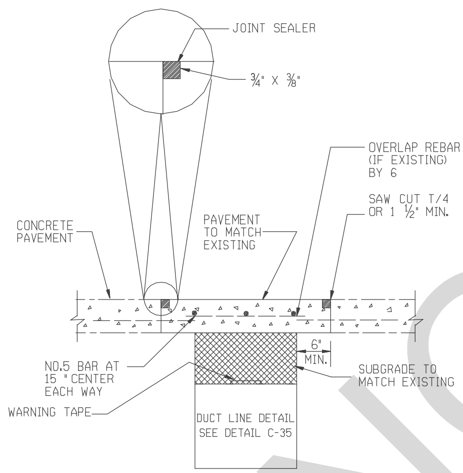
DIRECT BURIAL CABLE

DETAIL C-31



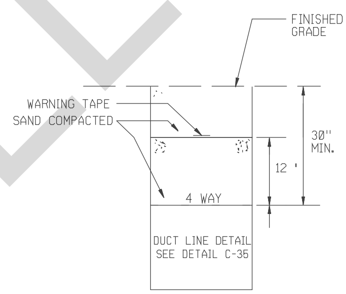
DUCT INSTALLATION UNDER SIDEWALK

DETAIL C-32



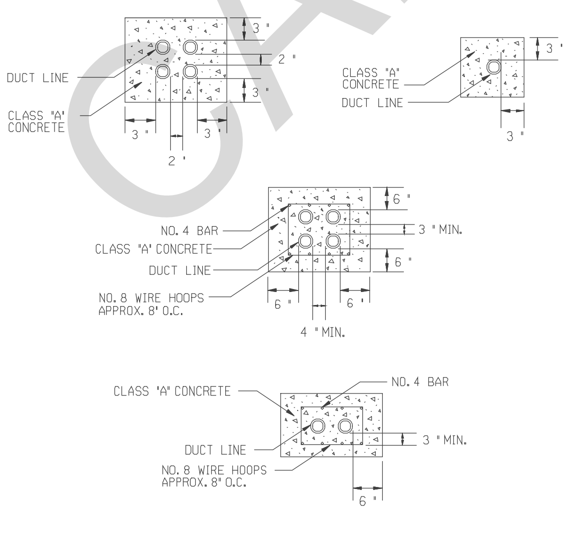
REINFORCED DUCTS UNDER CONCRETE PAVEMENT

DETAIL C-33



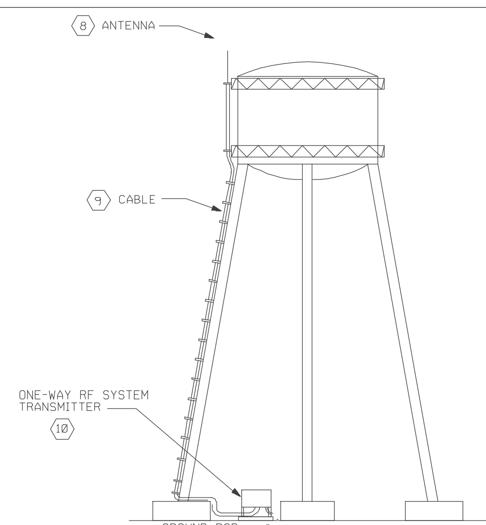
DUCT BANK INSTALLATION\UNPAVED AREAS

DETAIL C-34



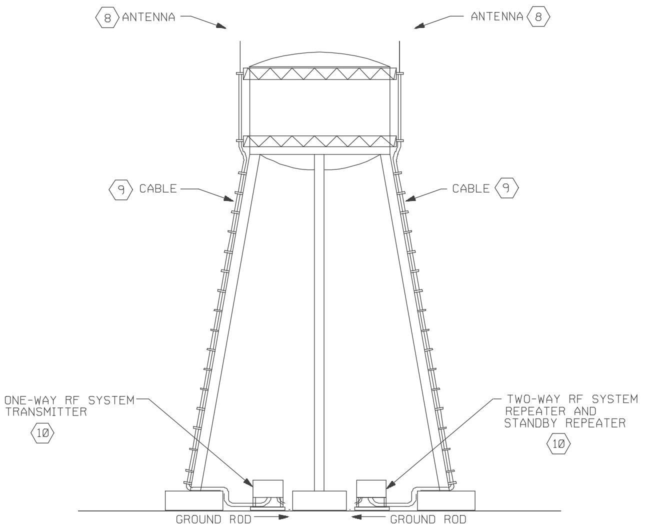
TYPICAL DUCT LINE INSTALLATION

DETAIL C-35



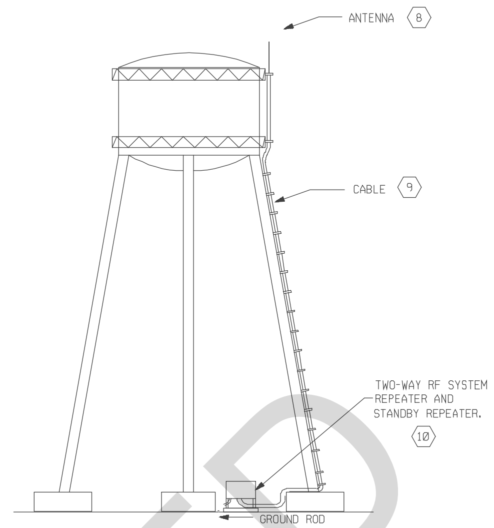
ONE-WAY RF EQUIPMENT INSTALLATION AT ELEVATED WATER TANK

DETAIL C-36



ONE-WAY & TWO-WAY RF EQUIPMENT INSTALLATION AT ELEVATED WATER TANK

DETAIL C-37



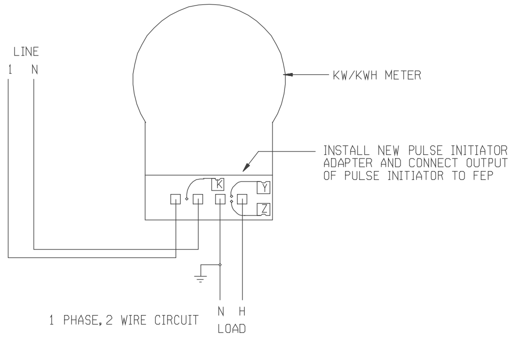
TWO-WAY RF EQUIPMENT INSTALLATION AT ELEVATED WATER TANK

DETAIL C-38

PART 3. ELECTRICAL DETAILS

Table of Contents

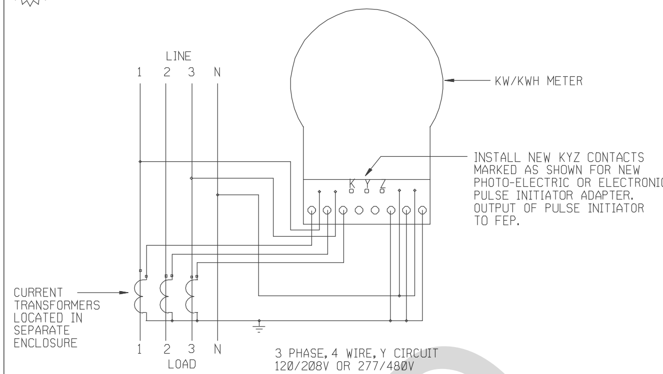
DIJ E1 POWER METER, EXISTING 2 WIRE SINGLE PHASE W/NEW PULSE INITIATOR (UNDER 600V)



EXISTING 2 WIRE SINGLE PHASE METER W/NEW PULSE INITIATOR

DETAIL E-1

DIJ E2 POWER METER, EXISTING 3 PHASE W/NEW PULSE INITIATOR (UNDER 600V)

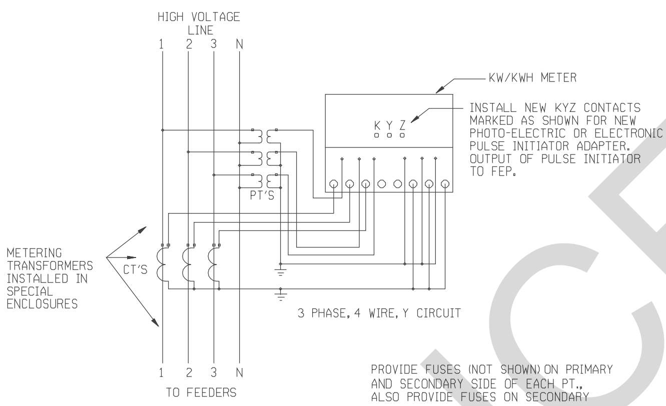


PROVIDE FUSES (NOT SHOWN) ON PRIMARY AND SECONDARY SIDE OF EACH PT., ALSO PROVIDE FUSES ON SECONDARY SIDE OF EACH CT.

EXISTING 3 PHASE METER W/NEW PULSE INITIATOR

DETAIL E-2

DIJ E3 POWER METER, EXISTING 3 PHASE W/NEW PULSE INITIATOR (OVER 600V)

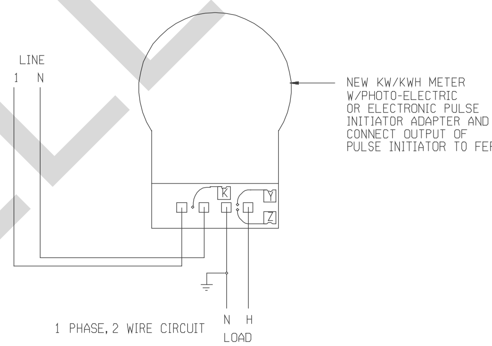


PROVIDE FUSES (NOT SHOWN) ON PRIMARY AND SECONDARY SIDE OF EACH PT., ALSO PROVIDE FUSES ON SECONDARY SIDE OF EACH CT.

EXISTING 3 PHASE METER W/NEW PULSE INITIATOR, CTs, & PTs AT SUBSTATION

DETAIL E-3

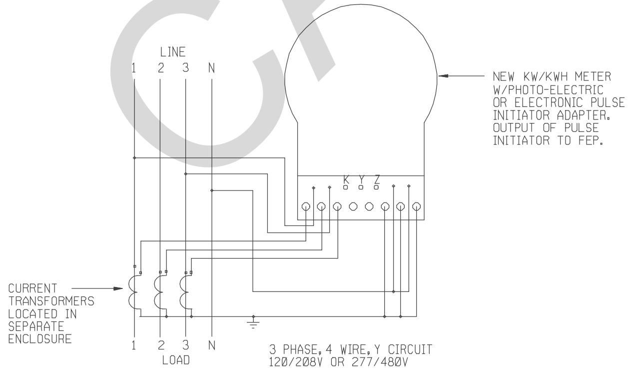
DIJ E4 POWER METER, NEW 2 WIRE SINGLE PHASE W/NEW PULSE INITIATOR (UNDER 600V)



NEW 2 WIRE SINGLE PHASE METER W/NEW PULSE INITIATOR

DETAIL E-4

DIJ E5 POWER METER, NEW 3 PHASE W/NEW PULSE INITIATOR (UNDER 600V)

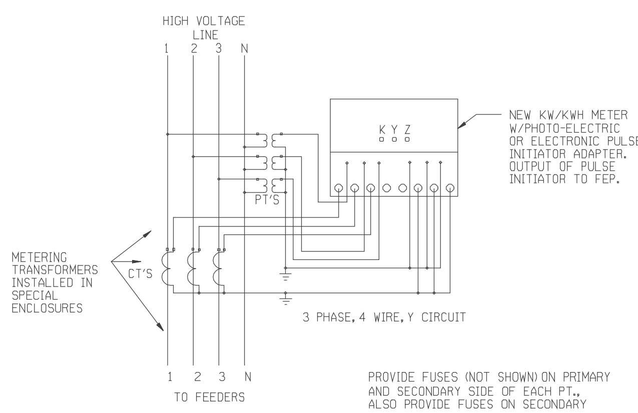


PROVIDE FUSES (NOT SHOWN) ON PRIMARY AND SECONDARY SIDE OF EACH PT., ALSO PROVIDE FUSES ON SECONDARY SIDE OF EACH CT.

NEW 3 PHASE METER W/NEW PULSE INITIATOR

DETAIL E-5

DIJ E6 POWER METER, NEW 3 PHASE W/NEW PULSE INITIATOR (OVER 600V)

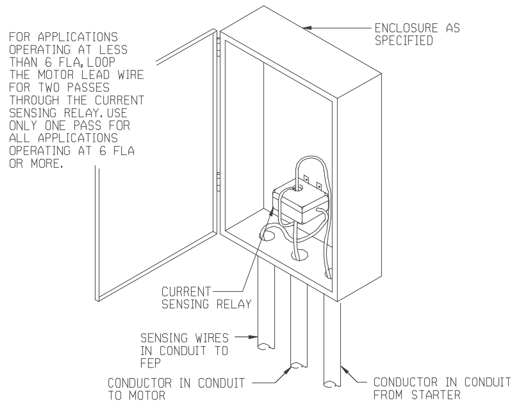


PROVIDE FUSES (NOT SHOWN) ON PRIMARY AND SECONDARY SIDE OF EACH PT., ALSO PROVIDE FUSES ON SECONDARY SIDE OF EACH CT.

NEW 3 PHASE METER W/NEW PULSE INITIATOR, CTs, & PTs AT SUBSTATION

DETAIL E-6

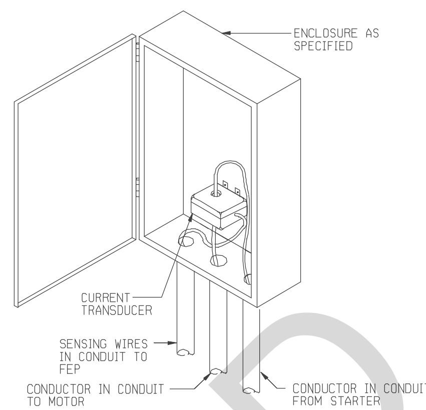
DIJ E7 CURRENT SENSING RELAY



CURRENT SENSING RELAY

DETAIL E-7

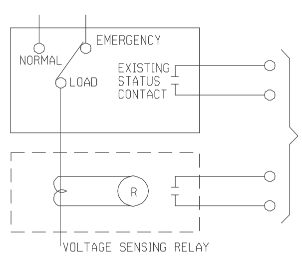
AIJ E8 CURRENT SENSING TRANSDUCER



CURRENT SENSING TRANSDUCER

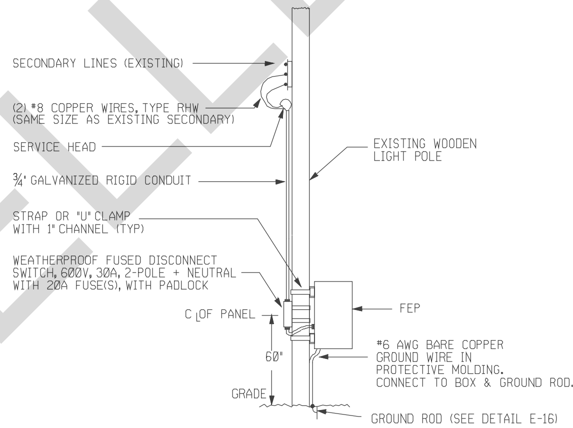
DETAIL E-8

DIX E9 TRANSFER SWITCH INTERFACE



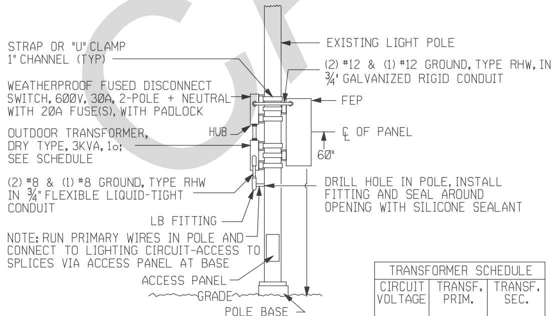
TRANSFER SWITCH INTERFACE

DETAIL E-9



REMOTE LOCATION POWER SUPPLY-
120 OR 240 VOLT SINGLE PHASE

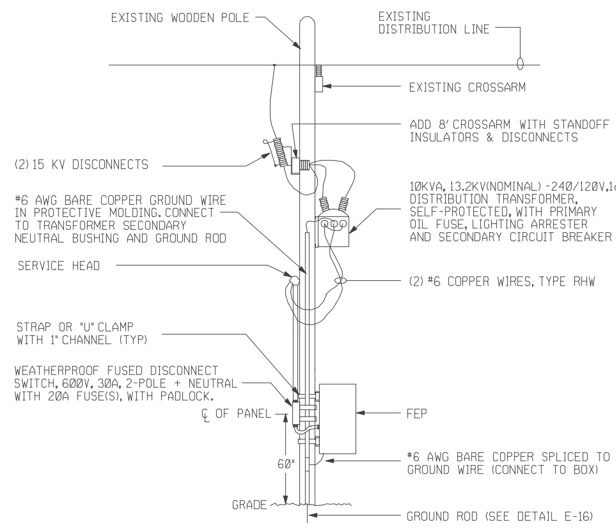
DETAIL E-10



TRANSFORMER SCHEDULE		
CIRCUIT VOLTAGE	TRANSF. PRIM.	TRANSF. SEC.
480	480	120
277	277	120
120	NONE	NONE

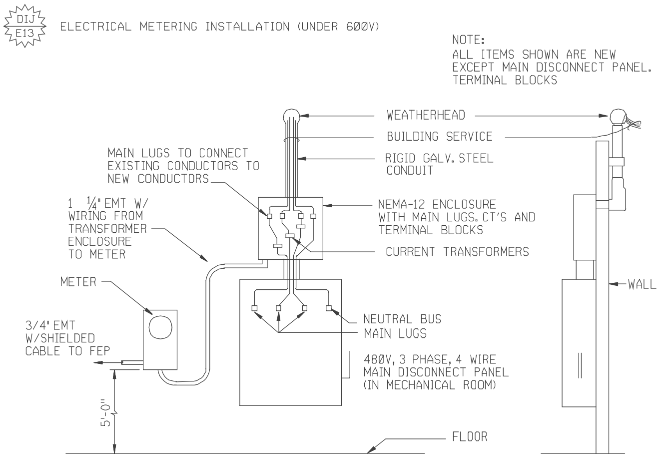
REMOTE LOCATION POWER SUPPLY-
MEDIUM VOLTAGE

DETAIL E-11



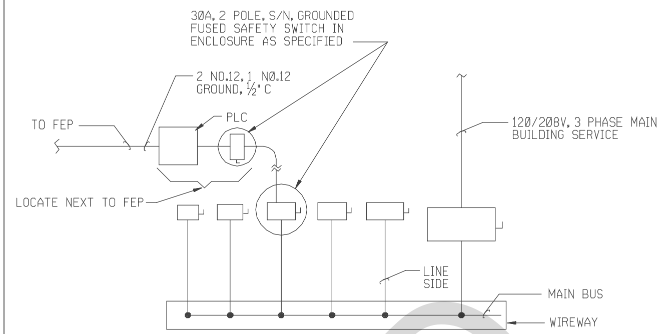
REMOTE LOCATION POWER SUPPLY-
HIGH VOLTAGE

DETAIL E-12



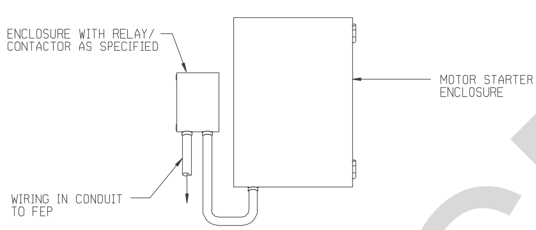
ELECTRIC METERING INSTALLATION BUILDING ENTRANCE ONLY

DETAIL E-13



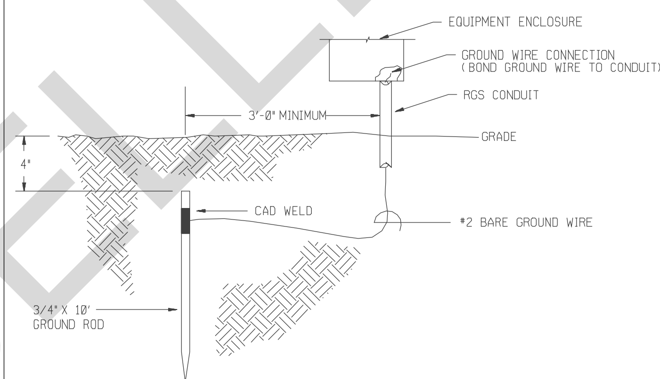
120V POWER CONNECTION TO FEP

DETAIL E-14



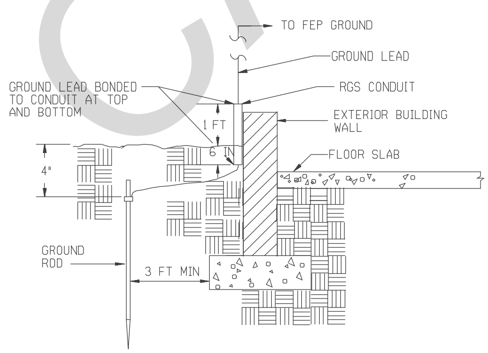
RELAY/CONTACTOR ENCLOSURE

DETAIL E-15



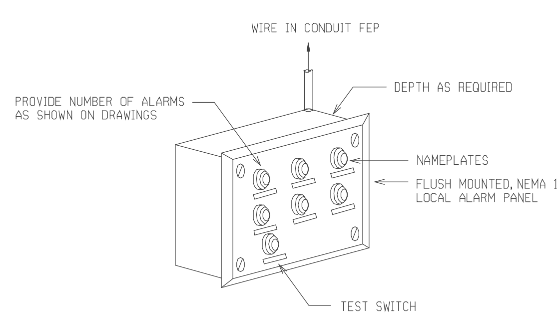
TYPICAL OUTDOOR GROUNDING

DETAIL E-16



GROUND ROD CONNECTION

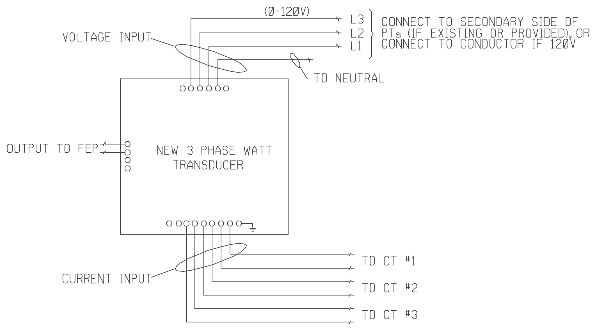
DETAIL E-17



LOCAL ALARM PANEL

DETAIL E-18

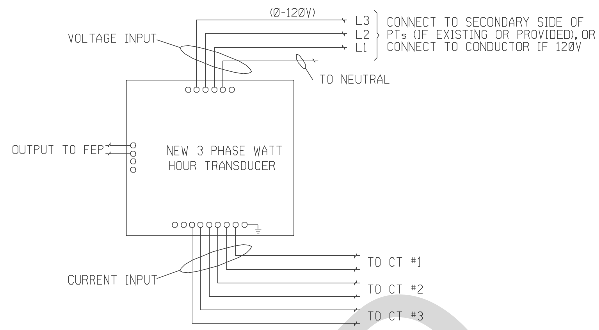
AIJ E19 TRANSDUCER, WATT (3 PHASE, 4 WIRE WYE SYSTEM)



WATT TRANSDUCER FOR 3 PHASE, 4 WIRE WYE SYSTEM

DETAIL E-19

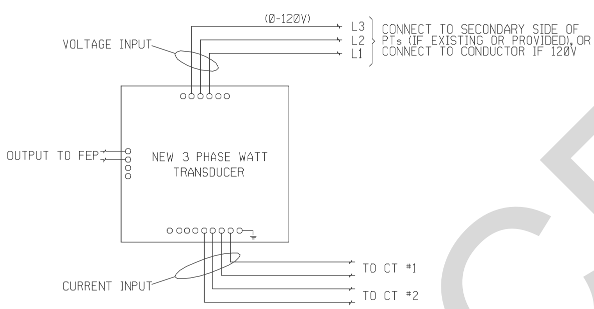
AIJ E20 TRANSDUCER, WATT HOUR (3 PHASE, 4 WIRE WYE SYSTEM)



WATT HOUR TRANSDUCER FOR 3 PHASE, 4 WIRE WYE SYSTEM

DETAIL E-20

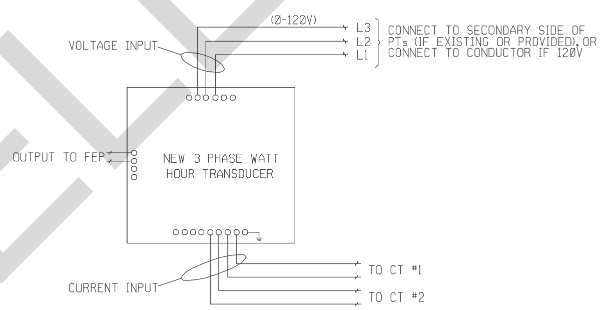
AIJ E21 TRANSDUCER, WATT (3 PHASE, 3 WIRE DELTA SYSTEM)



WATT TRANSDUCER FOR 3 PHASE, 3 WIRE DELTA SYSTEM

DETAIL E-21

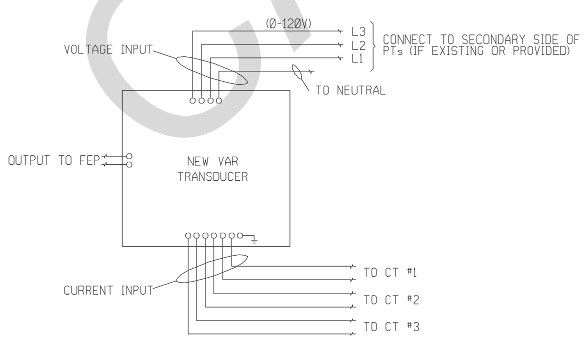
AIJ E22 TRANSDUCER, WATT HOUR (3 PHASE, 3 WIRE DELTA SYSTEM)



WATT HOUR TRANSDUCER FOR 3 PHASE, 3 WIRE DELTA SYSTEM

DETAIL E-22

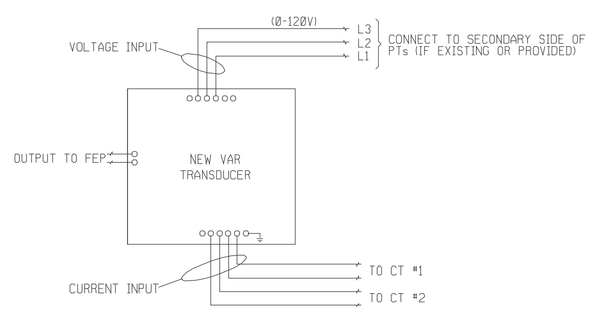
AIJ E23 TRANSDUCER, VAR (3 PHASE, 4 WIRE WYE SYSTEM)



VAR TRANSDUCER FOR 3 PHASE, 4 WIRE WYE SYSTEM

DETAIL E-23

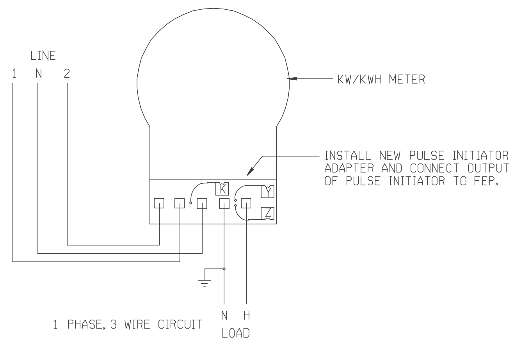
AIJ E24 TRANSDUCER, VAR (3 PHASE, 3 WIRE DELTA SYSTEM)



VAR TRANSDUCER FOR 3 PHASE, 3 WIRE DELTA SYSTEM

DETAIL E-24

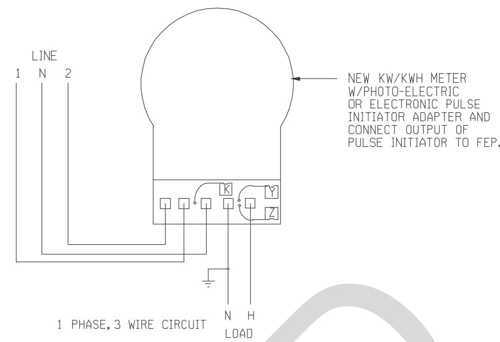
D1J E25 POWER METER, EXISTING 3 WIRE SINGLE PHASE
W/NEW PULSE INITIATOR (UNDER 600V)



EXISTING 3 WIRE SINGLE PHASE METER
W/NEW PULSE INITIATOR

DETAIL E-25

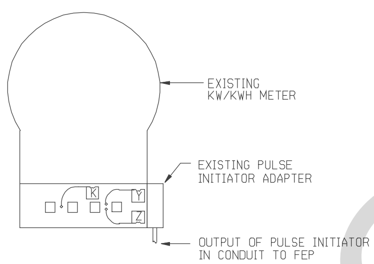
D1J E26 POWER METER, NEW 3 WIRE SINGLE PHASE
W/NEW PULSE INITIATOR (UNDER 600V)



NEW 3 WIRE SINGLE PHASE METER
W/NEW PULSE INITIATOR

DETAIL E-26

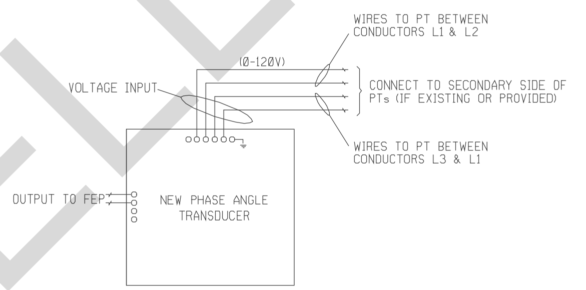
D1J E27 POWER METER, EXISTING W/EXISTING
PULSE INITIATOR



EXISTING POWER METER
W/EXISTING PULSE INITIATOR

DETAIL E-27

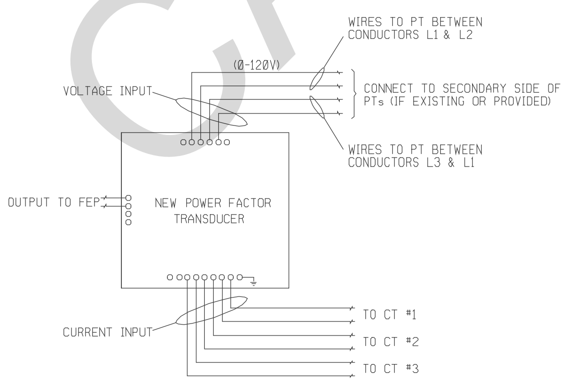
A1J E28 TRANSDUCER, PHASE ANGLE



PHASE ANGLE TRANSDUCER FOR
3 PHASE, 4 WIRE WYE SYSTEM

DETAIL E-28

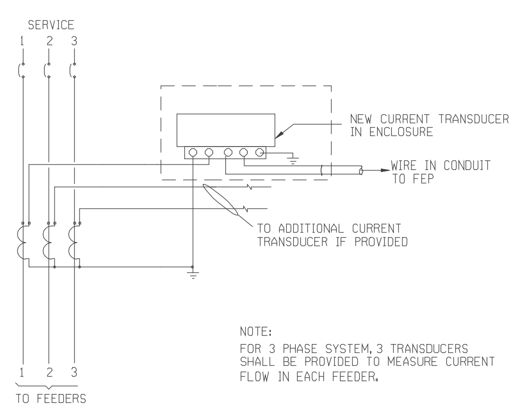
A1J E29 TRANSDUCER, POWER FACTOR



POWER FACTOR TRANSDUCER FOR
3 PHASE, 4 WIRE WYE SYSTEM

DETAIL E-29

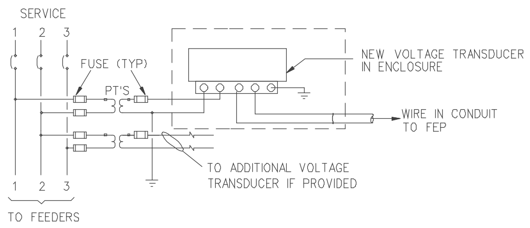
A1J E30 TRANSDUCER, CURRENT



CURRENT TRANSDUCER

DETAIL E-30

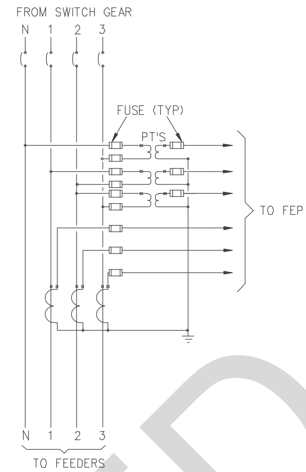
TRANSDUCER, VOLTAGE



NOTE:
FOR 3 PHASE SYSTEM, 3 TRANSDUCERS SHALL BE PROVIDED TO MEASURE VOLTAGE OF EACH PHASE.

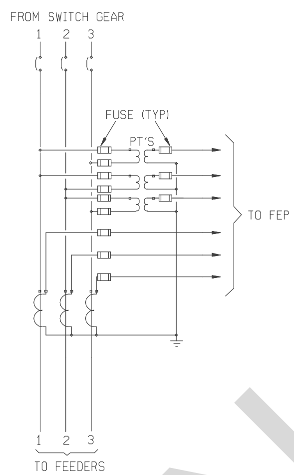
VOLTAGE TRANSDUCER

DETAIL E-31



TYPICAL METERING ARRANGEMENT FOR 3 PHASE, 4 WIRE WYE SYSTEM

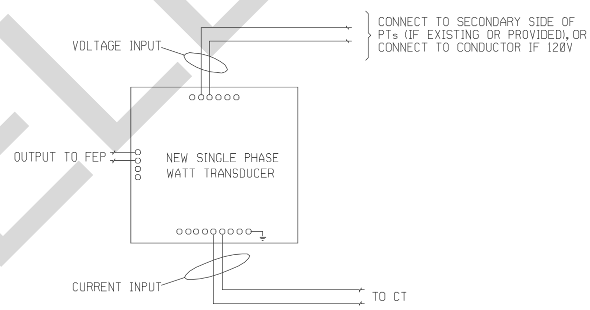
DETAIL E-32



TYPICAL METERING ARRANGEMENT FOR 3 PHASE, 3 WIRE DELTA SYSTEM

DETAIL E-33

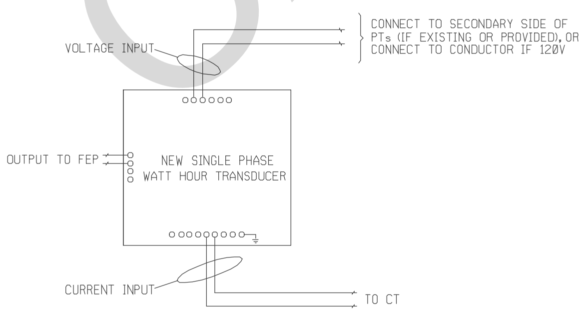
TRANSDUCER, WATT (SINGLE PHASE)



WATT TRANSDUCER FOR SINGLE PHASE

DETAIL E-34

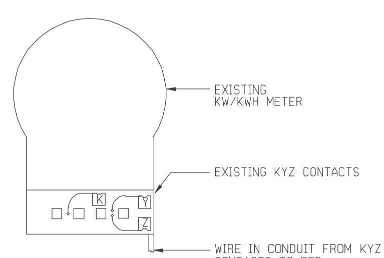
TRANSDUCER, WATT HOUR (SINGLE PHASE)



WATT HOUR TRANSDUCER FOR SINGLE PHASE

DETAIL E-35

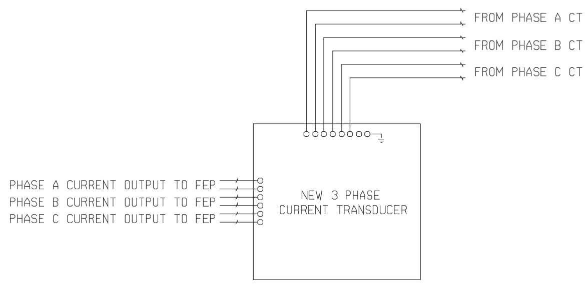
POWER METER, EXISTING W/EXISTING KYZ CONTACTS



EXISTING POWER METER W/EXISTING KYZ CONTACTS

DETAIL E-36

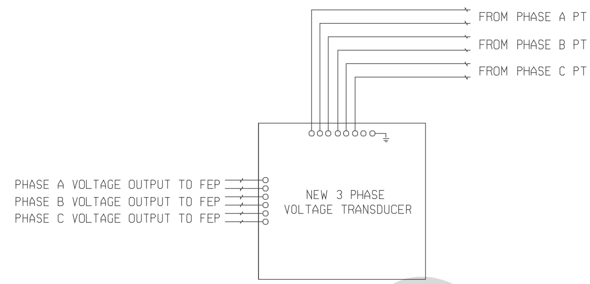
AIJ E37 TRANSDUCER, NEW 3 PHASE CURRENT



3 PHASE CURRENT TRANSDUCER

DETAIL E-37

AIJ E38 TRANSDUCER, NEW 3 PHASE VOLTAGE



3 PHASE VOLTAGE TRANSDUCER

DETAIL E-38

NOTES: TYPICAL INSTALLATION DETAILS

1. SECURE TO CONCRETE FOUNDATION USING EXPANSION ANCHORS OR EMBEDDED ANCHOR BOLTS.

2. ATTACH RAIN/SUN SHIELD TO SUPPORT ANGLES WITH 1/4" STEEL HOT DIPPED GALAVNIZED NUTS AND BOLTS. CAULK OVER BOLTS TO PREVENT LEAKING. ALL STEEL SHAPES SHALL BE HOT DIPPED GALVANIZED.

3. RED LAMINATED WARNING PLATE SHALL BE MOUNTED ON ALL UMCS CONTROLLED EQUIPMENT IN A CONSPICUOUS PLACE, VISIBLE TO PEOPLE WHO WOULD BE NEAR MOVING PARTS ON THE EQUIPMENT. FASTEN PLATE ON SHEET METAL DUCT WITH MACHINE SCREWS, ON OTHER EQUIPMENT WITH VANDAL PROOF NUTS AND BOLTS. CONTRACTOR TO OBTAIN BUILDING AND TELEPHONE NUMBERS FROM THE CONTRACTING OFFICER. LETTERING HEIGHT OF WARNING SIGN (BESIDES HEADING) SHALL BE A MINIMUM OF ONE-HALF INCH.

4. MINIMUM CLEARANCE FOR FLOW METER IS 30". HEIGHT OF PIT ABOVE GRADE WILL VARY WITH DEPTH OF PIPE. PIPE SEAL DEPTHS VARY FROM 24" TO 72" FROM GRADE TO TOP OF PIPE.

PART 4. INTERFACE DETAILS

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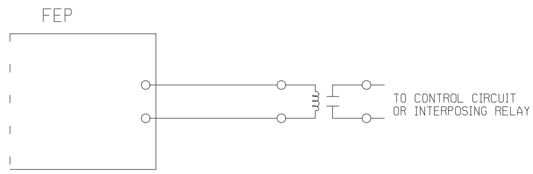
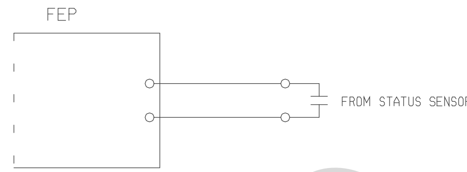
DOC I1 CONTROL RELAY, DIGITAL OUTPUT



DIGITAL OUTPUT

DETAIL I-1

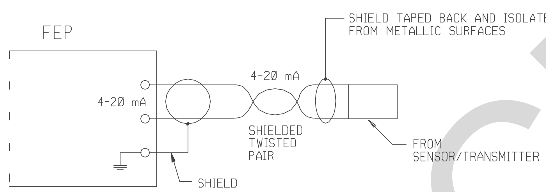
DIX I2 AUXILARY CONTACT, DIGITAL INPUT



DIGITAL INPUT

DETAIL I-2

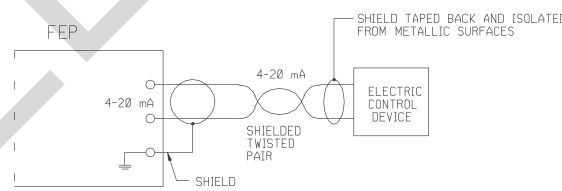
AIX I3 ANALOG INPUT, SENSOR



ANALOG INPUT

DETAIL I-3

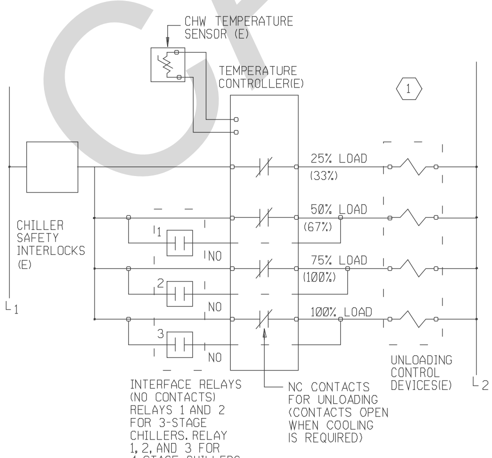
AOC I4 ANALOG OUTPUT, ELECTRIC CONTROL DEVICE



ANALOG OUTPUT

DETAIL I-4

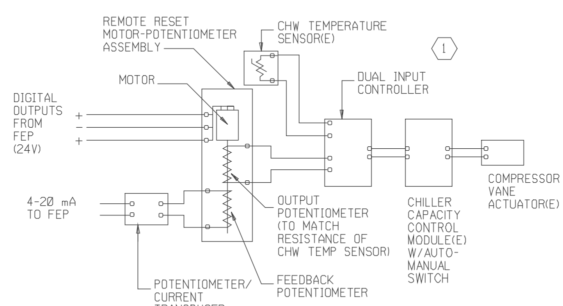
DOC I5 CONTROLLER, RECIPROCATING CHILLER (DEMAND LIMIT)



RECIPROCATING CHILLER DEMAND LIMIT INTERFACE (2)

DETAIL I-5

DOC I6 CONTROLLER, CENTRIFUGAL CHILLER (DEMAND LIMIT)

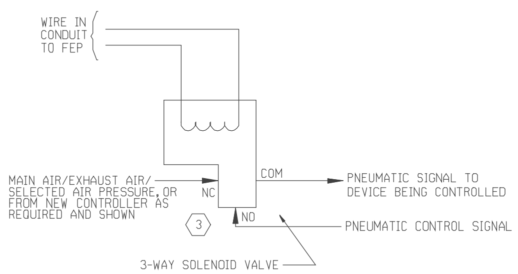


CENTRIFUGAL CHILLER DEMAND LIMIT INTERFACE (2)

DETAIL I-6

DOC I7

SOLENOID VALVE, 3-WAY, 2-POSITION OVERRIDE

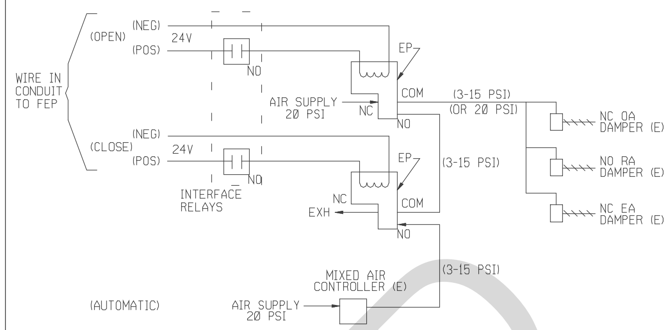


SOLENOID VALVE, 3-WAY, 2-POSITION OVERRIDE

DETAIL I-7

DOC I8

CONTROLLER, DAMPER, 3-MODE ECONOMIZER/VENT RECIRCULATION

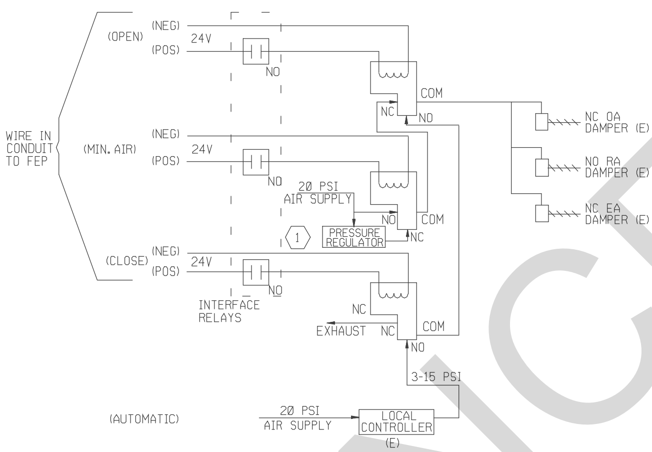


3-MODE ECONOMIZER/VENT-RECIRC CONTROL (OPEN/AUTOMATIC/CLOSE)

DETAIL I-8

DOC I9

CONTROLLER, 4-MODE ECONOMIZER/VENT-RECIRCULATION

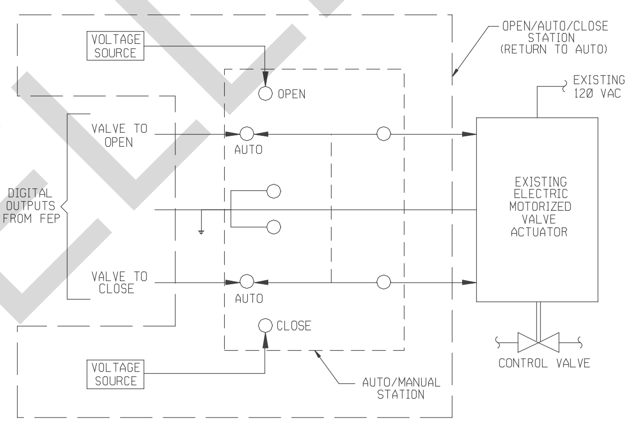


4-MODE ECONOMIZER/VENT-RECIRC CONTROL (OPEN/MIN. AIR/AUTOMATIC/CLOSE)

DETAIL I-9

DOZ I10

MOTORIZED VALVE CONTROL

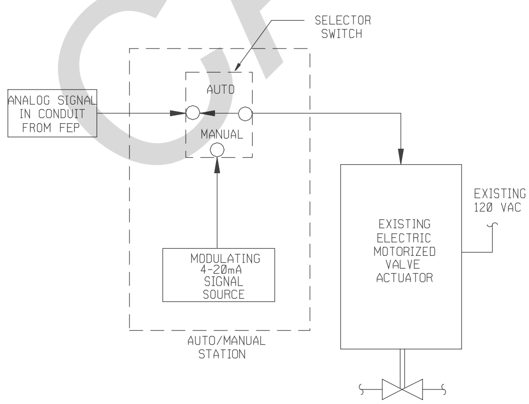


MOTORIZED VALVE CONTROL W/FEP INTERFACE AND MANUAL OVERRIDE

DETAIL I-10

AOZ I11

ANALOG VALVE CONTROL W/MANUAL OVERRIDE

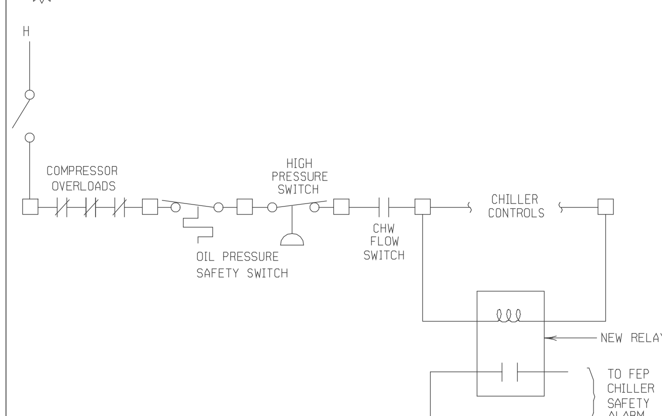


ANALOG VALVE CONTROL WITH FEP INTERFACE AND MANUAL OVERRIDE

DETAIL I-11

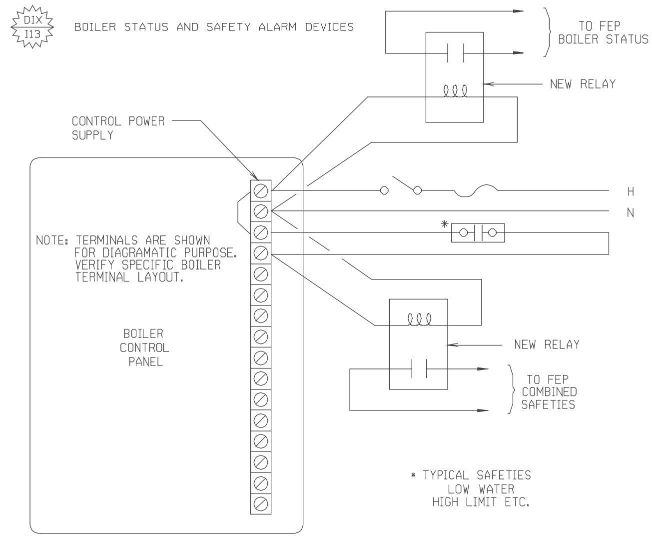
DIX I12

CHILLER SAFETY ALARMS DEVICE



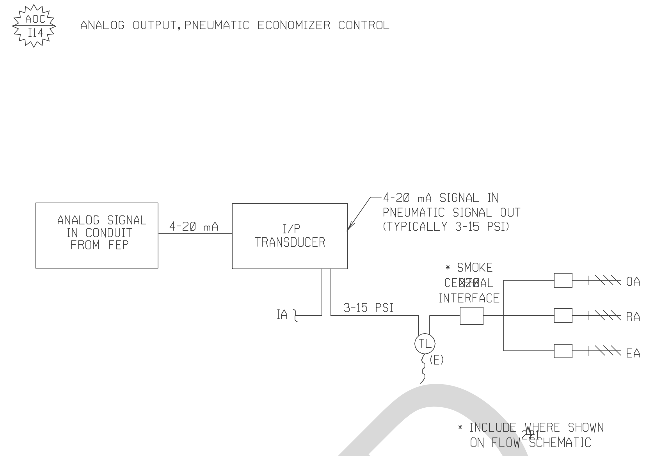
CHILLER SAFETY ALARMS DEVICE

DETAIL I-12



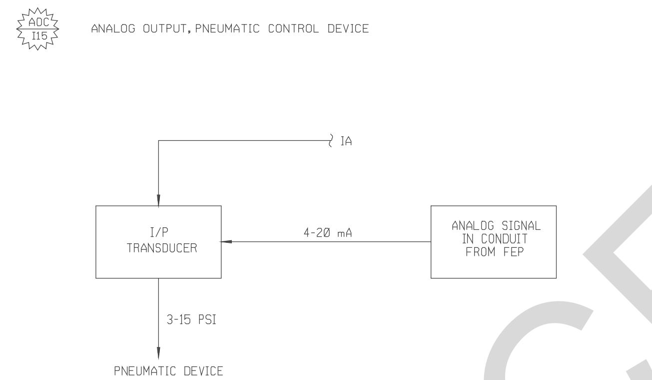
BOILER STATUS & SAFETY ALARM DEVICES

DETAIL I-13



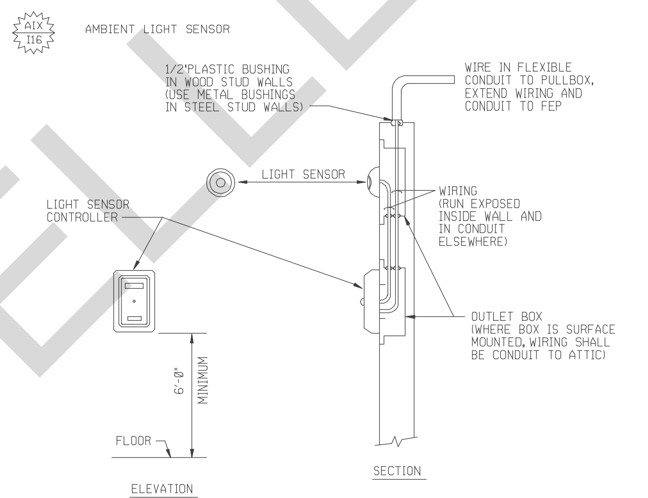
ECONOMIZER CONTROL (PNEUMATIC)

DETAIL I-14



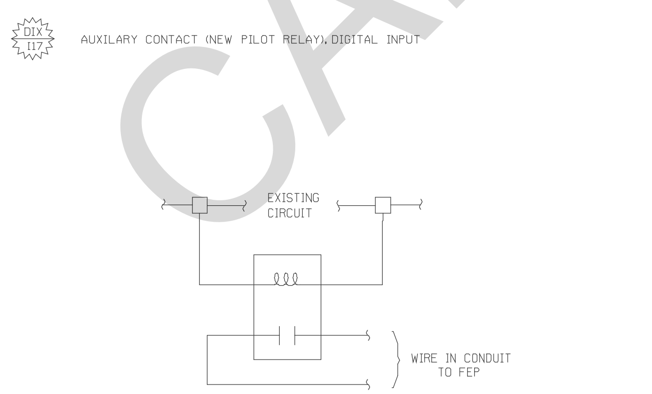
ANALOG OUTPUT, PNEUMATIC CONTROL DEVICE

DETAIL I-15



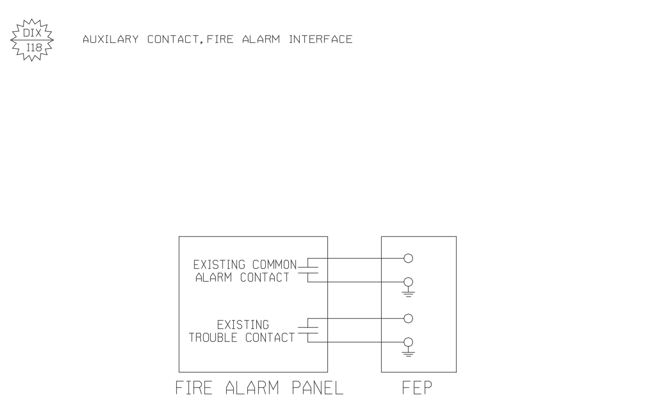
AMBIENT LIGHT SENSOR

DETAIL I-16



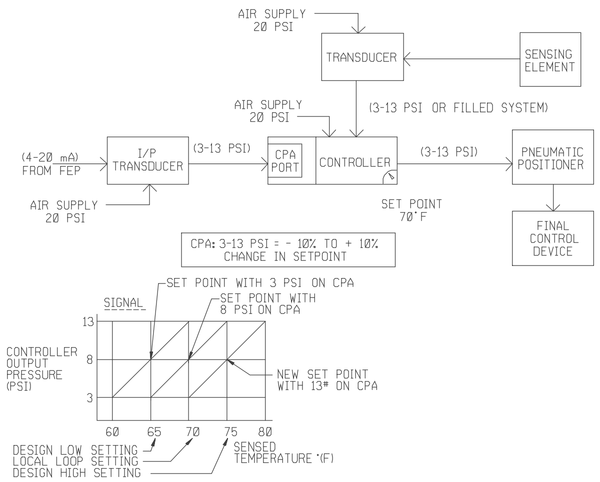
AUXILIARY CONTACT (NEW PILOT RELAY), DIGITAL INPUT

DETAIL I-17



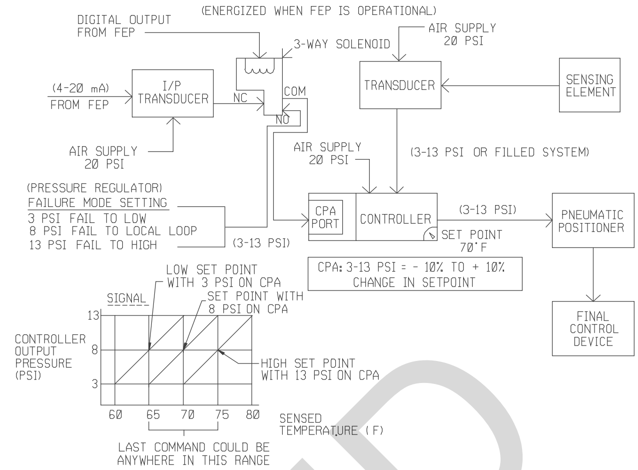
AUXILIARY CONTACT, FIRE ALARM INTERFACE

DETAIL I-18



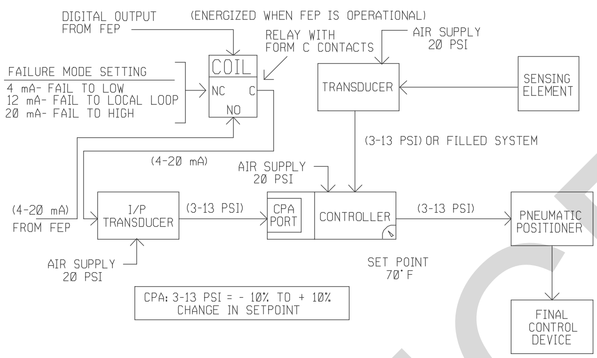
PNEUMATIC LOCAL LOOP
WITH CPA PORT

DETAIL I-19



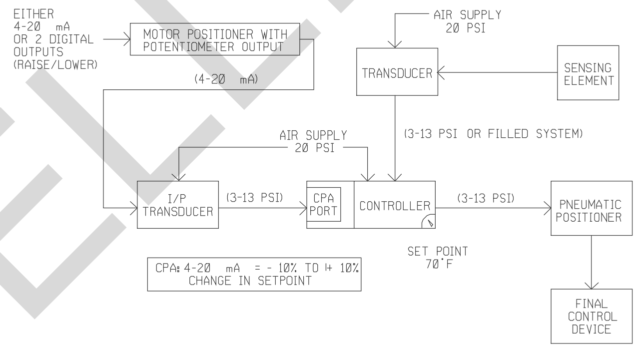
PNEUMATIC LOCAL LOOP WITH CPA PORT
AND FAILOVER 3-WAY AIR SOLENOID VALVE

DETAIL I-20



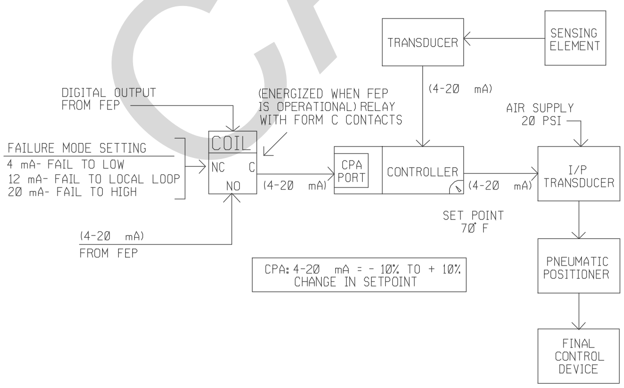
PNEUMATIC LOCAL LOOP WITH CPA
PORT AND FAILOVER WITH ELECTRIC
RELAY WITH FORM C CONTACTS

DETAIL I-21



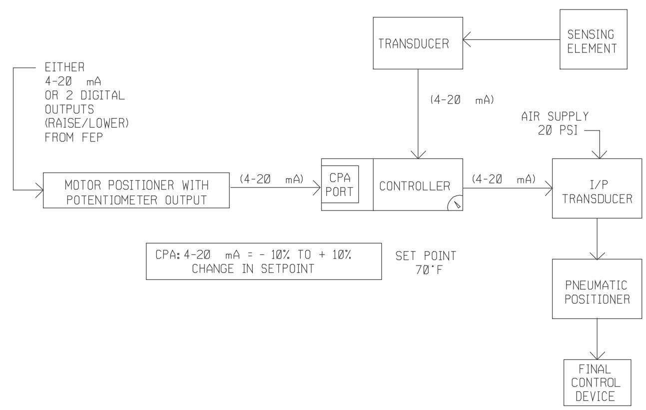
PNEUMATIC LOCAL LOOP WITH CPA PORT
PORT AND FAIL TO LAST COMMAND

DETAIL I-22



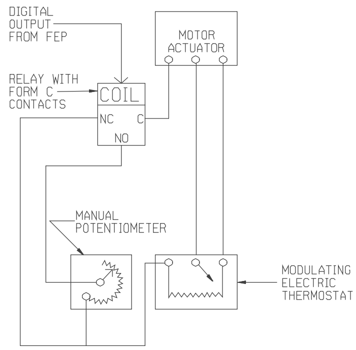
ELECTRONIC LOOP WITH SET POINT RESET
AND FAILOVER RELAY WITH FORM C CONTACTS

DETAIL I-23



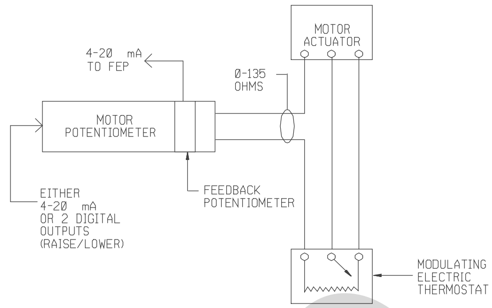
ELECTRONIC LOOP WITH SET POINT
RESET AND FAIL TO LAST COMMAND

DETAIL I-24



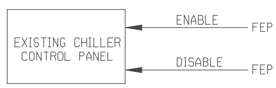
MODULATING ELECTRIC THERMOSTAT WITH FEP DAY/NIGHT SETBACK INTERFACE

DETAIL I-25



MODULATING ELECTRIC THERMOSTAT WITH FEP DAY/NIGHT SETBACK INTERFACE WITH SETBACK TEMPERATURE ADJUSTABLE BY FEP

DETAIL I-26



NOTE:

WIRE THE ENABLE/DISABLE INPUT, AT CHILLER PANEL, TO ALLOW CHILLER TO CONTINUE PERFORMING PER MANUFACTURER's START/STOP ROUTINE. ALL SAFETIES TO REMAIN AS EXISTING.

CHILLER ENABLE/DISABLE

DETAIL I-27

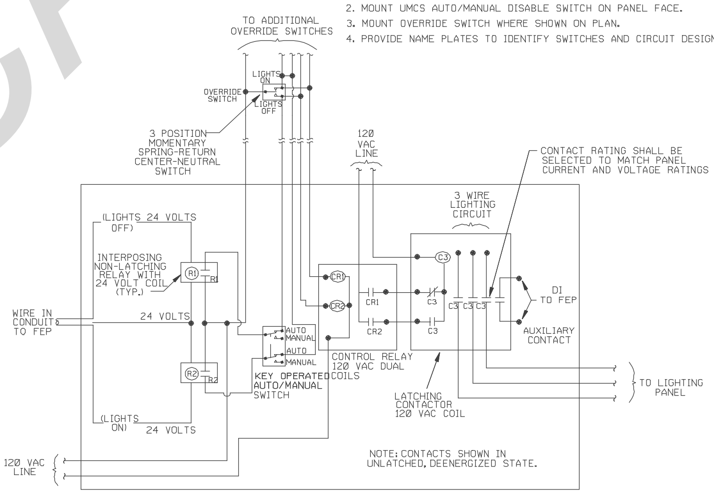
RESERVED

DOC 128

CONTROL RELAY AND LATCHING CONTACTOR W/AUXILIARY CONTACT

NOTE:

1. MOUNT RELAYS AND CONTACTOR IN AN ENCLOSURE WHERE SHOWN.
2. MOUNT UMCS AUTO/MANUAL DISABLE SWITCH ON PANEL FACE.
3. MOUNT OVERRIDE SWITCH WHERE SHOWN ON PLAN.
4. PROVIDE NAME PLATES TO IDENTIFY SWITCHES AND CIRCUIT DESIGNATIONS.

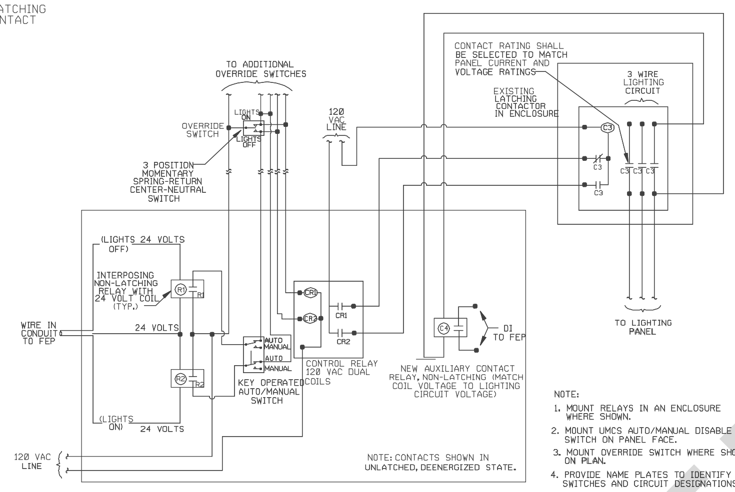


LIGHTING CONTROL PANEL

DETAIL I-28

DOC I29

CONTROL RELAY AND EXISTING LATCHING CONTACTOR W/NEW AUXILIARY CONTACT



NOTE:

1. MOUNT RELAYS IN AN ENCLOSURE WHERE SHOWN.
2. MOUNT UMCS AUTO/MANUAL DISABLE SWITCH ON PANEL FACE.
3. MOUNT OVERRIDE SWITCH WHERE SHOWN ON PLAN.
4. PROVIDE NAME PLATES TO IDENTIFY SWITCHES AND CIRCUIT DESIGNATIONS.

LIGHTING CONTROL PANEL
W/EXISTING LATCHING CONTACTOR

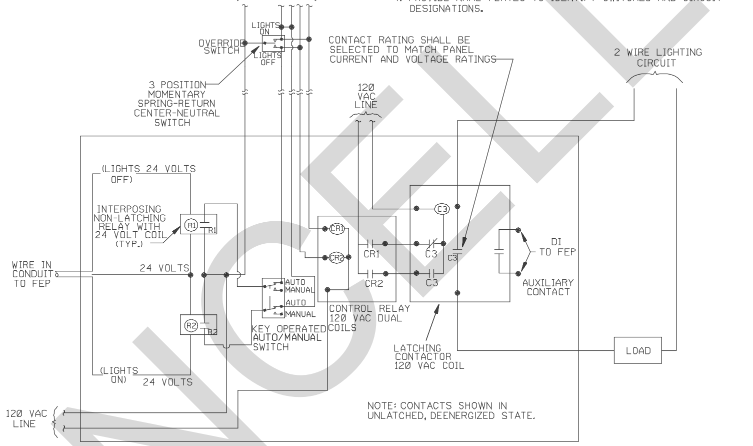
DETAIL I-29

DOC I30

CONTROL RELAY AND LATCHING CONTACTOR FOR ONE LIGHTING CIRCUIT/FIXTURE W/AUXILIARY CONTACT

NOTE:

1. MOUNT RELAYS AND CONTACTOR IN AN ENCLOSURE WHERE SHOWN.
2. MOUNT UMCS AUTO/MANUAL DISABLE SWITCH ON PANEL FACE.
3. MOUNT OVERRIDE SWITCH WHERE SHOWN ON PLAN.
4. PROVIDE NAME PLATES TO IDENTIFY SWITCHES AND CIRCUIT DESIGNATIONS.

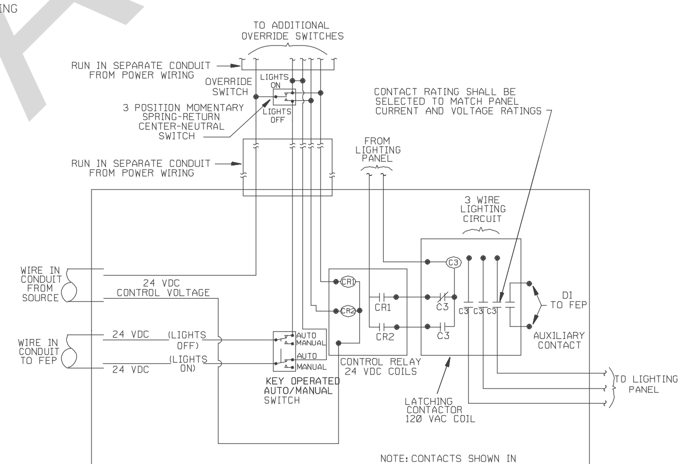


LIGHTING CONTROL PANEL
FOR ONE CIRCUIT OR FIXTURE

DETAIL I-30

DOC I31

CONTROL RELAY (24VDC) AND LATCHING CONTACTOR W/AUXILIARY CONTACT

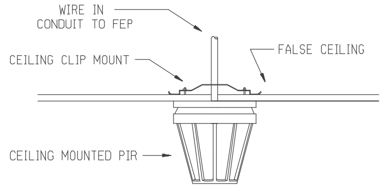


LIGHTING CONTROL PANEL
FOR 24 VDC CONTROL CIRCUITS

DETAIL I-31

DIC I32

LIGHTING CONTROL, PIR SENSOR
(CEILING MOUNTED)

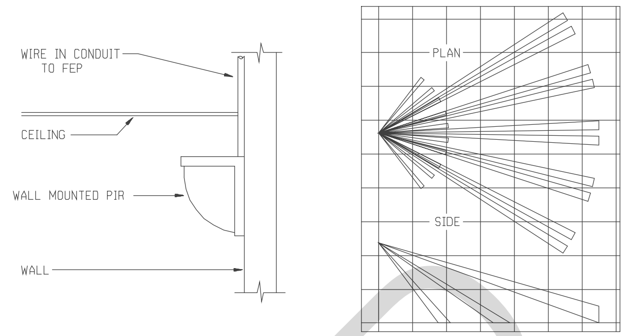


PIR SENSOR, LIGHTING CONTROL

DETAIL I-32

DIC I33

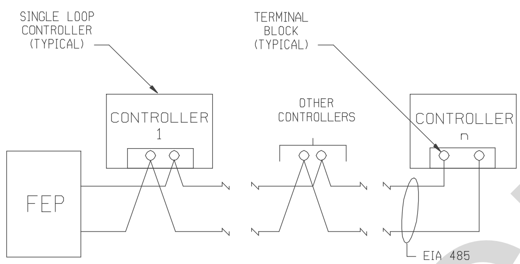
LIGHTING CONTROL, PIR SENSOR
(WALL MOUNTED)



TYPICAL PIR DETECTION COVERAGE GRID = 10' SQ

PIR SENSOR, LIGHTING CONTROL

DETAIL I-33



NOTES:

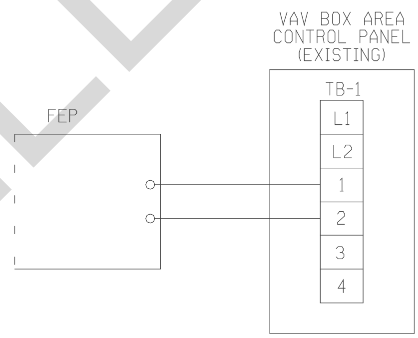
1. NO MORE THAN 31 CONTROLLERS SHALL BE ON ONE EIA 485 LOOP.
2. CONTROLLERS OF DIFFERENT MANUFACTURERS SHALL BE CONNECTED ON SEPARATE EIA 485 PORTS.

SINGLE LOOP CONTROLLERS INTERFACE

DETAIL I-34

DOC I35

VAV BOX, AREA CONTROL PANEL
FIRE ALARM INTERFACE, DIGITAL OUTPUT



VAV BOX AREA CONTROL PANEL
FIRE ALARM INTERFACE, DIGITAL OUTPUT

DETAIL I-35

PART 5. INSTALLATION DETAILS

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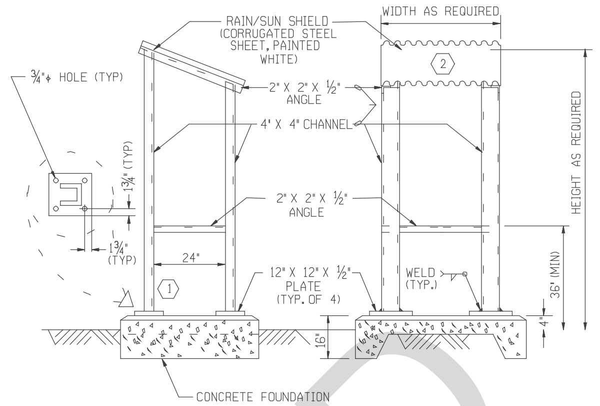
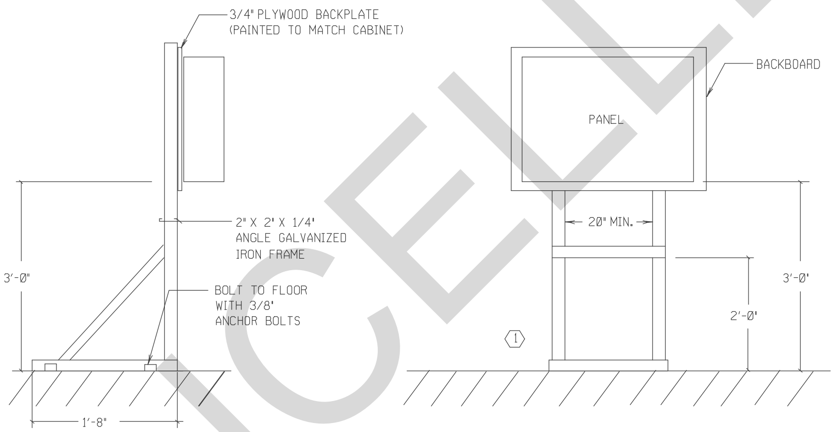
RESERVED



SIDE VIEW FRONT VIEW

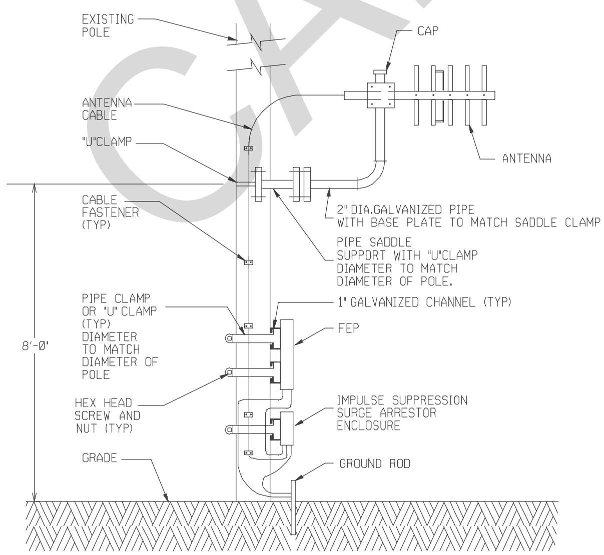
FEP OUTDOOR MOUNTING FOR NEMA 4 ENCLOSURE

DETAIL D-2



FREE STANDING PANEL MOUNTING

DETAIL D-3



RTU MOUNTING WITH ANTENNA (OUTDOOR)

DETAIL D-4

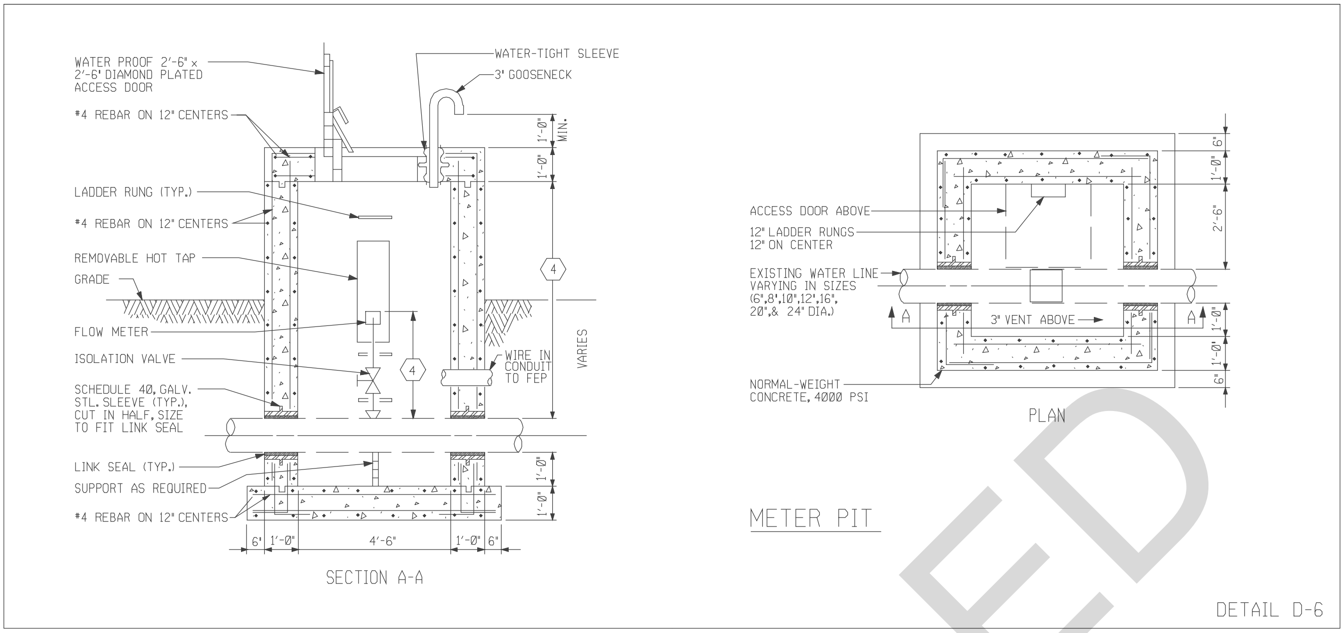
WARNING !

AUTOMATICALLY CONTROLLED EQUIPMENT

THIS EQUIPMENT IS UNDER UMCS CONTROL AND WILL START AND STOP SUDDENLY. CONTACT UMCS CONSOLE OPERATOR IN BLDG. NO. ______, TELEPHONE NO. ______ PRIOR TO PERFORMING ANY SERVICE, MAINTENANCE OR DISCONNECTING ANY COMPONENTS.

RED LAMINATED WARNING SIGN FOR UMCS CONTROLLED EQUIPMENT 3

DETAIL D-5



NOTES: TYPICAL UMCS INTERFACE DETAILS

1. FOR EQUIPMENT SPECIFIC INFORMATION REFER TO CHILLER DETAILS AS APPLICABLE. CH-1 IS A 4-STAGE RECIPROCATING CHILLER WITH FEP INTERFACE RELAYS FOR UNLOADING 3 STAGES (50%, 75%, AND 100%). CH-2 IS A 3-STAGE RECIPROCATING CHILLER WITH FEP INTERFACE RELAYS FOR UNLOADING 2 STAGES (67%, AND 100%). CH-3 IS A CENTRIFUGAL CHILLER AND REQUIRES 2 FEP (STEP INPUTS) SIGNALS.

2. DETAIL IS APPLICABLE FOR CHILLERS THAT DO NOT HAVE MICROPROCESSOR BASED CONTROLS.

3. THE CONTRACTOR SHALL SELECT THE APPROPRIATE AIR CIRCUIT CONNECTIONS TO SATISFY THE REQUIREMENTS FOR THE DEVICE'S FAILURE MODE SHOWN.

PART 6. MECHANICAL DETAILS

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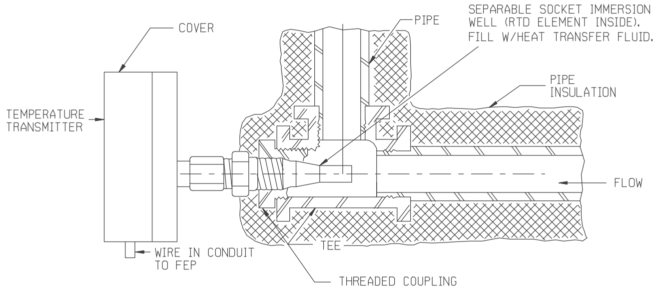
Table of Contents - continued

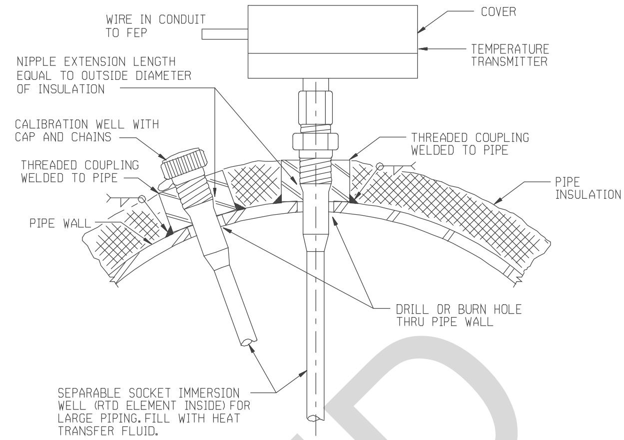
AIT M1 — TEMPERATURE SENSOR, PIPE



RTD INSTALLATION - SMALL PIPING

DETAIL M-1

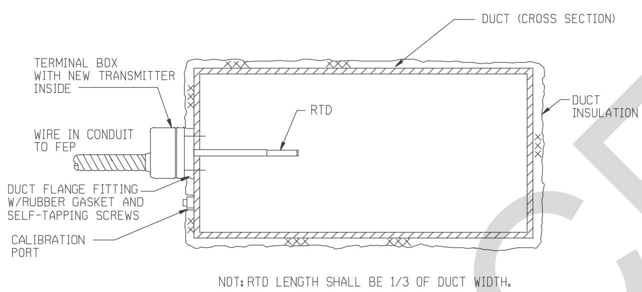
AIT M2 — TEMPERATURE SENSOR, LARGE PIPE



RTD INSTALLATION - LARGE PIPING

DETAIL M-2

AIT M3 — TEMPERATURE SENSOR, DUCT

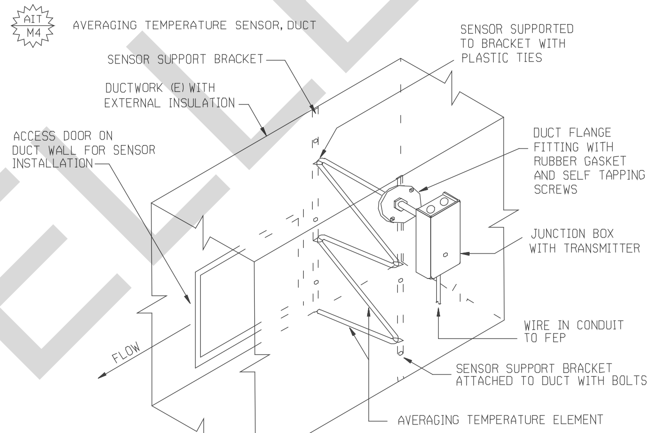


NOT: RTD LENGTH SHALL BE 1/3 OF DUCT WIDTH.

DUCT POINT TEMPERATURE INSTRUMENT INSTALLATION

DETAIL M-3

AIT M4 — AVERAGING TEMPERATURE SENSOR, DUCT



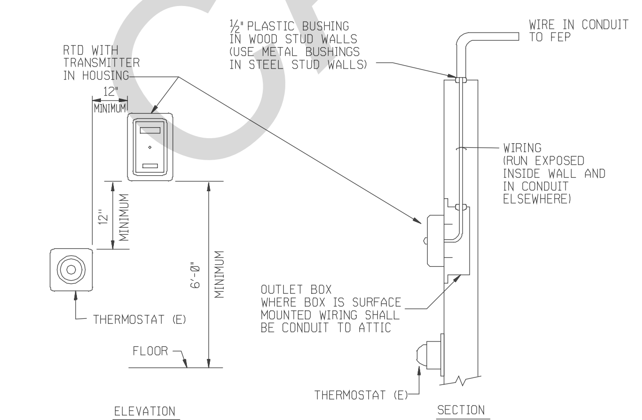
NOTES :

1. PROVIDE 1 FT LENGTH OF SENSING ELEMENT FOR EVERY SQ. FT. OF DUCT CROSS SECTION.
2. MINIMUM BENDING RADIUS OF AVERAGING TEMPERATURE ELEMENT IS 3 INCHES.

DUCT-MOUNTED AVERAGING TEMPERATURE SENSOR INSTALLATION

DETAIL M-4

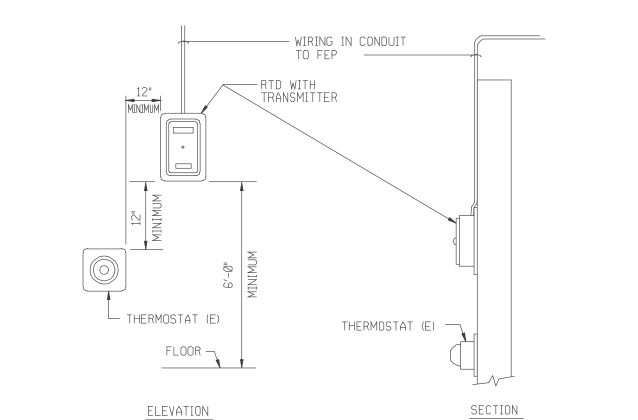
AIT M5 — TEMPERATURE SENSOR, FINISHED SPACE



SPACE RTD MOUNTING (FOR FINISHED INTERIORS)

DETAIL M-5

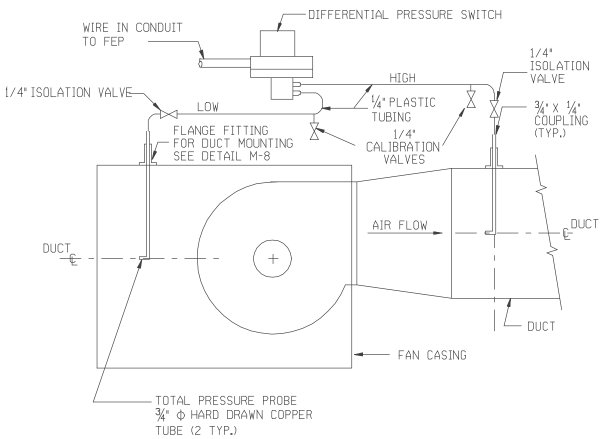
AIT M6 — TEMPERATURE SENSOR, UNFINISHED SPACE



SPACE RTD MOUNTING (FOR UNFINISHED INTERIORS)

DETAIL M-6

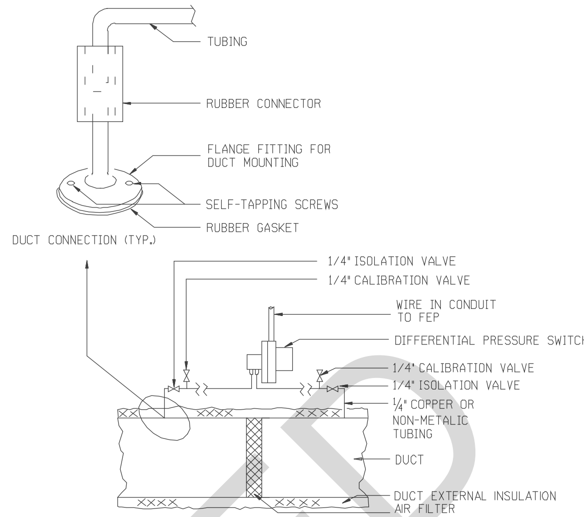
DIP M7 DIFFERENTIAL PRESSURE SWITCH, FAN AIR FLOW



FAN AIR FLOW SWITCH INSTALLATION

DETAIL M-7

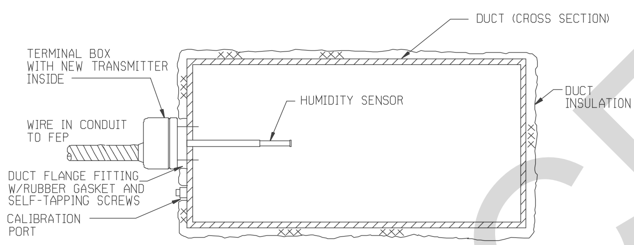
DIP M8 DIFFERENTIAL PRESSURE SWITCH, AIR FILTER



AIR FILTER DIFFERENTIAL PRESSURE SWITCH INSTALLATION

DETAIL M-8

AIM M9 HUMIDITY SENSOR, DUCT

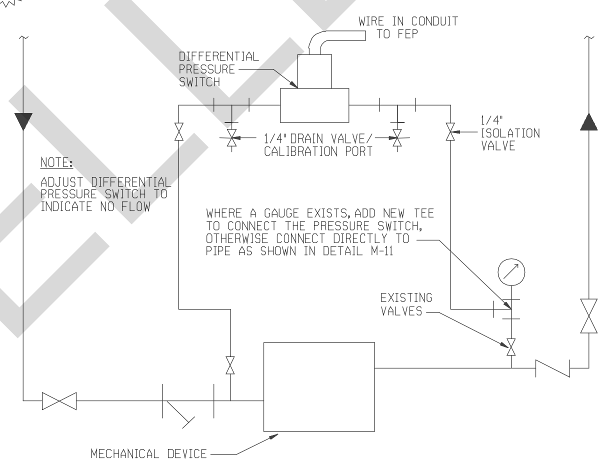


NOT: SENSOR LENGTH SHALL BE 1/3 OF DUCT WIDTH.

DUCT RELATIVE HUMIDITY INSTRUMENT INSTALLATION

DETAIL M-9

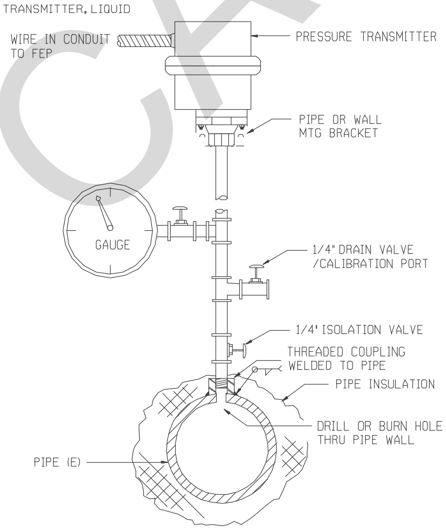
DIP M10 DIFFERENTIAL PRESSURE SWITCH, LIQUID



DIFFERENTIAL PRESSURE SWITCH, LIQUID INSTALLATION

DETAIL M-10

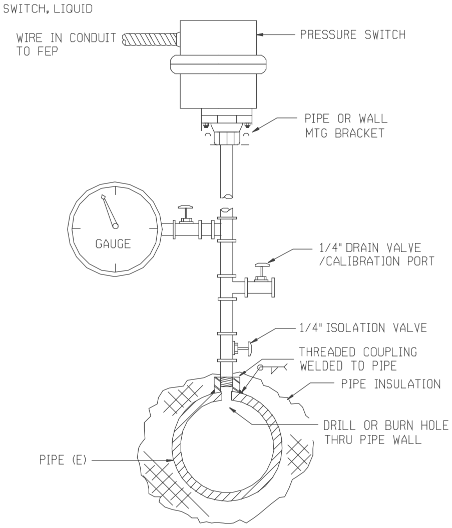
AIP M11 PRESSURE TRANSMITTER, LIQUID



INSTALLATION OF PRESSURE TRANSMITTER

DETAIL M-11

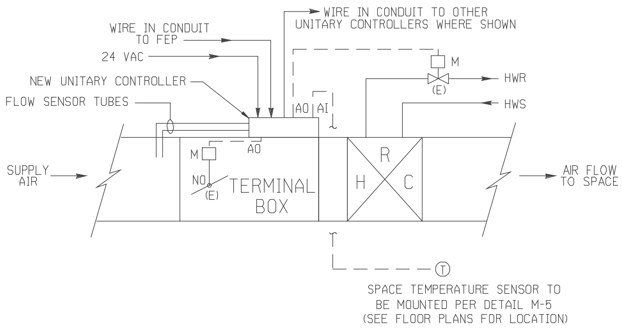
DIP M12 PRESSURE SWITCH, LIQUID



INSTALLATION OF PRESSURE SWITCH

DETAIL M-12

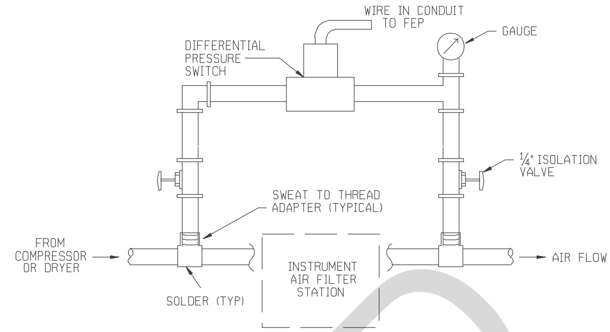
AOC M13 ANALOG OUTPUT, TERMINAL BOX CONTROLLER



TERMINAL BOX CONTROLLER

DETAIL M-13

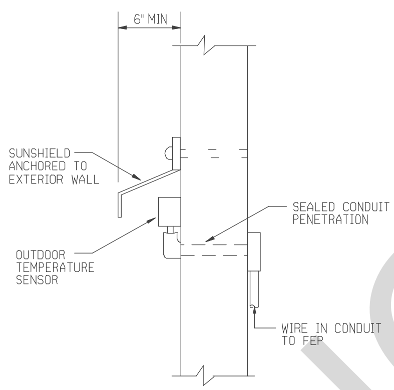
DIP M14 DIFFERENTIAL PRESSURE SWITCH, INSTRUMENT AIR FILTER



DIFFERENTIAL PRESSURE SWITCH FOR INSTRUMENT AIR FILTER

DETAIL M-14

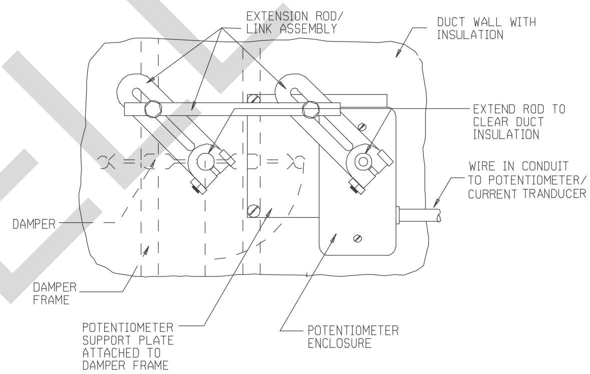
AIT M15 TEMPERATURE SENSOR, OUTDOOR (SUNSHIELD)



OUTDOOR TEMPERATURE SENSOR WITH SUNSHIELD

DETAIL M-15

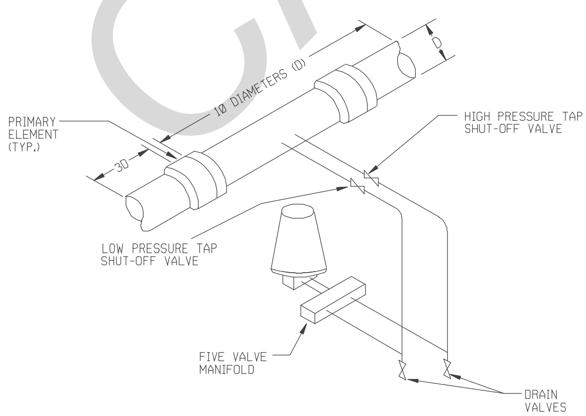
AIZ M16 POSITION INDICATION, DAMPER



DAMPER POSITION INDICATION POTENTIOMETER INSTALLATION DETAILS OUTSIDE DUCT MOUNTING

DETAIL M-16

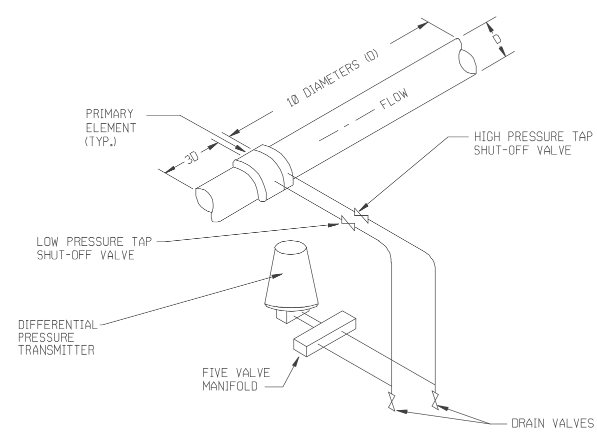
AIF M17 FLOW METER, VENTURI (DELTA-P)



FLOW METER, VENTURI (DELTA-P)

DETAIL M-17

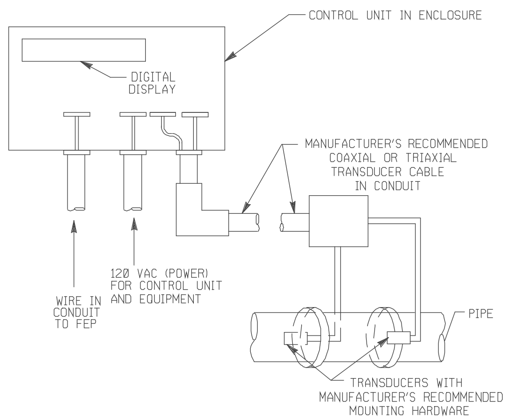
AIF M18 FLOW METER, ORIFICE PLATE (DELTA-P)



FLOW METER, ORIFICE PLATE (DELTA-P)

DETAIL M-18

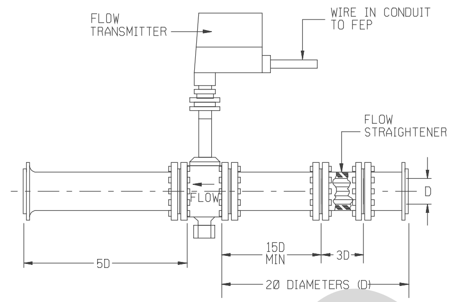
AIF M19 FLOW METER, ULTRASONIC



ULTRASONIC FLOW METER INSTALLATION

DETAIL M-19

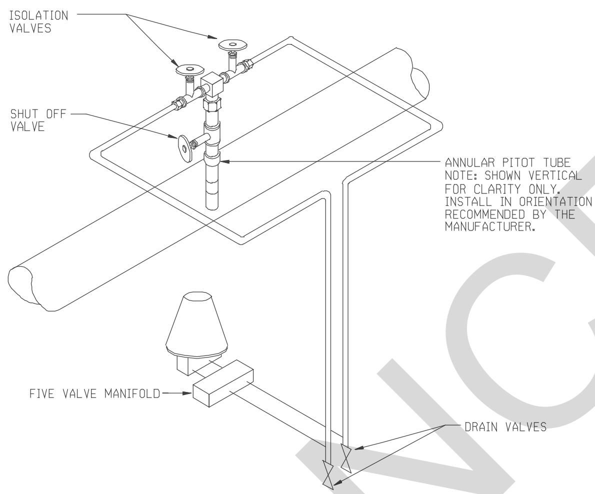
AIF M20 FLOW METER, VORTEX SHEDDING



VORTEX SHEDDING FLOW METER INSTALLATION

DETAIL M-20

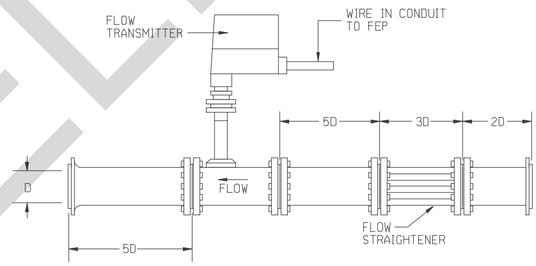
AIF M21 FLOW METER, LIQUID (ANNULAR PITOT TUBE)



FLOW METER, LIQUID (ANNULAR PITOT TUBE)

DETAIL M-21

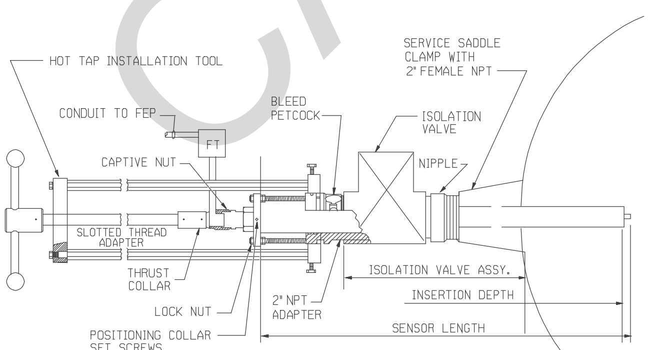
AIF M22 FLOW METER, TURBINE



TURBINE FLOW METER INSTALLATION

DETAIL M-22

AIF M23 FLOW METER, TURBINE (INSERTION TYPE)

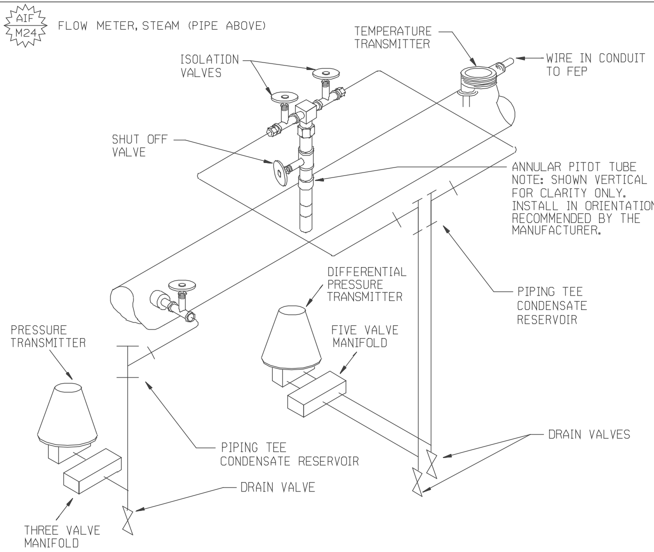


NOTE: CUTTING TOOL MAY REQUIRE ADDITIONAL CLEARANCE

FLOW METER, TURBINE (INSERTION TYPE)

DETAIL M-23

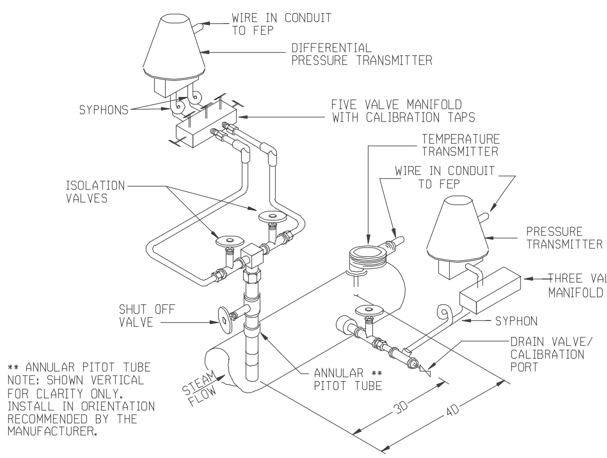
AIF M24 FLOW METER, STEAM (PIPE ABOVE)



STEAM FLOW METERING (PIPE ABOVE)

DETAIL M-24

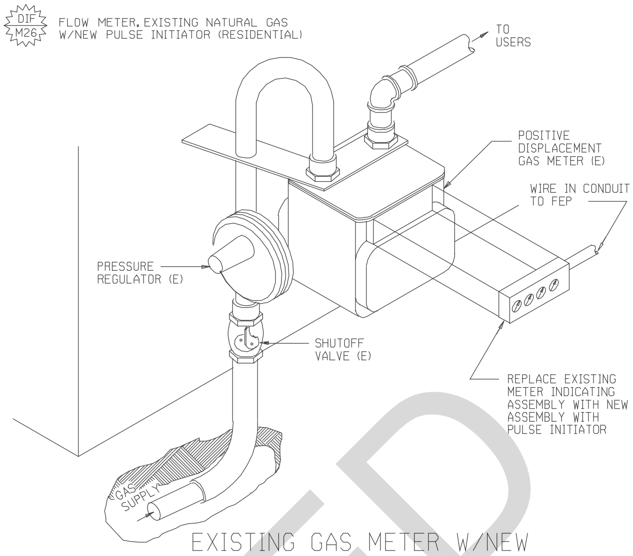
AIF M25 FLOW METER, STEAM (PIPE BELOW)



STEAM FLOW METERING (PIPE BELOW)

DETAIL M-25

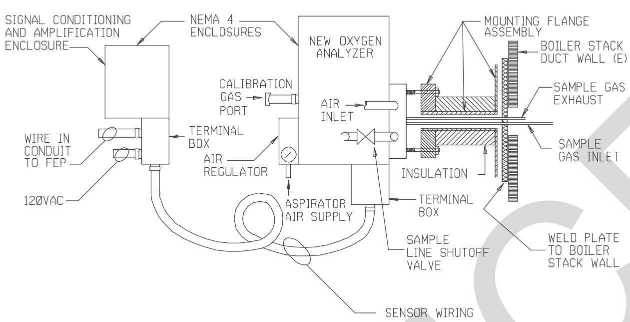
DIF M26 FLOW METER, EXISTING NATURAL GAS W/NEW PULSE INITIATOR (RESIDENTIAL)



EXISTING GAS METER W/NEW PULSE INITIATOR (RESIDENTIAL)

DETAIL M-26

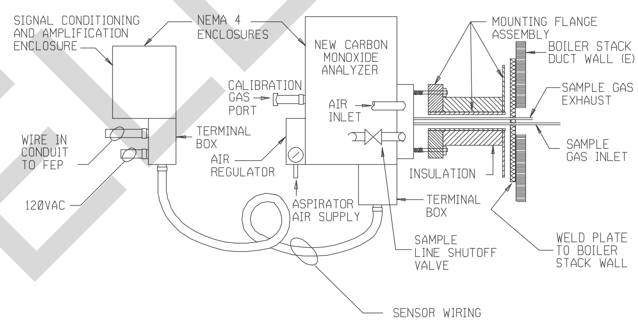
AIA M27 ANALYZER, OXYGEN



OXYGEN ANALYZER INSTALLATION

DETAIL M-27

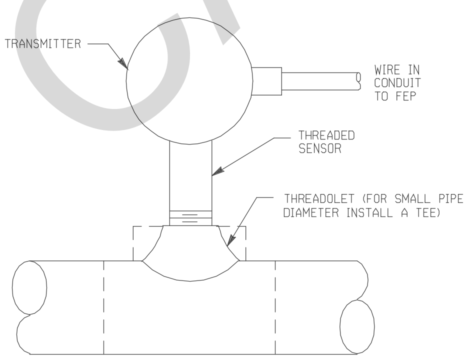
AIA M28 ANALYZER, CARBON MONOXIDE



CARBON MONOXIDE ANALYZER INSTALLATION

DETAIL M-28

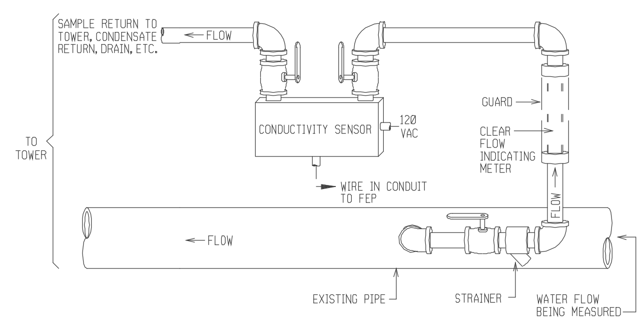
AIA M29 ANALYZER, pH SENSOR



pH SENSOR ANALYZER INSTALLATION

DETAIL M-29

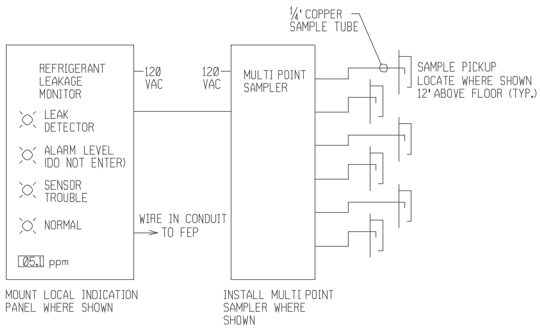
AIA M30 ANALYZER, CONDUCTIVITY



CONDUCTIVITY SENSOR

DETAIL M-30

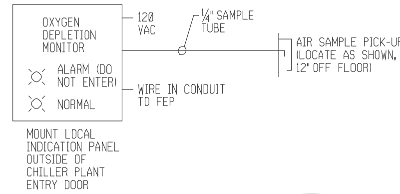
AIA M31 ANALYZER, REFRIGERANT LEAKAGE



REFRIGERANT LEAKAGE ANALYZER

DETAIL M-31

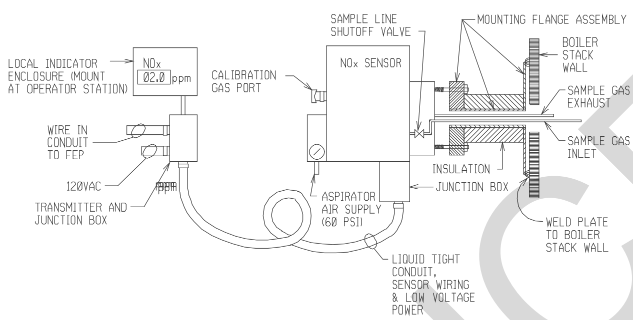
AIA M32 ANALYZER, OXYGEN DEPLETION



OXYGEN DEPLETION ANALYZER

DETAIL M-32

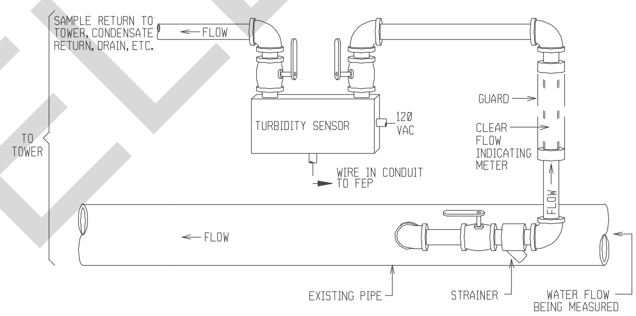
AIA M33 ANALYZER, NITROUS GASES (NOx)



NOx ANALYZER INSTALLATION

DETAIL M-33

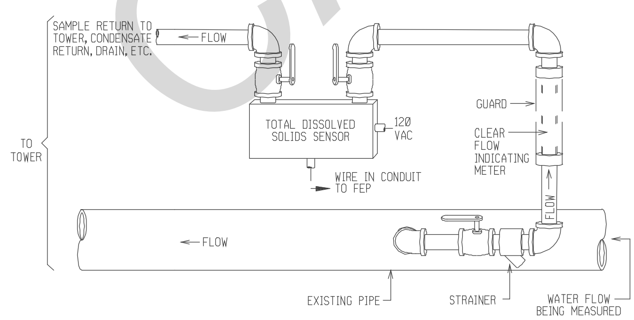
AIA M34 ANALYZER, TURBIDITY



TURBIDITY SENSOR

DETAIL M-34

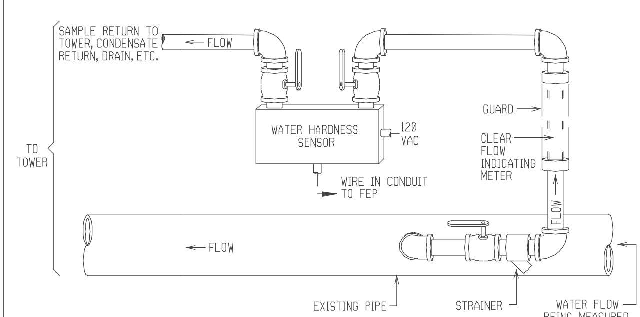
AIA M35 ANALYZER, TOTAL DISSOLVED SOLIDS



TOTAL DISSOLVED SOLIDS SENSOR

DETAIL M-35

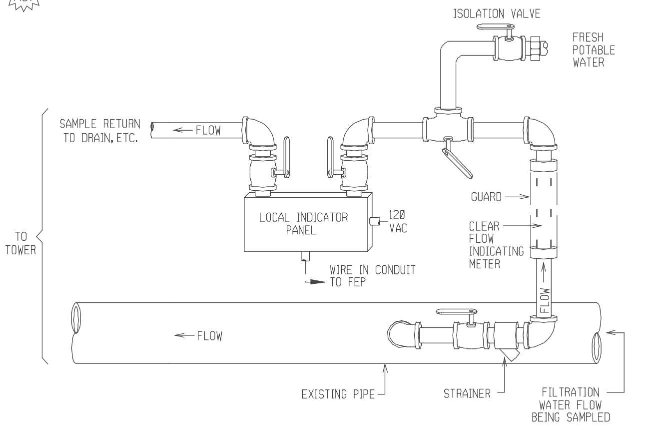
AIA M36 ANALYZER, WATER HARDNESS



WATER HARDNESS SENSOR

DETAIL M-36

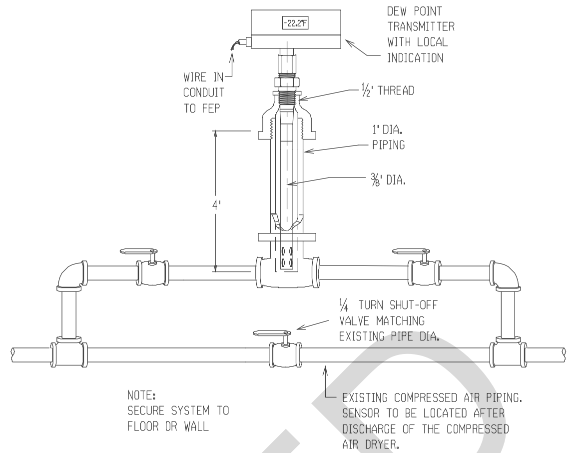
AIA M37 ANALYZER, CHLORINE (POOL WATER)



POOL WATER CHLORINE ANALYZER

DETAIL M-37

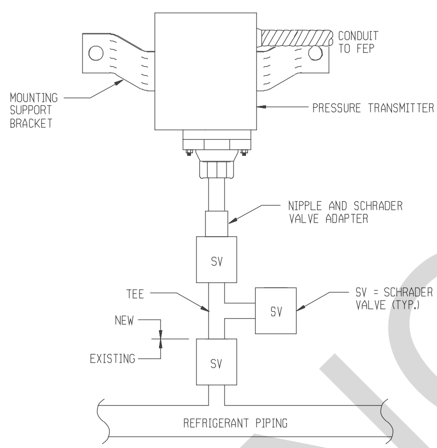
AIM M38 DEW POINT SENSOR, COMPRESSED AIR



COMPRESSED AIR DEW POINT SENSOR

DETAIL M-38

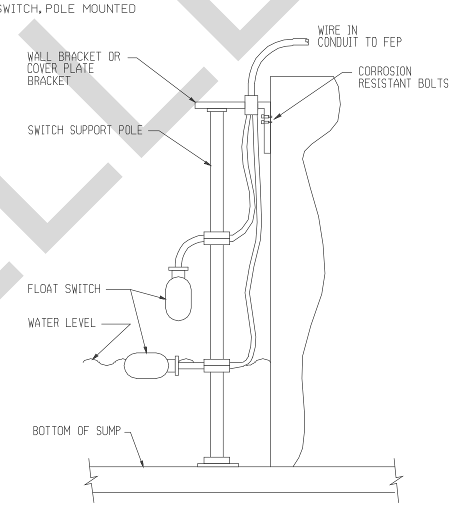
AIP M39 PRESSURE TRANSMITTER, REFRIGERANT



REFRIGERANT PRESSURE TRANSMITTER

DETAIL M-39

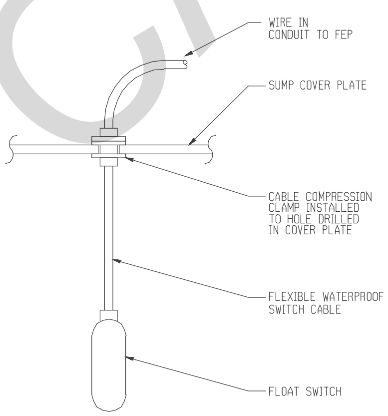
DIL M40 FLOAT SWITCH, POLE MOUNTED



FLOAT SWITCH - SUPPORT POLE MOUNTED

DETAIL M-40

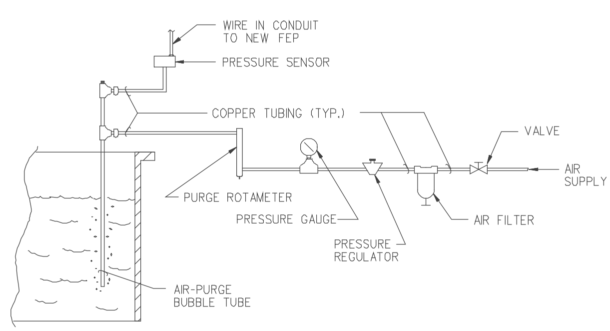
DIL M41 FLOAT SWITCH, SUSPENDED



FLOAT SWITCH - SUSPENDED

DETAIL M-41

AIL M42 LEVEL TRANSMITTER, BUBBLER TYPE

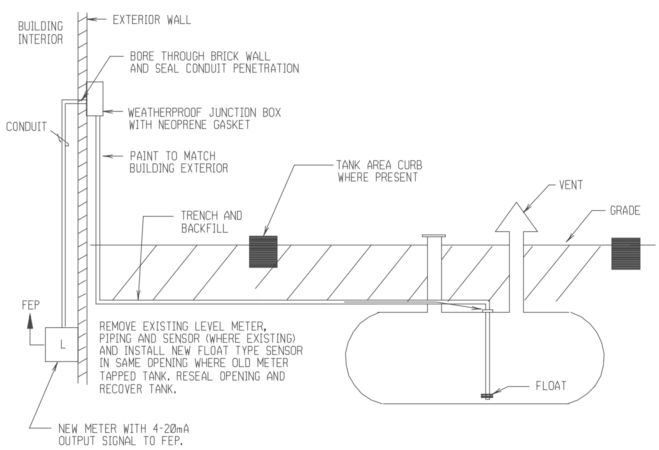


NOTE: EQUALIZING LINE IS REQUIRED FOR UNVENTED TANKS.

FUEL OIL TANK LEVEL MEASUREMENT (CONTINUOUS PURGE SYSTEM)

DETAIL M-42

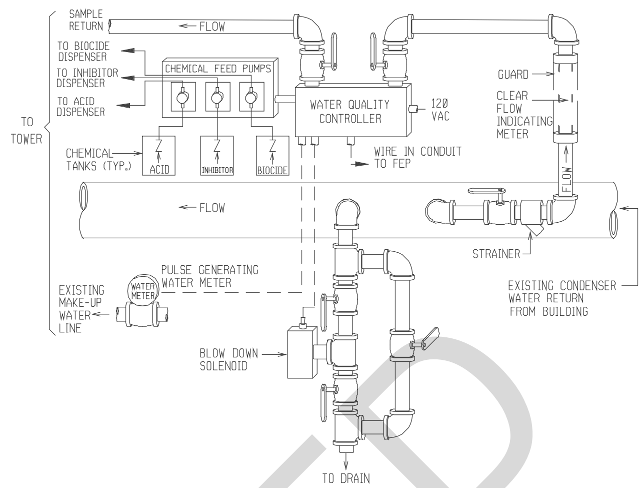
AIL M43 LEVEL TRANSMITTER, VENTED TANK



TANK LEVEL MONITORING

DETAIL M-43

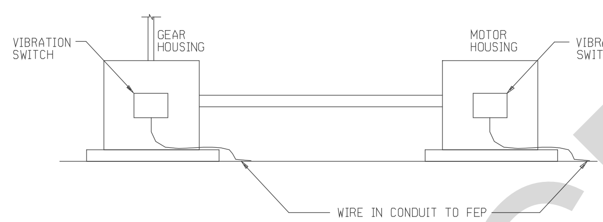
DIA M44 WATER QUALITY CONTROLLER



WATER QUALITY CONTROLLER

DETAIL M-44

DIX M45 VIBRATION SWITCH

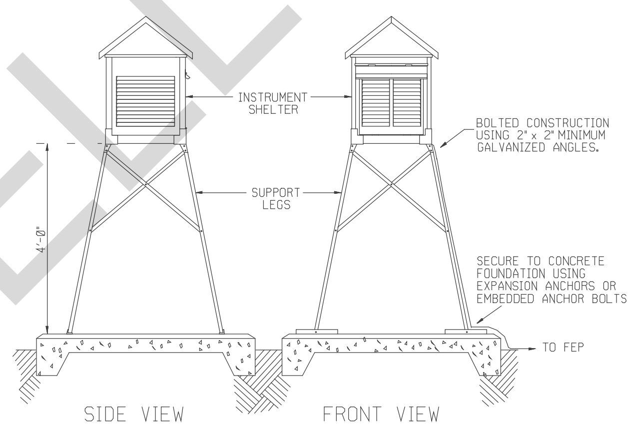


NOTE:
IF ONLY ONE VIBRATION SWITCH IS REQUIRED, MOUNT IT AT THE GEAR HOUSING. IF TWO VIBRATION SWITCHES ARE REQUIRED, MOUNT THEM AT THE GEAR AND MOTOR HOUSING.

VIBRATION SWITCH

DETAIL M-45

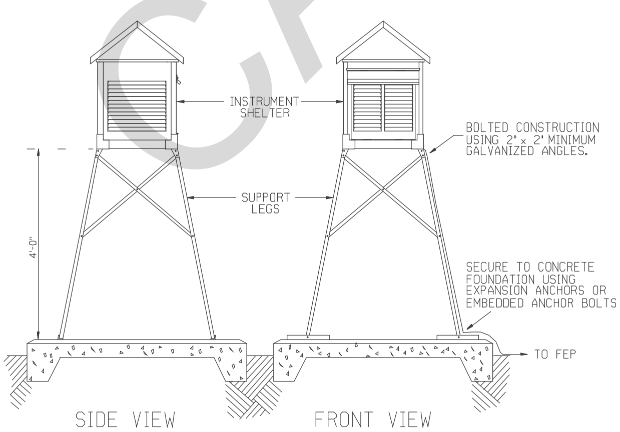
AIT M46 INSTRUMENT SHELTER W/TEMPERATURE SENSOR



INSTRUMENT SHELTER W/TEMPERATURE SENSOR

DETAIL M-46

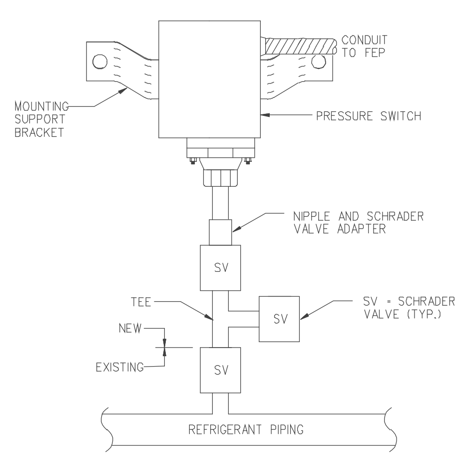
AIM M47 INSTRUMENT SHELTER W/TEMPERATURE AND HUMIDITY SENSORS



INSTRUMENT SHELTER W/TEMPERATURE AND HUMIDITY SENSORS

DETAIL M-47

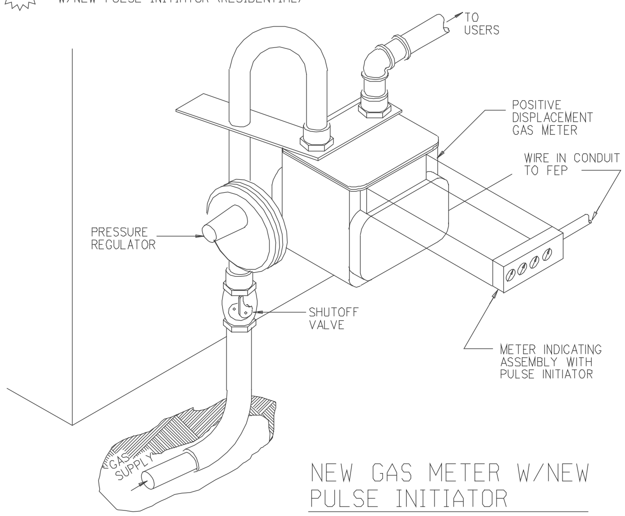
DIP M48 PRESSURE SWITCH, REFRIGERANT



REFRIGERANT PRESSURE SWITCH

DETAIL M-48

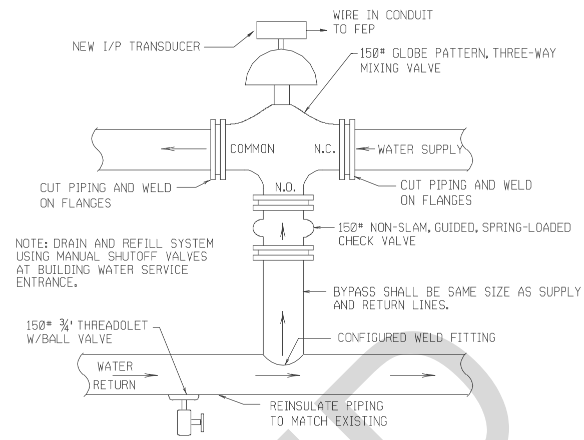
DIF M49 FLOW METER, NEW NATURAL GAS W/NEW PULSE INITIATOR (RESIDENTIAL)



NEW GAS METER W/NEW PULSE INITIATOR

DETAIL M-49

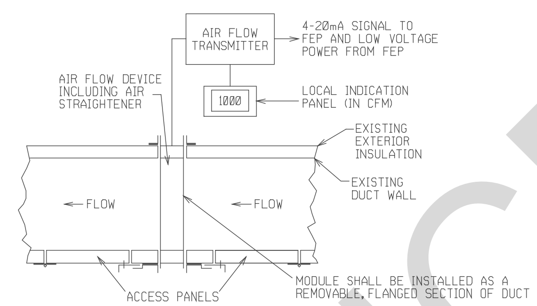
AOZ M50 NEW THREE-WAY MIXING VALVE W/PNEUMATIC ACTUATOR



NEW THREE-WAY MIXING VALVE W/PNEUMATIC ACTUATOR

DETAIL M-50

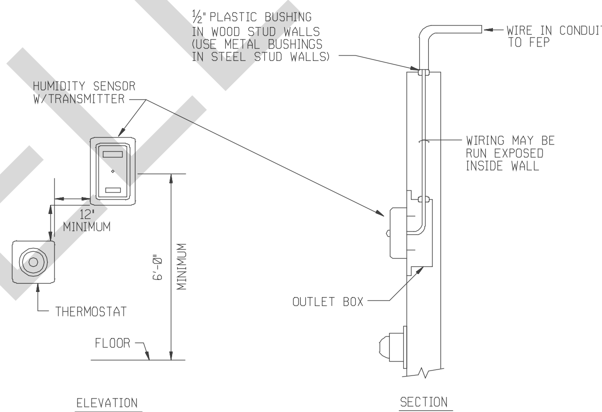
AIF M51 AIR FLOW MEASURING STATION



AIR FLOW MEASURING STATION

DETAIL M-51

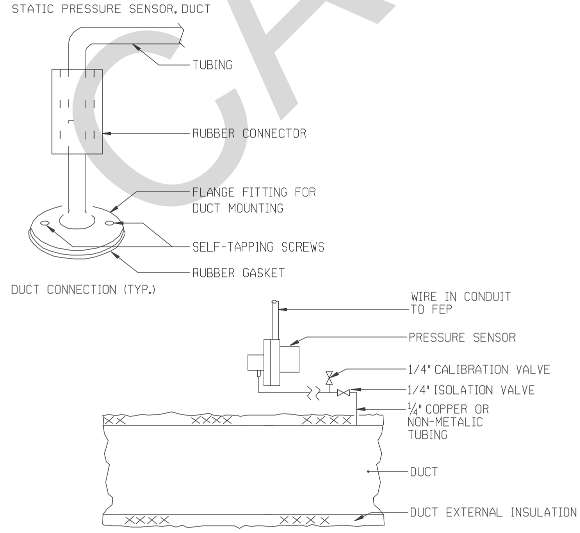
AIM M52 HUMIDITY SENSOR, SPACE



HUMIDITY SENSOR, SPACE

DETAIL M-52

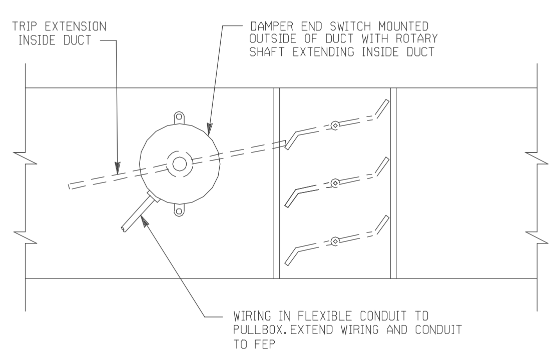
AIP M53 STATIC PRESSURE SENSOR, DUCT



DUCT STATIC PRESSURE SENSOR

DETAIL M-53

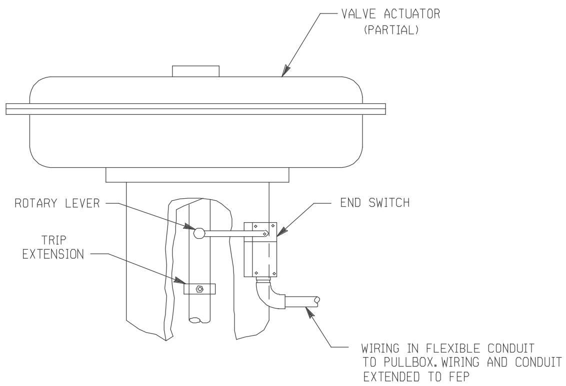
DIZ M54 POSITION SWITCH, DAMPER



POSITION SWITCH DAMPER

DETAIL M-54

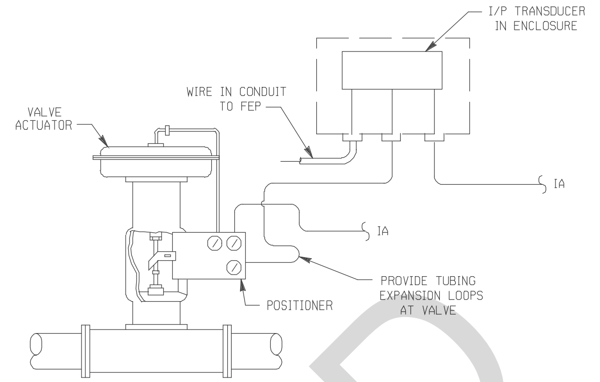
DIZ M55 POSITION SWITCH, VALVE



POSITION SWITCH VALVE

DETAIL M-55

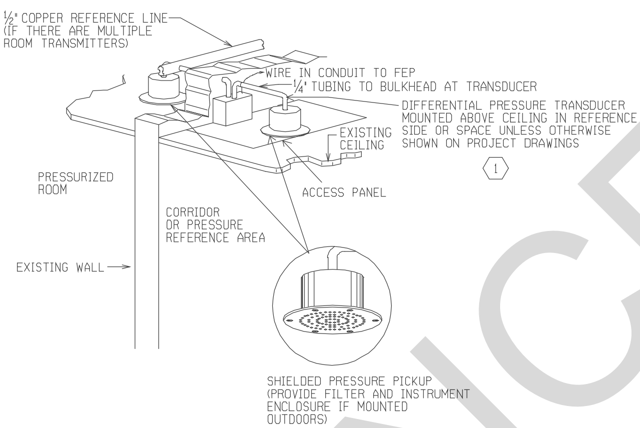
AOZ M56 VALVE ACTUATOR/POSITIONER W/TRANSDUCER



VALVE ACTUATOR/POSITIONER W/TRANSDUCER

DETAIL M-56

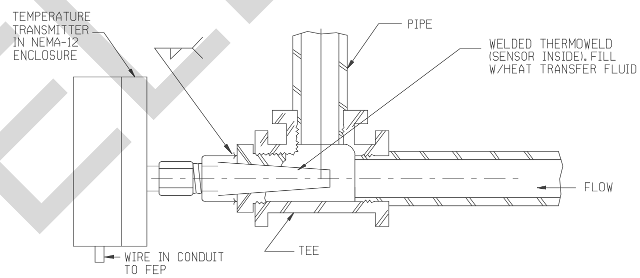
AIP M57 DIFFERENTIAL PRESSURE SENSOR, ROOM



DIFFERENTIAL PRESSURE SENSOR (ROOM)

DETAIL M-57

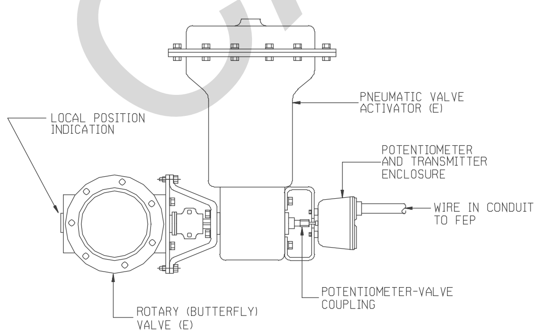
AIT M58 TEMPERATURE SENSOR, FUEL OIL (PIPE)



FUEL OIL TEMPERATURE SENSOR

DETAIL M-58

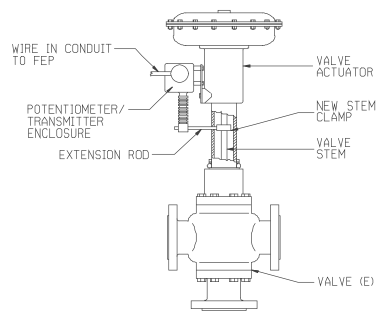
AIZ M59 POSITION INDICATION, ROTARY VALVE



ROTARY VALVE CONTINUOUS POSITION INDICATION

DETAIL M-59

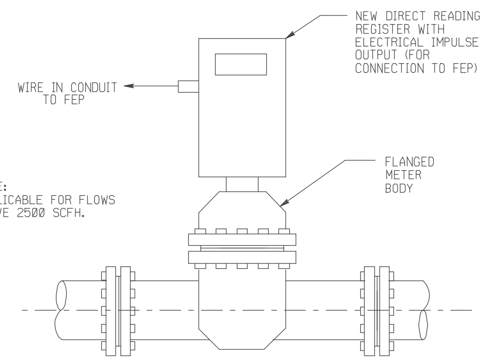
AIZ M60 POSITION INDICATION, RISING STEM VALVE



RISING STEM VALVE CONTINUOUS POSITION INDICATION

DETAIL M-60

DIF M61 FLOW METER, EXISTING NATURAL GAS W/NEW PULSE INITIATOR (INDUSTRIAL)

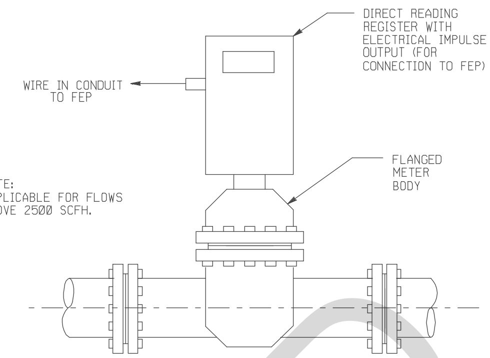


NOTE:
APPLICABLE FOR FLOWS ABOVE 2500 SCFH.

EXISTING NATURAL GAS METER W/NEW PULSE INITIATOR (INDUSTRIAL)

DETAIL M-61

DIF M62 FLOW METER, NEW NATURAL GAS W/NEW PULSE INITIATOR (INDUSTRIAL)

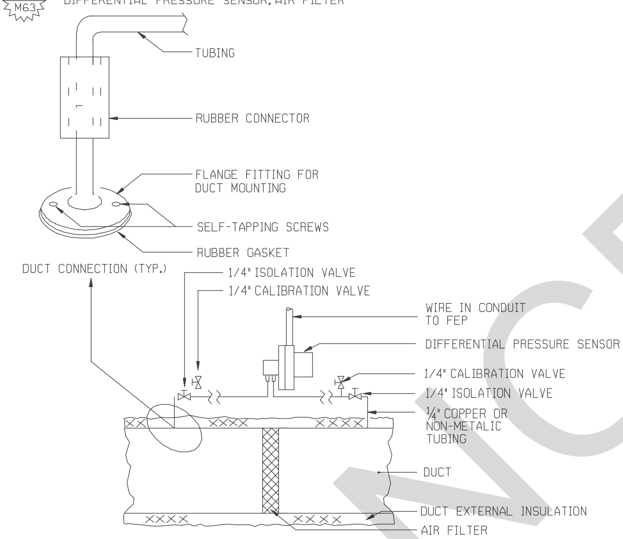


NOTE:
APPLICABLE FOR FLOWS ABOVE 2500 SCFH.

NATURAL GAS METER W/NEW PULSE INITIATOR (INDUSTRIAL)

DETAIL M-62

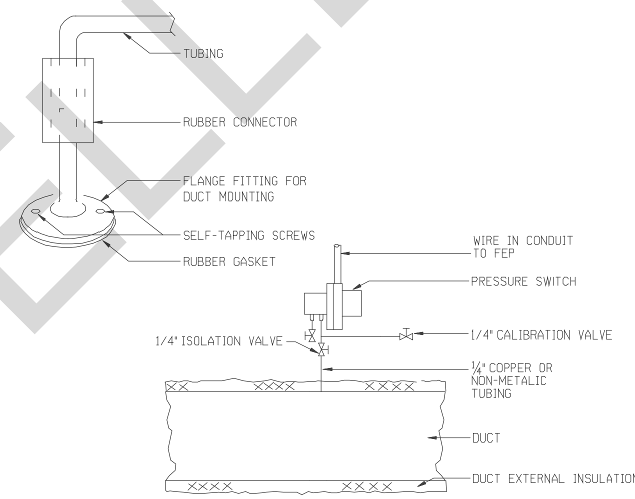
AIP M63 DIFFERENTIAL PRESSURE SENSOR, AIR FILTER



AIR FILTER DIFFERENTIAL PRESSURE SENSOR

DETAIL M-63

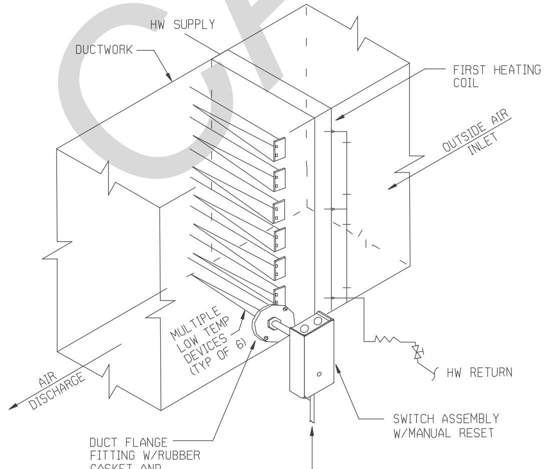
DIP M64 DUCT STATIC PRESSURE SWITCH



DUCT STATIC PRESSURE SWITCH

DETAIL M-64

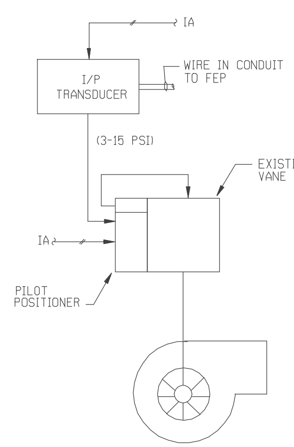
DIT M65 LOW TEMPERATURE DEVICE, DUCT MOUNTED



DUCT MOUNTED LOW TEMPERATURE DEVICE

DETAIL M-65

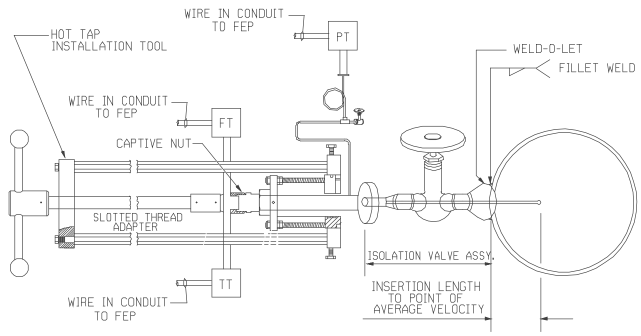
AOC M66 ANALOG OUTPUT, FAN PNEUMATIC INLET VANE OPERATOR



ANALOG OUTPUT, FAN PNEUMATIC INLET VANE OPERATOR

DETAIL M-66

AIF M67 FLOW METER, VORTEX SHEDDING (INSERTION TYPE)

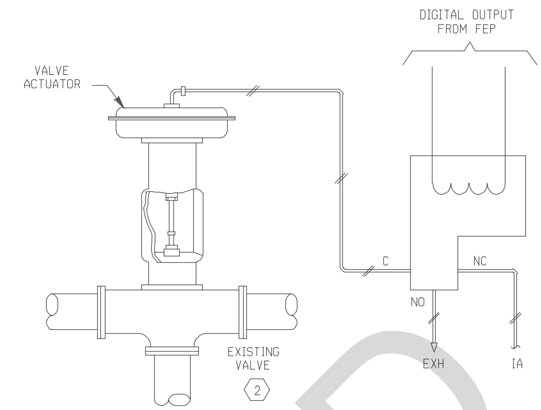


NOTE: CUTTING TOOL MAY REQUIRE ADDITIONAL CLEARANCE

FLOW METER, VORTEX SHEDDING (INSERTION TYPE)

DETAIL M-67

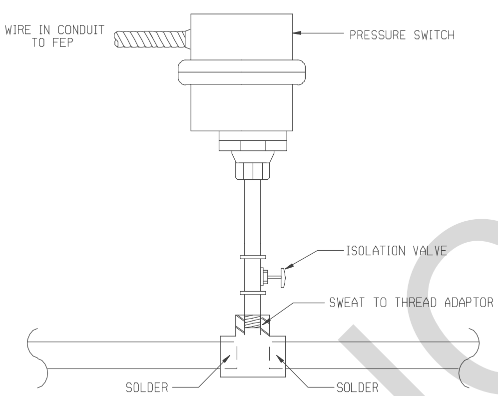
DOZ M68 VALVE (2-POSITION), ACTUATOR W/SOLENOID VALVE



VALVE (2-POSITION), ACTUATOR W/SOLENOID VALVE

DETAIL M-68

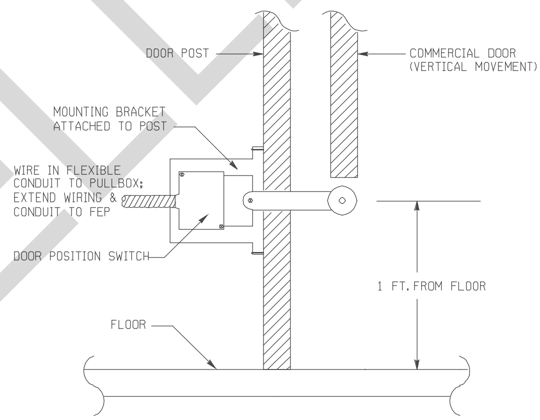
DIP M69 PRESSURE SWITCH, AIR LINE



INSTRUMENT AIR LINE PRESSURE SWITCH

DETAIL M-69

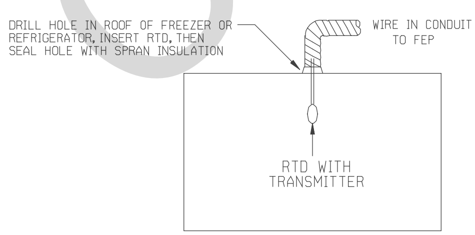
DIZ M70 POSITION SWITCH, DOOR



DOOR POSITION SWITCH

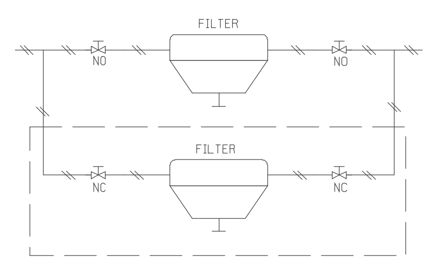
DETAIL M-70

AIT M71 TEMPERATURE SENSOR, FREEZER OR REFRIGERATOR



TEMPERATURE SENSOR, FREEZER OR REFRIGERATOR

DETAIL M-71

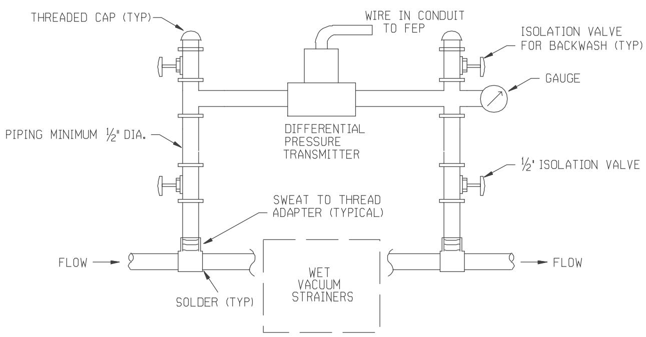


NOTE: PROVIDE ADDITIONAL FILTER WHERE SHOWN.

INSTRUMENT AIR FILTER STATION

DETAIL M-72

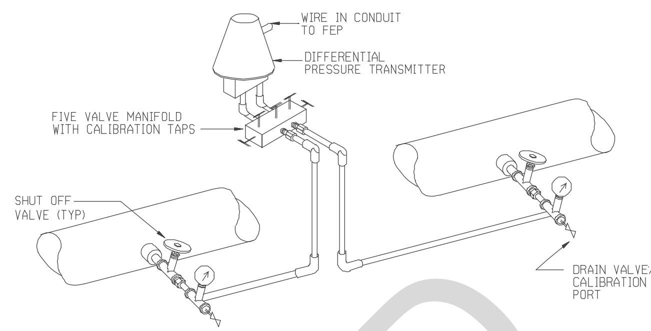
AIP M73 DIFFERENTIAL PRESSURE SENSOR, WET VACUUM STRAINER STATION



DIFFERENTIAL PRESSURE SENSOR FOR WET VACCUM STRAINER STATION

DETAIL M-73

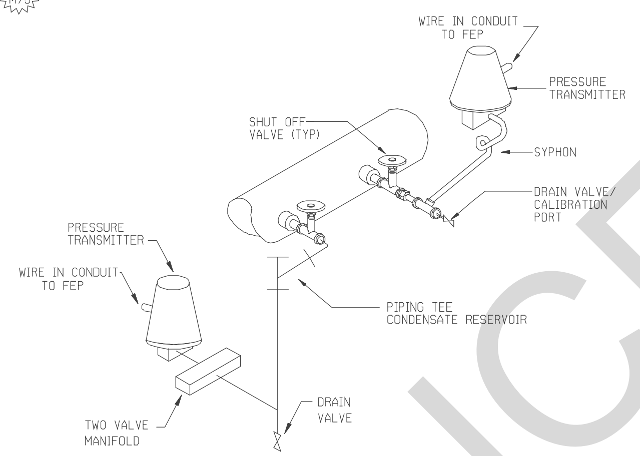
AIP M74 DIFFERENTIAL PRESSURE TRANSMITTER (LIQUID)



DIFFERENTIAL PRESSURE SENSOR (PIPE)

DETAIL M-74

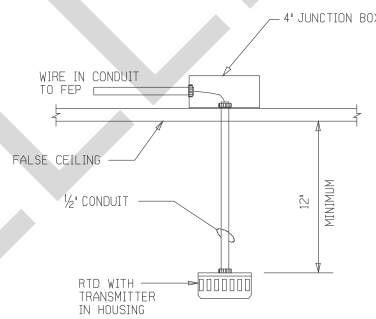
AIP M75 PRESSURE TRANSMITTER, STEAM



PRESSURE SENSOR (STEAM PIPE)

DETAIL M-75

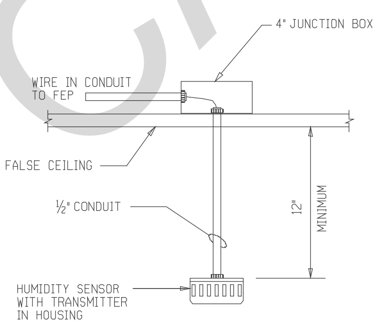
AIT M76 TEMPERATURE SENSOR, CEILING MOUNT



SPACE RTD MOUNTING (FOR CEILING MOUNT)

DETAIL M-76

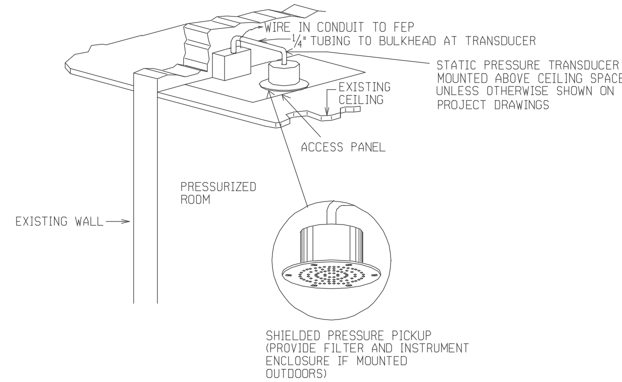
AIM M77 HUMIDITY SENSOR, CEILING MOUNT



SPACE HUMIDITY MOUNTING (FOR CEILING MOUNT)

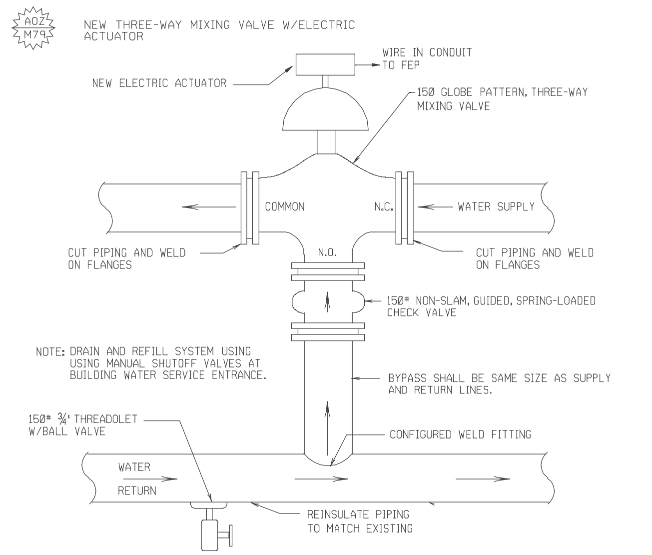
DETAIL M-77

AIP M78 STATIC PRESSURE SENSOR, ROOM



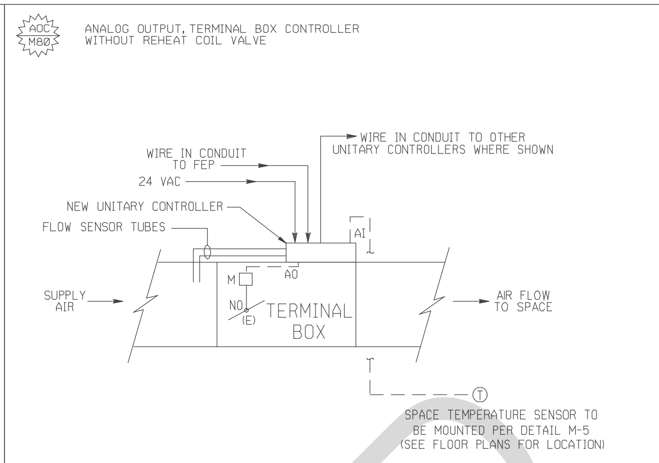
STATIC PRESSURE SENSOR (ROOM)

DETAIL M-78



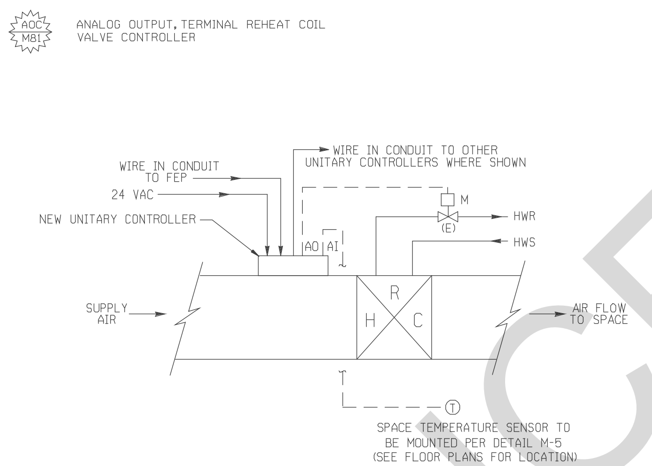
NEW THREE-WAY MIXING VALVE W/ELECTRIC ACTUATOR

DETAIL M-79



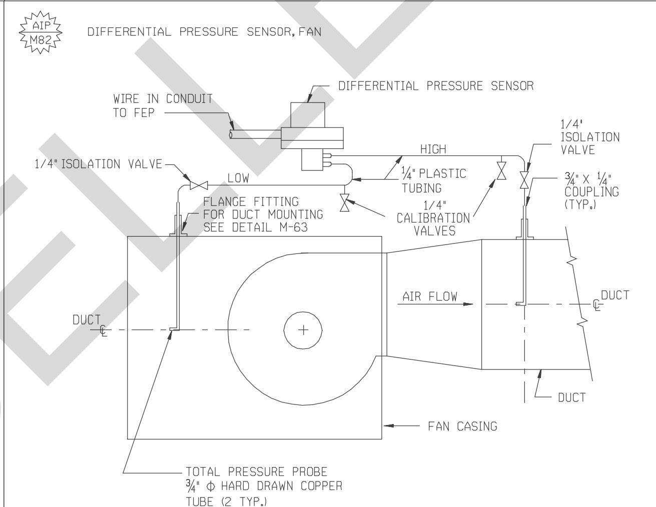
TERMINAL BOX CONTROLLER WITHOUT REHEAT COIL VALVE

DETAIL M-80



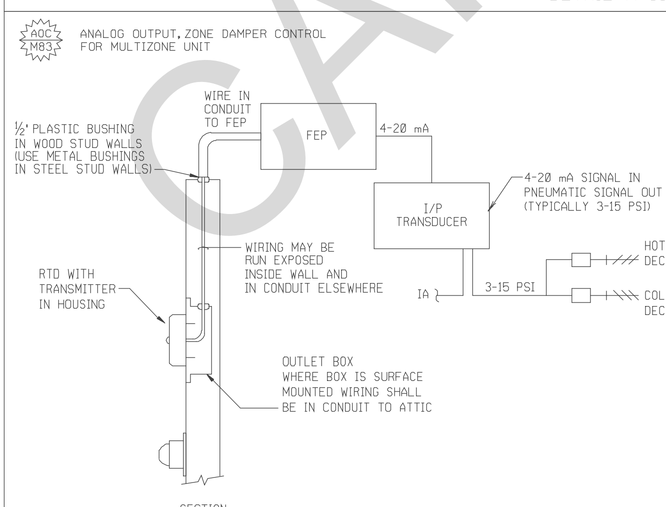
TERMINAL REHEAT COIL VALVE CONTROLLER

DETAIL M-81



FAN DIFFERENTIAL PRESSURE SENSOR INSTALLATION

DETAIL M-82



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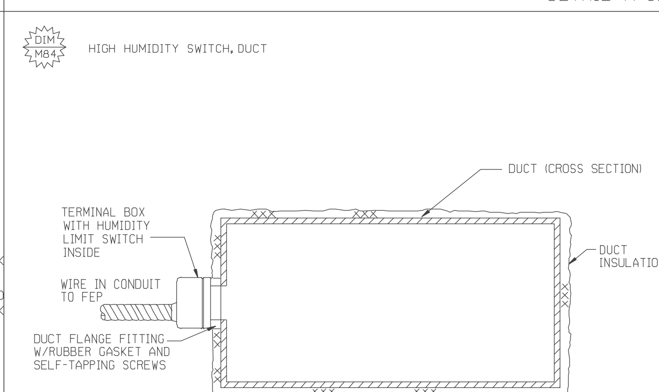

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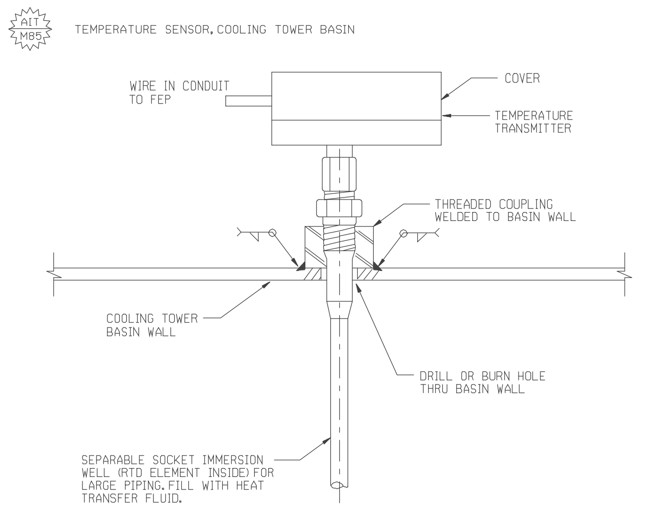

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RESERVED

PART 7. STARTER DETAILS

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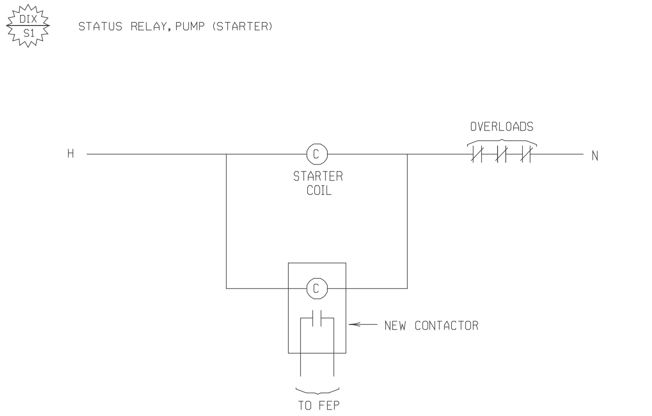

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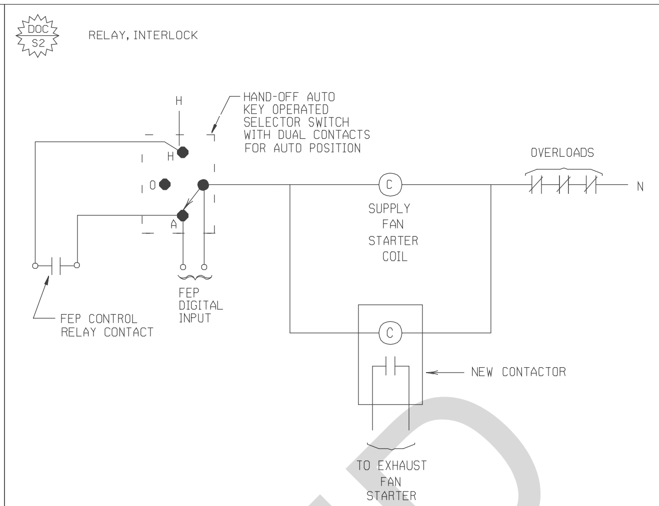
DETAIL S-1



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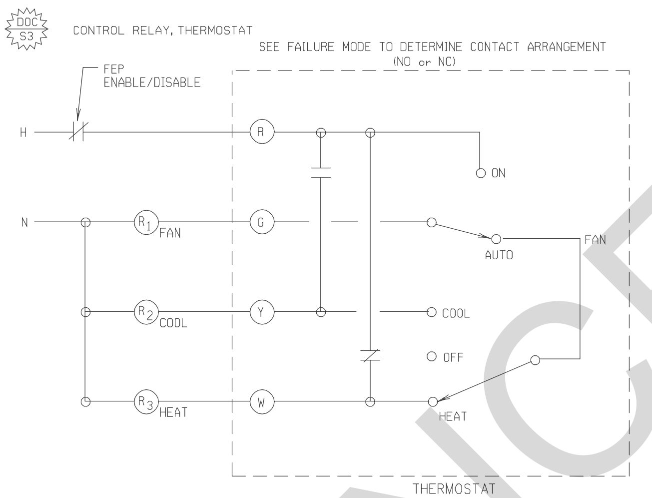
DETAIL S-2



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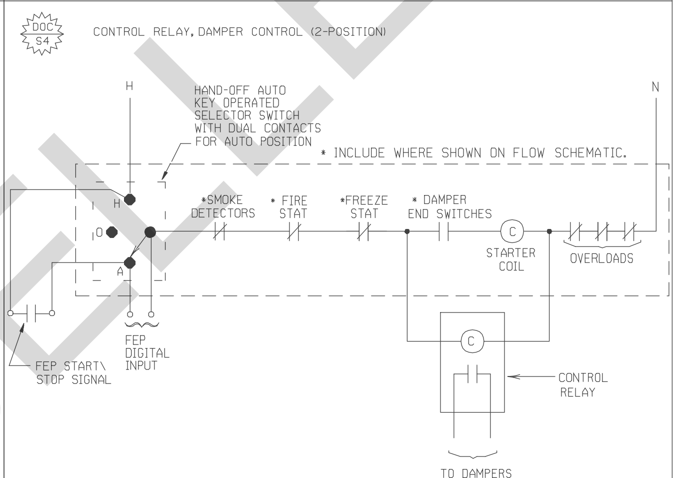
DETAIL S-3



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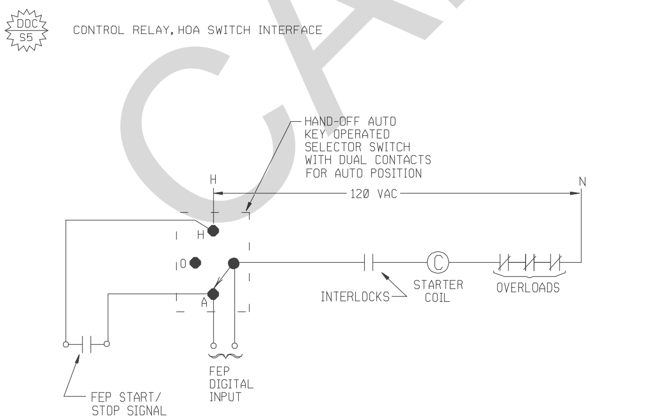

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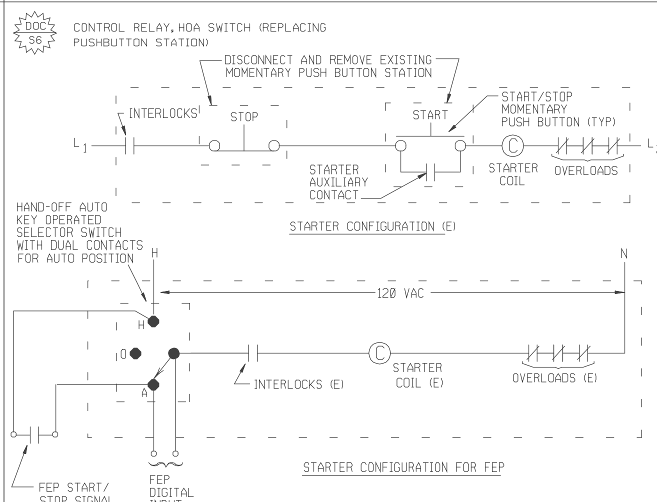
DETAIL S-5



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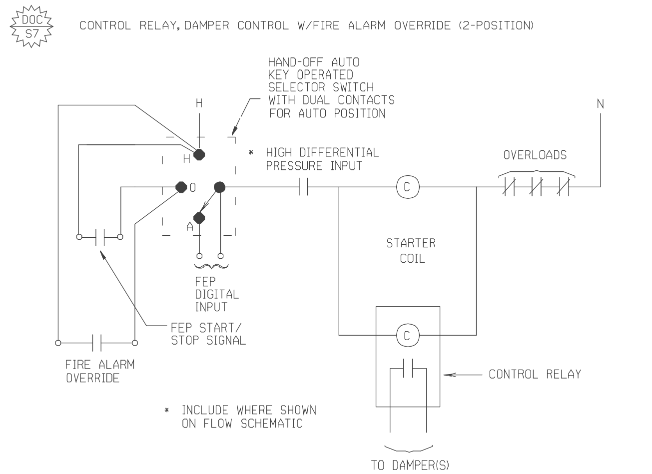

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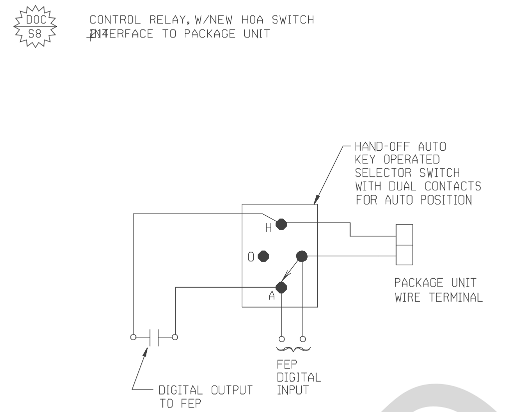
DETAIL S-7



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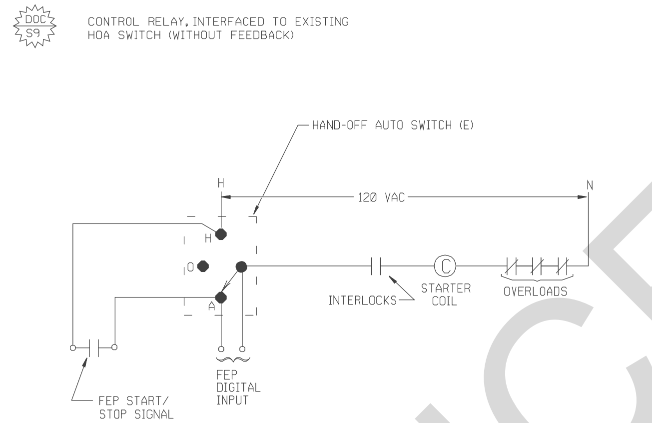
DETAIL S-8



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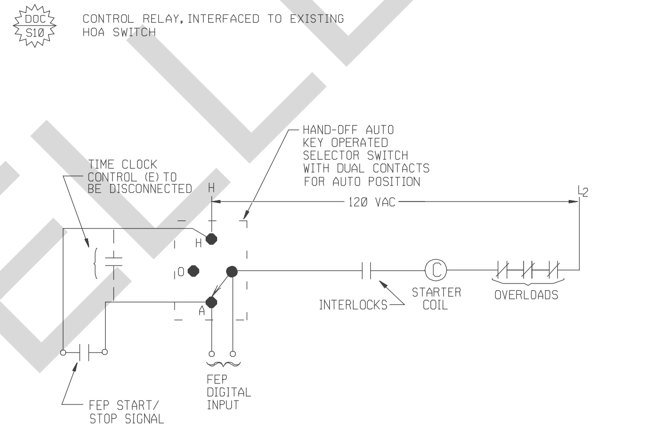

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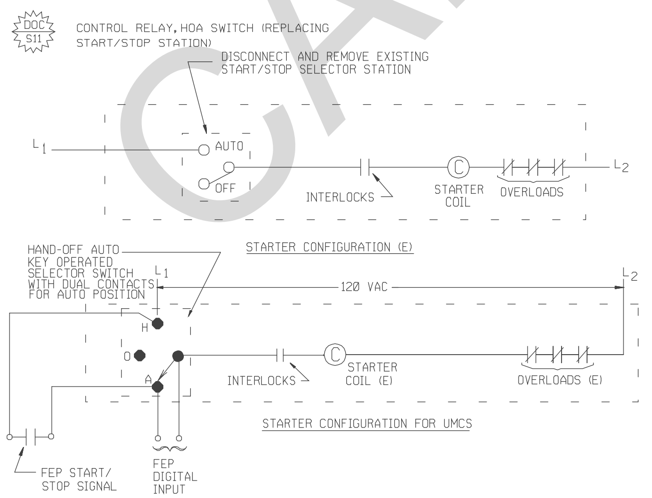

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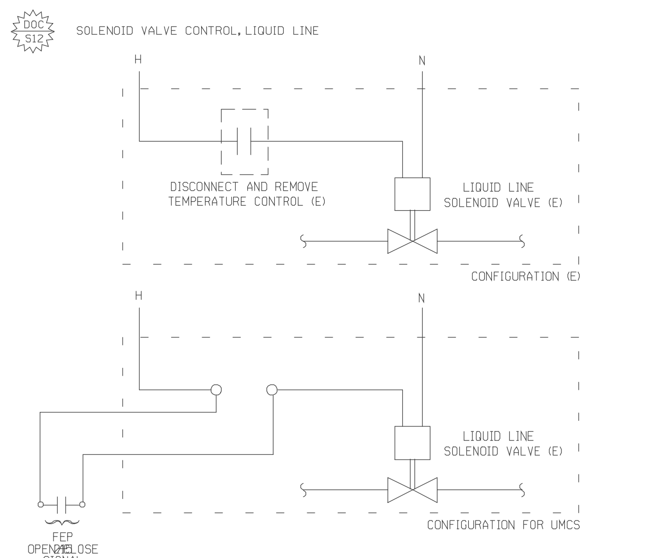

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DOC S13

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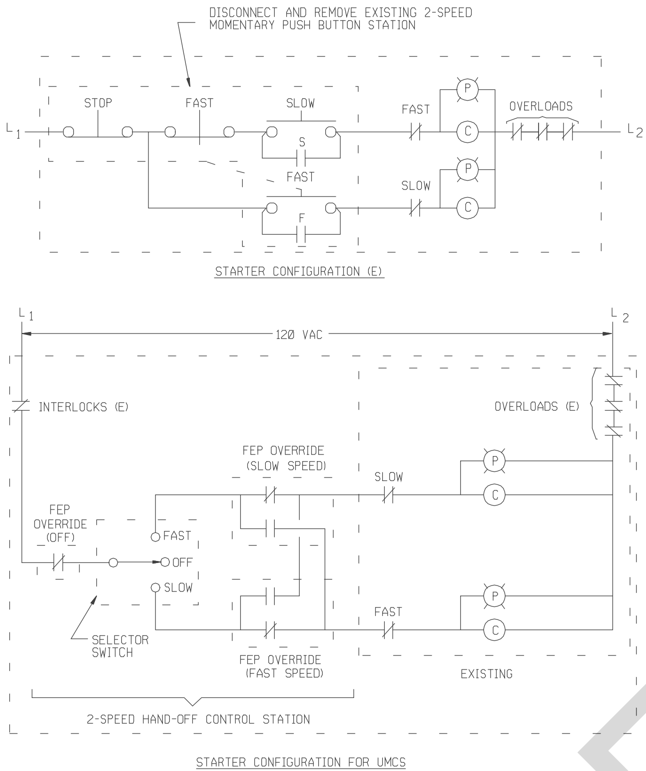

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DOC S14

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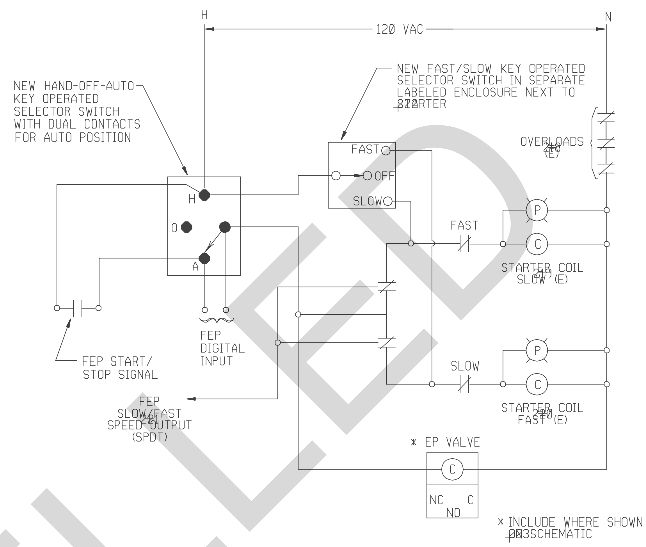

FEP INTERFACE WITH NEW HAND-OFF-AUTO (HOA) AND 2-SPEED SELECTOR SWITCHES

DETAIL S-14

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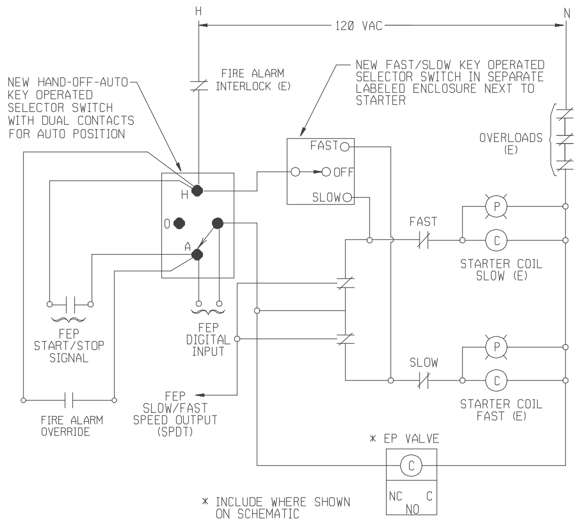

FEP INTERFACE WITH NEW HAND-OFF-AUTO (HOA) AND 2-SPEED SELECTOR SWITCHES AND FIRE ALARM OVERRIDE INTERLOCK

DETAIL S-15

RESERVED

RESERVED

APPENDIX C

VIABILITY SURVEY PROCEDURES FOR UMCS

1. PURPOSE AND SCOPE.

a. Introduction. A Utility Monitoring and Control System (UMCS) is an energy management system which employs hardware and software to effect energy as well as manpower and equipment savings. Energy savings may be accomplished by monitoring and providing control and/or control overrides for heating, ventilation, and air conditioning (HVAC) systems as well as for lighting and central plant equipment. Manpower savings may be accomplished by remotely monitoring equipment, meters or systems which would otherwise require periodic visual observation. Equipment savings can be accomplished by early detection of equipment failure or reductions in equipment performance levels. The UMCS may also be used to assist in building and maintenance management.

b. Purpose. The purpose of this document is to provide guidelines to prepare documents for obtaining funds for a UMCS. The viability survey is the first opportunity to collect engineering data to quantitatively evaluate the feasibility of a UMCS as well as to support future project activities. It is a necessary prerequisite for funding authorization for further study, design and construction. After a decision has been made to pursue a new or expanded UMCS, the proper programming documents must be prepared in order to receive ultimate authorization for the expenditure of funds. This programming document is the DD form 1391 for Military Construction-Army (MCA) projects over $500,000 and Operations and Maintenance (O&M) projects. Other criteria or funding documents may be required to authorize expenditures from other funding sources. Prior to completion of the programming documents, the installation must have a scope of work for the project, a budgetary construction cost estimate and the appropriate economic analyses justifying the need for the UMCS project.

c. Scope of the UMCS Survey. The major purpose of the UMCS survey is to obtain site specific data which can then be used to justify and support future project related efforts. For example, the survey will identify the approximate number and types of required monitoring and control points as well as the type and extent of the data transmission system (DTS). These data can be used to estimate the installed cost of the new or expanded system. The survey will also identify potential energy saving opportunities (ESOs) as well as potential manpower or equipment saving opportunities. These cost and savings data allow the estimation of an economic payback figure for the project. This payback figure can then be evaluated in accordance with guidance provided by the Department of the Army (DA) or the installation's major command (MACOM). The site specific data obtained during the survey can also be used in the preparation of scopes of work for future project activities. Finally, the system cost estimates can be used in the preparation of the government cost estimate. After these steps are successfully accomplished, the proper programming documents can be completed. To support these ultimate goals, the primary data to be collected during the survey include:

(1) A list of candidate facilities and/or other energy, equipment or manpower saving opportunities which are to be included in the project.

(2) A description of the required site preparation to prepare the Central Station and to network the remote UMCS equipment to the Central Station.

(3) A preliminary list of the number and type of points to be monitored or controlled. These data may be used to develop a project cost estimate. Methods for system cost estimating and energy savings calculations are available from the UMCS Mandatory Center of Expertise (MCX).

(4) Data for use in estimating potential energy savings.

(5) Descriptions of any modifications or repairs to existing equipment or controls which are required for an UMCS system to function effectively.

(6) Operating schedules of the various facilities included in the project in order to estimate potential energy savings.

(7) A descriptive list of existing UMCS components, (i.e. existing sensors or control devices) to be utilized with the new or expanded system.

(8) A list of utility records for the Post and candidate facilities in order to quantify the economic impact of the potential energy savings.

d. General. This document is directed solely to providing procedural guidelines for UMCS surveys. Other activities which occur in the course of a UMCS project beginning with the DD form 1391 preparation and ending with the acceptance of the system, are covered in other references. Section 1.4, *References*, provides further documentation and guidance on UMCS projects.

e. UMCS-MCX Responsibilities. The U.S. Army Corps of Engineers UMCS-MCX is responsible for all phases of UMCS projects as detailed in ER-1110-3-109, *Centers of Expertise*. When requested, the UMCS-MCX will provide survey support and services on a reimbursable basis.

f. References.

(1) U.S. Army Engineering and Support Center, Huntsville , Corps of Engineers, *Energy Savings Analysis for UMCS.*

(2) U.S. Army Engineering and Support Center, Huntsville , Corps of Engineers, *UMCS Viability Cost Estimator*, 21 Nov 96.

(3) U.S. Army Engineering and Support Center, Huntsville , Corps of Engineers, *UMCS Design Cost Estimator*, 21 Nov 96.

(4) Department of the Army, *Cost Estimates-Military Construction,* TM 5-800-2, 12 June 1985.

2. RESPONSIBILITIES.

a. General. The survey for preparation of funding documents can be accomplished using personnel from various sources such as the installation, the MACOM, specialized engineering firms, Corps District offices, and the UMCS-MCX. Installation personnel will be familiar with needs of the installation and characteristics of existing facilities, utilities and other systems. Representatives from the MACOM and UMCS-MCX will be experienced personnel who have been involved with the initiation, design, installation and operation of other UMCS projects. The basic responsibilities for each team member or group are listed below.

b. Participants. The survey team may include representatives from the following principal participants:

(1) UMCS-MCX. The UMCS-MCX is tasked to ensure proper design, installation, testing and acceptance of UMCS projects and to provide engineering support to DoD and other government agencies. To accomplish this, the UMCS-MCX will:

(a) Perform surveys upon request.

(b) Provide team leadership and team members.

(c) Provide technical assistance for UMCS projects.

(d) Develop UMCS guidance for design and construction.

(e) Ensure compliance with UMCS design standards.

(f) Develop procedures and techniques for installation and checkout.

(g) Define levels of responsibility for UMCS inspection, testing and acceptance.

(h) dentify UMCS consulting sources, both commercial vendors and design services, for end users.

(i) Define UMCS inspection requirements.

(2) Corps District Office Representative. The local Corps District office may be involved in administering either the UMCS design or construction contract, or both. Therefore, their participation in the survey will familiarize them with all project parameters from the outset.

(3) MACOM Energy Office Representative. The MACOM establishes procedures for review and approval of requests for UMCS installations. The MACOM is then responsible for forwarding survey requests to the UMCS-MCX and providing support and funding for the survey activities.

(4) Directorate of Public Works Representative. The primary source of information concerning the candidate facilities, utilities and energy consumption will be the DPW. This information is necessary in order to develop a system concept and to support the needed economic analyses.

(5) Communications Office. The communications office should assist in the conceptual planning of the communication network from the field equipment back to the central equipment in the Central Station. This individual should have all necessary data on any existing communications network and be involved in the design of any new network.

(6) UMCS Manager. The UMCS manager is the on-site manager of any existing UMCS and is responsible for its operation and maintenance. An UMCS manager may not yet be identified if the installation does not have a existing system.

(7) Other Installation Personnel. Other installation personnel such as shop foremen, plant operators, HVAC mechanics and UMCS operators who can provide significant guidance to the survey should be available.

c. The Survey Team. The survey team is responsible for the actual building-to-building survey and the resulting economic analysis. The number of survey team members and their individual specialties will vary according to the size and complexity of the proposed system and the time available to accomplish the survey. As a minimum, the survey team should include an electrical engineer, a mechanical engineer and a technician. Larger teams will include multiples of the above positions with some of the members specializing in a specific aspect of UMCS application. The people on the team should possess the skills necessary to identify areas of UMCS application with the potential for economic savings. Qualifications and responsibilities of each team member are discussed below.

(1) Team Chief. The team chief should typically be either a mechanical or controls engineer with experience in both fields. The team chief will be experienced in the selection, design, installation, operation and maintenance of UMCS systems. The team chief will direct all survey activities and coordinate with Post personnel as required to accomplish the survey. The responsibilities of the team chief include:

(a) Coordinating the survey activities in advance with the installation including sending the survey notice.

(b) Assembling the team.

(c) Organizing and scheduling the survey.

(d) Handling the survey team logistics.

(e) Conducting briefings.

(2) Mechanical Engineer. An engineer with experience in the design and analysis of all types of mechanical systems including central plants and other utility systems such as water and wastewater treatment systems. This person should have experience in inspecting HVAC systems and components including controls. If a controls engineer is not available, one of the engineers on the survey team should be well versed in instrumentation and controls.

(3) Electrical Engineer. An engineer with experience in the design and checkout of various types of local control systems (i.e. pneumatic, electric, etc.) as well as the hardware and software requirements of an UMCS system. Additional experience in design and analysis of electrical power distribution systems for both building power distribution systems as well as installation-wide power distribution systems is desirable.

(4) Technician. The technician's primary task is to work with and assist the engineers listed above in both data gathering and analysis. They should be experienced in the field in which they are to be working.

3. SURVEY REQUIREMENTS.

a. Initiation. A survey is initiated when an installation has established the need to install or add to an UMCS. Survey support can be requested from the UMCS MCX while site specific data should be requested from the installation. A survey team chief will be chosen to prepare a survey plan, assemble the survey team and perform the survey. Responsibilities of survey team members are outlined in Section 2.

b. Survey Notice. The assistance of site personnel is crucial to the success of a survey. The assistance required ranges from arranging for Post and facility access to provision of site engineering data. It is essential that the installation be notified of the pending survey and required support as much in advance as possible so that survey needs can be met without significantly impacting the normal workload. This notification is provided through the survey notice letter. The survey team chief will provide the survey notice letter to the Post commander and closely coordinate with his designated point of contact, usually the DPW. The survey notice will cover, as a minimum, the following subjects:

(1) Proposed survey schedule.

(2) Survey team members (including clearances where necessary).

(3) Facility access requirements.

(4) Safety, fire and security regulations.

(5) Necessary site specific data, such as:

(a) As-built drawings (i.e., Architectural, Mechanical, Electrical, Existing UMCS, Communications, etc.).

(b) Candidate UMCS applications.

(c) Utility Records (e.g., Fuel consumption, Electrical consumption, Utility rate contracts, Central plant data).

(d) Real Property Records

(e) Building occupancy schedules.

(f) Major equipment operating schedules.

(g) Buildings scheduled for demolition.

(h) Major equipment scheduled for shutdown or removal.

(6) Desired design and construction schedule.

c. Security Clearances. Applicable security restrictions will be carefully observed during all survey activities including information gathering. Any classified data gathered or developed as part of the site survey will be safeguarded appropriately. All team members will possess the necessary clearance levels required by the installation prior to the start of the on-site portions of the survey.

4. THE SURVEY.

a. Beginning the Survey. An entrance briefing will be conducted with the survey team and the responsible installation personnel. An installation DPW representative will brief the survey team on the proposed scope of the project and the economic analysis guidelines to be used. The DPW representative is responsible for providing site specific information such as contact persons for as-built drawings, facility access, utility information, secure areas, and other areas of general installation coordination. DPW personnel will also provide information on any existing UMCS and other associated control systems.

b. Candidate Facilities and Systems. The survey teams will work with the DPW and other installation and facility personnel to develop a preliminary list of candidate facilities and other system applications. Prime candidates for inclusion on the site survey list are facilities and/or systems which have large energy consumption or equipment ratings. Buildings which are occupied less than sixteen hours per day or less than seven days per week are generally good candidates as are central chiller and boiler plants. Other candidates should include utility or other system meters, especially remote meters which must be manually logged frequently. Site specific circumstances may also result in other candidate UMCS applications.

c. Tasks. There are three primary tasks of the UMCS survey. The first is to obtain information that was requested but not obtained prior to arrival on site. This could potentially include any of the items discussed previously in Section 3. The second is to verify the site specific information received including the as-built drawings, major equipment and building operating and occupancy schedules, buildings scheduled for demolition and major equipment scheduled for shutdown. The third is to obtain information not readily available from existing documentation. This would include:

(1) Identify any major equipment not documented.

(2) Identify any potential savings opportunities not documented.

(3) Identify communications system requirements.

(4) Determine the routing of any new or extensions to the existing communications system in order to serve all potential UMCS points.

(5) Determine the extent of any existing UMCS and the condition and suitability of the installed equipment.

(6) Prepare initial sketches of any readily identifiable changes which must be made to the existing mechanical or electrical systems.

(7) Determine the source and type of heating and cooling for each building.

(8) Verify data gathered to calculate heat loss and the cooling load of each building.

(9) Verify the existence and condition of economizer capabilities for each major air system.

(10) Identify local loop controls or devices which are in need of repair or replacement.

(11) Develop an input/output (I/O) point estimate. This is a function of the degree of control required, types of systems to be monitored, and the selected application programs. The I/O point count will have a direct impact on the system cost.

(12) Develop a preliminary list of required application programs. Commonly used programs include:

(a) Scheduled start/stop.

(b) Steam boiler selection.

(c) Optimum start/stop.

(d) Hot water boiler selection.

(e) Hot water outside air reset.

(f) Lighting control.

(g) Demand limiting.

(h) Chiller selection.

(i) Day/night setback.

(j) Chilled water reset.

(k) Economizer.

(l) Condenser water reset.

(m) Chiller demand limit.

(n) Ventilation/recirculation.

(o) Hot/cold deck reset.

(p) Remote boiler monitoring control.

(q) Reheat coil reset.

Specific requirements for the design survey are covered in Appendix D, DESIGN SURVEY PROCEDURES. Included in Appendices C and D are survey data forms. These forms are intended for use during the survey to record data for use in the subsequent analyses.

5. SURVEY REPORT.

a. Survey Report. The end product of the survey is a compilation of the data used to complete the DD form 1391 or other funding documents as well as to support future project related activities. Preparation of the survey report consists of compiling information gained during the survey in a concise and organized manner. The report will present the information obtained on each building individually. The report will also tabulate all information required to perform the project cost estimate and the project economic analysis.

b. Project Cost Estimate. The project cost estimate will be prepared using information obtained during the survey. Spreadsheet-based UMCS cost estimators with comprehensive lists of devices and systems are available from the UMCS-MCX. One version is intended to determine the viability of UMCS at a specific site and the other applies to the final design. See Section 1.4, References.

c. Project Economic Analysis. The project economic analyses are prepared using information obtained from the viability survey and cost estimate. A methodology to determine energy savings for the economic analyses may be found in the Energy Savings Analysis (ESA) manual and computer program for UMCS.

d. Preparing the DD form 1391 or other funding documents. As appropriate, data obtained in the site survey, the cost estimate, and the economic analysis will be summarized in DD form 1391. Instructions for completing DD form 1391 are found in appropriate programming guides.

6. SURVEY PROCEDURES.

a. Introduction. Much of the survey effort will involve identifying and documenting the equipment to be controlled. This includes verifying equipment, piping and electrical circuits, and tracing out local control loops. The purpose of the survey is to obtain adequate information to evaluate the economic feasibility of a proposed UMCS and support future project activities. Once candidate buildings have been selected and all available records have been obtained on each building, the detailed building survey may be started. During the detailed building survey it is important to:

(1) Verify major energy using equipment.

(2) Verify present and required operating conditions.

(3) Make preliminary selection of application programs.

(4) Note any major required equipment modifications.

(5) Note existing building occupancy schedules.

b. Verify and Identify Energy Using Equipment. During the survey, locate and identify all major systems which could be monitored or controlled by the UMCS. Note discrepancies between actual field conditions and as-built drawings or equipment lists. Survey observation sheets for the different system types are located at the end of this Appendix. The necessary survey data differs depending on the types of systems found in each building. The information to be collected for each system type is summarized below.

(1) Air Handling Units. The broad category of air handling units (AHU) comprises many types of systems: single zone, multizone, reheat, variable air volume, fan coils, heating and ventilating, and unit heaters. All these systems provide heating and/or air-conditioning by forced air movement. The items of importance while surveying AHUs are:

(a) The type of AHU.

(b) The building area served by the AHU.

(c) Type of temperature control system.

(d) Types of coils (hot water, steam, electric, chilled water, etc.).

(e) Types of damper controls (fixed, modulating, economizers, etc.).

(f) Starter and motor type and size.

(g) Start up and operational items associated with the system.

(h) Summer/winter operational data.

(i) Equipment constraints.

(j) Valves.

Survey Sheet 1, Air Handling Unit Survey Observations, lists the noteworthy items.

(2) Perimeter Radiation Systems. Perimeter radiation systems are heating units normally found in exterior zones of buildings and are typically sized to match the heat losses from walls, windows, and doorways. The main items of importance while surveying perimeter radiation systems include:

(a) The type of perimeter radiation system (steam, hot water, electric, etc.).

(b) The building area served by the perimeter radiation system.

(c) The type of temperature control system.

(d) Start up and operational items associated with the system.

(e) Kilowatt (kW) rating of the equipment.

Survey Sheet 2, Perimeter Radiation Survey Observations, lists noteworthy items.

(3) Boiler and Converter Systems. When central boiler systems provide heating to buildings via steam to hot water or hot water to steam converters, the converter capacities (including any storage and associated pump sizes) should be noted. On such systems, the UMCS will normally interface with the existing control loop to regulate the temperature or pressure output of the unit. It is necessary to inspect the control system to see what local control loops exist and if additional control valves will be required. On most hot water systems, an important energy saver is outside air reset. The existing control systems should be inspected to see if local reset controls already exist. On hot water systems, pumps should be noted as candidates for UMCS controlled equipment. Survey Sheet 3, Boiler and Converter Survey Observations, lists noteworthy items.

(4) Chillers and Compressors. When surveying chiller and compressor units it is important to identify which unit serves which air handling units. This is necessary to know whether an air conditioning compressor system is serving AHUs which can be shut down during unoccupied hours or AHUs which condition critical areas where the chiller needs to provide cooling 24 hours a day (i.e., computer areas, hospitals, mission critical facilities, etc.). The following information must be obtained:

(a) The type of chiller or compressor system.

(b) Rated capacity of the system.

(c) The compressor and auxiliaries motor data.

(d) The type of controls used on the systems.

(e) Method of condenser temperature control.

(f) Chiller alarms and interlocks (if any exist) for future monitoring by the UMCS.

Survey Sheet 4, Refrigeration Equipment Survey Observations, lists noteworthy data.

(5) Domestic Hot Water. Domestic water heaters may be either direct fired using fossil fuels, electric resistance, or receive heat from a central plant. Note the tank capacity, setpoint, heating input and peak use periods. Survey Sheet 5, Domestic Hot Water Survey Observations, lists noteworthy items.

(6) Lighting. To accomplish lighting control through the UMCS, the power distribution system configuration for the lighting circuits must be known. Identify the branch circuits in a building and note local switching arrangements. Determine the lighting wattage for the building. Field verify the electrical plans to make sure the lighting layout has not changed. Note whether delamping (which will reduce the overall light wattage and potential UMCS savings) has been implemented. Survey Sheet 6, Lighting Survey Observations, lists noteworthy data.

(7) Miscellaneous Equipment. There are a few systems which may be analyzed during the survey which were not included in the above system descriptions. These systems include: (1) exhaust fans, (2) water pumping systems, and (3) miscellaneous loads which could be cycled on predetermined time schedules. Survey data required for exhaust fans include: (1) fan use (i.e. laboratory, toilet, etc.), (2) horsepower, (3) capacity in cubic feet per minute (cfm), and (4) present and required operating schedule. Other miscellaneous electrical or thermal equipment may not be routinely identified, but could offer the potential for energy savings through UMCS control. For such equipment note the capacity and present and required schedule of operation. There may be savings by shutting the equipment off during hours when it is not required.

c. Verify Present and Required Operating Schedules. After inspecting the energy using equipment, the most critical data to retrieve are operating schedules of the equipment. Most of the savings estimated depend heavily on this information. Building and operational and maintenance personnel should be interviewed to determine how the systems are currently operated. Are the fan systems deenergized during unoccupied hours? Are the thermostats setback at night? Are there any existing timeclock devices, and if so, do they work? Next, interview the building manager to determine the actual required hours of operation for each system. If, for example, an AHU is only providing conditioning to spaces for occupant comfort, then the system could be shut off during unoccupied hours. However, if the AHU is providing ventilation for special equipment (i.e., laboratory, computer, or special process area) or providing make-up air for exhaust systems, the AHU may need to operate 24 hours a day. See Survey Sheet 7, Building Data Survey Observations, for a list of what data should be recorded for operating schedules.

d. Identification of Equipment Modifications. If the implementation of the UMCS requires modification of a piece of mechanical or electrical equipment, adequate information must be obtained during the survey to develop a budgetary estimate of the cost for the modification. Areas where mechanical and/or electrical modifications may be necessary include things such as:

(1) Duct work additions or changes.

(2) Piping additions or changes.

(3) Additional fans or pumps.

(4) Control circuit components.

(5) Disconnect switches.

(6) Electrical service changes.

e. Identify Input/Output (I/O) Point Selection. Identify the application programs which relate to the particular systems identified in each building. The selected application programs will largely determine the I/O points required for each system and impact the potential economic savings.

f. System Deficiency Survey Report. After a visual inspection and interviews with operations personnel, note the existing control devices that must be repaired or replaced in order for the system to be in good working order.

g. Local Controls Interface. In general, existing local control loops will need to be modified to include the interface required for UMCS supervisory control. During the survey, verify how each control loop is presently connected and operated and identify the required failure mode for each control loop and piece of equipment.

h. Electrical Power. At each building, new electrical power will be required for field equipment panels and other control devices, such as equipment transformers, control actuators, etc. During the survey, identify where the contractor will obtain power for UMCS devices. Generally, the power source should be 120/208 volt, 3 phase, 4 wire system. If this power type is not available, make a note in the survey report so that an estimate of the cost to provide suitable power can be included in the project budgetary cost estimate.

i. Device Mounting Locations. During the survey, ensure adequate space is available to mount UMCS components such as field equipment panels, programmable logic controllers (PLCs), data terminal cabinets (DTCs) and various sensors. If circumstances arise where special space or mounting considerations will significantly alter the budgetary cost estimate, document this in the survey report.

j. Building Wiring. Note all interior and exterior wall and ceiling construction throughout the building where wiring will be run. If wiring cannot be installed concealed, note how and where new conduit shall be installed (for example, install conduit exposed across ceiling of shop area). Also note all ceiling heights where wiring will be run.

k. Central Station/Island Stations. The recent and continuous advancements in computer technology have minimized space and power requirements with respect to the Central/Island Stations and remote workstations. Desktop personal computers are now available with abundant speed and memory to serve any function in the system. Determine the probable location of the Central Station and note the availability of communication lines. When fiber optic DTS is specified, locating the Central Station in buildings with existing fiber optic capacity is highly recommended.

l. Energy Metering. Energy meters should be located at the public utility service point and additional energy meters may be installed at the building level. The survey requirements for these two areas are described below.

(1) Main Site Utility Distribution Metering. The electrical meters at the point of service by the utility company must also be metered by the UMCS if electrical demand limiting is implemented. Determine the location of all the electrical meters used for billing the facility by the power company. The UMCS will need to monitor all of the same points. In most cases, this will involve only one main point where the utility company substation or transformer banks are located. The utility company generally will provide a meter output from their meter at the request of the customer. This can be verified through the utility company representative who can also provide an estimate of the cost. If gas or other main utility metering is being considered, the same approach is recommended for existing meter locations. In many cases a pulse contact may be added to the existing meter head for the UMCS to monitor.

(2) Building Submetering. For building submetering, there are a number of different energy and flow measurements available. For gas or liquids, determine the fluid to be measured (gas, water, steam,

etc.), and its maximum flow rate. For electrical service metering, determine the secondary voltage to the building and the maximum amp service. With this data, cost estimates can be developed for installing building and equipment submetering.

m. Data Transmission System. There are three methods available for DTS: (1) fiber optics (FO), (2) wirelines, and (3) radio frequency (RF). Each DTS type has its economic and technical benefits. The preferred DTS is fiber optics or wirelines. The selection will be based on economics and the particular site requirements. Any new communications systems at a facility will have to be coordinated with the local communications office for approval. For DTS to be installed on existing aerial poles, meet with the communications personnel at the installation and go over the proposed DTS routing on site plans showing existing telephone and electrical power poles. The local communications office should identify all rights-of-way for adding cables on these poles. In addition, if the facility has specific design criteria for installation of overhead wires, the communications office should provide these guidelines. For underground direct buried DTS, the communications office should locate on site plans special obstructions or right-of-way problems. On some facilities where communications wiring is run underground, there may be spare conduits available for special applications, such as UMCS or fire/security. Communications office approval is normally required to use these conduits. The use of radio frequency equipment requires approved frequencies to transmit data signals to receivers on the facility. Again, the communications office should identify any problem areas to reach with RF signals (for example, "shadows" behind obstructions or other RF noise interference).

(1) Fiber Optics and Wireline DTS Application. Each facility will have its own design criteria for installation of communication cables. In some instances the DTS will be aerial, and in some cases it will be underground. After identifying the routing of the DTS from building-to-building, locate the DTS entrance to the building floor plan where the contractor will mount the cable terminations and junction boxes. Also note the exterior wall construction, which is needed for wall penetration details and cost estimating. Once the basic method of installation of the cabling has been determined through coordination with the communications office, conduct a visual survey with the facility site plans to verify pole locations, direct buried cable obstructions and other factors which might significantly impact the budgetary cost estimate.

(2) Radio Frequency DTS. The use of radio frequency (RF) DTS involves the installation of radio receivers and transmitters for data communications. Coordinate the possible use of RF with the communications office to avoid problems with the availability of radio frequencies for data transmission. On some facilities, all available frequencies are used and RF will not be an option. To survey a facility for RF DTS, look at the local geography. Make note of large hills and valleys which may obstruct the communications of the RF. Also, determine where the main transmitter antenna should be located. Many times a tall building will provide a suitable location for elevating the antenna system. If there is no available tall building, identify an alternative location for a new antenna tower. The transmitter for the RF must be located in close proximity to the antenna. If the antenna is located on top of a building, the transmitter could be located in the building. If a new antenna tower is built, a new enclosure may be necessary to house the transmitter. Since the RF DTS is only used for communication between the UMCS central equipment and the SFPs, the designer must choose an alternate DTS for SFP to field equipment panel communication.

n. Energy Savings Estimation. Collect all essential data to estimate potential energy savings and system cost. Survey Sheet 8, Energy Estimating Survey Observations, is a list of information required for this purpose.

o. Documentation of Results. After completing the survey, compiling and organizing the data will help in determining whether the data is complete. All survey notes and sketches should be dated and initialed by the engineer in charge of the survey. In many cases, changes will occur during and after the UMCS design. If there is any question as to the conditions at the time the notes were made, it is important to have the date and person responsible for the survey data. During this period, it is also important to write a short memorandum to summarize the results of the survey. This memo should include:

(1) A list of people involved in the survey.

(2) The time and dates of the survey.

(3) The list of names and phone numbers of people contacted at the facility.

(4) Any special problems or comments related to the UMCS design.

(5) General progress made on the survey.

(6) Notes from the entrance and exit interviews with facility personnel.

This information will help as the project matures if questions arise regarding design decisions based on meetings at the facility. Furthermore, the background data and reasons why these choices were made will be documented.

SURVEY SHEET 1

PROJECT:	DATE:
LOCATION:	PREPARED BY:
PROJECT ENG:	CHECKED BY:
BUILDING:	FILE:

AIR HANDLING UNIT SURVEY OBSERVATIONS

	AHU NO.		LOCATION (RM)
	REF. SYS. SERVING AHU		SERVES AREA

UNIT TYPE:

	SINGLE ZN		2-PIPE FC		4-PIPE FC		UNIT HTR		HEATING & VENTILATING
	MULTIZONE		DOUBLE DT		REHEAT		INDUCTION		VARIABLE AIR VOLUME
	NUMBER OF ZONES				OTHER				
	COMMENT:								

NAMEPLATE:

					MFG.				MODEL
	SUPPLY FAN HP				MFG.				MODEL
	RET/EXH FAN HP				MFG.				MODEL
	CFM-HTG		CFM-CLG		MIN %OA		MAX %OA		% HTG AREA SERVED
COMMENT:									

COILS:

	NONE		STM		HW		ELEC		MOD VLV	PREHEAT
	NONE		STM		HW		ELEC		MOD VLV	HEATING
	NONE		STM		HW		ELEC		MOD VLV	REHEAT
	NONE		STM		HW		EVAP MEDIA		MOD VLV	HUMIDIFYING
	NONE		DX		CW				MOD VLV	COOLING

OPERATION:

HOURS ON:	S	M	T	W	T	F	S	COMMENTS
PRESENT START TIME								TIMECLOCK?
PRESENT STOP TIME								
REQUIRED START TIME								
REQUIRED STOP TIME								

MONTHS ON:

J	F	M	A	M	J	J	A	S	O	N	D

CONTROLS:

		PNEUMATIC		ELECTRIC		ELEC'NIC		DDC	COMMENTS
THERMOSTAT TYPE:		SINGLE STPT		DUAL SETPNT		SETBACK			
SPACE SETPOINT (IF):		OCC HEAT		UNOCC HEAT		OCC COOL		UNOCC COOL	
OTHER SETPOINTS (IF):		HOT DECK		COLD DECK		MIXED AIR		OTHER	
DAMPER CONTROL:		MIN OA (Y/N)		MAX OA (Y/N)		RA (Y/N)		EA (Y/N)	
		MA CONTROL		ECONO-DB		ECONO-ENT		OTHER	
DEMAND LIMIT:		(Y - YES; N - NO)							
COMMENTS:									

Survey Form 1

SURVEY SHEET 2

PROJECT:	DATE:
LOCATION:	PREPARED BY:
PROJECT ENG:	CHECKED BY:
BUILDING:	FILE:

PERIMETER RADIATION SURVEY OBSERVATIONS

	PER RAD NO.		LOCATION (RM)
	SOURCE OF HEATING		SERVES AREA

UNIT TYPE:

	STEAM		HW		ELECTRIC				
	OTHER								
COMMENTS:									

NAMEPLATE:

	HW PUMP 1 - HP		MFG.		MODEL	
	HW PUMP 2 - HP		MFG.		MODEL	
	HW PUMP 3 - HP		MFG.		MODEL	
	HW PUMP 4 - HP		MFG.		MODEL	
COMMENTS:					% AREA HEATING	

OPERATION:

HOURS ON:	S	M	T	W	T	F	S	COMMENT
PRESENT START TIME								TIMECLOCK?
PRESENT STOP TIME								
REQUIRED START TIME								
REQUIRED STOP TIME								

MONTHS ON:

J	F	M	A	M	J	J	A	S	O	N	D

CONTROLS:

		PNEUMATIC		ELECTRIC		ELEC'NIC		DDC	COMMENTS
RADIATION CONTROL:		NONE		2-WAY VLV		3-WAY VLV		OTHER	
SPACE SETPOINT (F):		OCC HEAT		UNOCC HEAT		OCC COOL		UNOCC COOL	
RESET CONTROL (F):		HW HIGH		HW LOW		OA LOW		OA HIGH	
COMMENTS:									

Survey Form 2

SURVEY SHEET 3

PROJECT: DATE:
LOCATION: PREPARED BY:
PROJECT ENG: CHECKED BY:
BUILDING: FILE:

BOILER & CONVERTER SURVEY OBSERVATIONS

	BOILER/CONVERTER NO.		LOCATION (RM)
	SOURCE OF HEATING (PLANT)		SERVES AREA

UNIT TYPE:

	STEAM		PSIG		HW		TEMP.		BOILER TYPE:
	NO.2 OIL		NO.6 OIL		N.GAS		ELEC		FUELS:
	STM/HW		HTHW/HW		HTHW/STM		OTHER		CONVERTER TYPE:
	SPACE HEAT		DHW		OTHER				USE:
COMMENTS:								% HEATING AREA SERVED (BASEBOARD RADIATION ONLY)

NAMEPLATE:

	MFG.		MODEL		CAPACITY OUTPUT (BTUH)	
					CAPACITY INPUT (BTUH)	
	MFG.		MODEL		CAPACITY OUTPUT (BTUH)	
					CAPACITY INPUT (BTUH)	
	HW PUMP 1 - HP		MFG.		MODEL	
	HW PUMP 2 - HP		MFG.		MODEL	
	HW PUMP 3 - HP		MFG.		MODEL	
COMMENTS:						

OPERATION:

HOURS ON:	S	M	T	W	T	F	S	COMMENT
PRESENT START TIME								TIMECLOCK?
PRESENT STOP TIME								
REQUIRED START TIME								
REQUIRED STOP TIME								

MONTHS ON:

J	F	M	A	M	J	J	A	S	O	N	D

CONTROLS:

		PNEUMATIC		ELECTRIC		ELEC'NIC		DDC	COMMENTS
SETPOINTS		PSIG		HW SUPPLY					
RESET CONTROL (oF):		HW HIGH		HW LOW		OA LOW		OA HIGH	
BURNER CONTROLS		O2 TRIM (Y/N)		OTHER					
COMMENTS:									

Survey Form 3

SURVEY SHEET 4

PROJECT: DATE:
LOCATION: PREPARED BY:
PROJECT ENG: CHECKED BY:
BUILDING: FILE:

REFRIGERATION EQUIPMENT SURVEY OBSERVATIONS

	CHILLER/COMPRESSOR NO.		LOCATION (RM)

UNIT TYPE:

	CENTRIFUGAL WITH WATER SIDE COOLING TOWER						OTHER
	RECIPROCATING WITH WATER SIDE COOLING TOWER						AHU'S SERVED
	RECIPROCATING WITH AIR COOLED CONDENSING UNIT						
	ABSORBTION WITH WATER SIDE COOLING TOWER						
	AIR COOLED CONDENSING UNIT						
	CHW		DX		OTHER		

NAMEPLATE:

CHILLER		MFG.				MODEL				SERIAL NO.
	VOLTS		AMPS		PH		HZ		CAPACITY (TONS)	
TOWER		MFG.				MODEL				# OF FANS
	VOLTS		AMPS		PH		HZ		HP each	
CW PUMP		MFG.				MODEL				SERIAL NO.
	VOLTS		AMPS		PH		HZ		HP	
CNW PUMP		MFG.				MODEL				SERIAL NO.
	VOLTS		AMPS		PH		HZ		HP	
COMMENTS:										

OPERATION:

HOURS ON:	S	M	T	W	T	F	S	COMMENT
PRESENT START TIME								TIMECLOCK?
PRESENT STOP TIME								
REQUIRED START TIME								
REQUIRED STOP TIME								

MONTHS ON:

J	F	M	A	M	J	J	A	S	O	N	D

CONTROLS:

		PNEUMATIC		ELECTRIC		ELEC'NIC		DDC	COMMENTS
SETPOINTS		CWS (oF)		CWR (oF)		CNWS (oF)		CNWR (oF)	
PANEL INDICATORS									
- PRESSURE		LITE-HI		LITE-LOW		GAUGES			
- TEMPERATURE		LITE-HI		LITE-LOW		GAUGES			
- OTHER									
COMMENTS:									

Survey Form 4

SURVEY SHEET 5

PROJECT: DATE:
LOCATION: PREPARED BY:
PROJECT ENG: CHECKED BY:
BUILDING: FILE:

DOMESTIC HW SURVEY OBSERVATIONS:			
	BOILER/CONVERTER NO.		LOCATION (RM)
	SOURCE OF HEATING (PLANT)		SERVES AREA

UNIT TYPE:									
	NO.2 OIL		NO.6 OIL		N.GAS		ELEC		FUELS:
	STM/HW		HTHW/HW		HTHW/STM		OTHER		CONVERTER TYPE:
COMMENTS:									

NAMEPLATE:					
MFG.		MODEL:		OUTPUT CAP (BTUH,KW):	
MFG.		MODEL:		OUTPUT CAP (BTUH,KW):	
DOMESTIC HW CIRCULATION PUMP:					
	HW PUMP 1 - HP		MFG.		MODEL
	HW PUMP 2 - HP		MFG.		MODEL
	HW PUMP 3 - HP		MFG.		MODEL
COMMENTS:					

TANK DIMENSIONS:	DIAMETER (INCHS):	HEIGHT OR LENGTH (INCHES):	TANK CAP (GALS):

OPERATION:								
HOURS ON:	S	M	T	W	T	F	S	COMMENTS
PRESENT START TIME								TIMECLOCK?
PRESENT STOP TIME								
REQUIRED START TIME								
REQUIRED STOP TIME								

MONTHS ON:											
J	F	M	A	M	J	J	A	S	O	N	D

CONTROLS:							
		PNEUMATIC		ELECTRIC		ELEC/NIC		DDC	COMMENTS
SETPOINTS				HW SUPPLY					
COMMENTS:							

Survey Form 5

SURVEY SHEET 6

LIGHTING SURVEY OBSERVATIONS

FACILITY INFORMATION :

Building Number : ______________________ Hours of Operation : ________

Building Description : ______________________ Building Voltage : ________

EXISTING LIGHTING INFORMATION :

Room Name/Type	Lamp Type (*)	Lamps/ Fixture	Watts/ Lamp	No. of Fixtures	Ballast Amp/Mult.	Number of Switches	Number of Circuits	Comments: Controls, Operating Hours, Daylight

GENERAL INFORMATION :

Project Name : ________________ Survey Date : ________

Project No. : ________________ Survey Team : ________

Notes : ____

* R = Recessed, S = Surface, P = Pendant, ST = Shop Type, W = Wall Mounted & G = Globe

** F = Fluroscent (2F, 4F, 8F), INC = Incandescent, MV = Mercury Vapor, MH = Metal Halide & HPS = High Pressure Sodium

Survey Form 6

SURVEY SHEET 7

PROJECT:
LOCATION:
PROJECT ENG:
BUILDING:

DATE:
PREPARED BY:
CHECKED BY:
FILE:

BUILDING DATA SURVEY OBSERVATIONS

BLDG NO: ________ BLDG NAME: ________________

ZONE NO.			FUNCTION:					
OCCUPANCY HOURS:	M-F		TO		SAT		TO	
	SUN		TO					
PRESENT TEMP	WINTER OCC	Degs F	UNOCC	Degs F				
	SUMMER OCC	Degs F	UNOCC	Degs F				

ZONE NO.			FUNCTION:					
OCCUPANCY HOURS:	M-F		TO		SAT		TO	
	SUN		TO					
PRESENT TEMP	WINTER OCC	Degs F	UNOCC	Degs F				
	SUMMER OCC	Degs F	UNOCC	Degs F				

ZONE NO.			FUNCTION:					
OCCUPANCY HOURS:	M-F		TO		SAT		TO	
	SUN		TO					
PRESENT TEMP	WINTER OCC	Degs F	UNOCC	Degs F				
	SUMMER OCC	Degs F	UNOCC	Degs F				

REMARKS: ________________

Survey Form 7

SURVEY SHEET 8

ENERGY ESTIMATING SURVEY OBSERVATIONS

DATE:
BY:
JOB:
CHK:
FILE:

BLDG NO. ____________ BLDG NAME: ____________
BLDG FUNCTION: ____________
FLOOR AREA: (SQ. FT) ____________ # FLOORS ____________
SLAB PERIMETER: (FT) ____________

I. AREAS: ([ ] FIELD VERIFIED ELEVATION PLANS)

		NORTH	SOUTH	EAST	WEST	TOTAL
WALLS, GROSS	(SQ. FT)					
GLASS	(SQ. FT)					
PERSONNEL DOOR,	(SQ. FT)					
OVERHEAD DOOR,	(SQ. FT)					
WALLS, NET	(SQ. FT)					
ROOF AREA (OR CEILING AREA IF ATTIC IS UNCONDITIONED)					(SQ. FT)	
OVERHEAD DOOR	(SQ. FT)	0	PERSONNEL DOOR		(SQ. FT)	
BASEMENT WALLS	(SQ. FT)					

II. CONSTRUCTION: ([ ] FIELD VERIFIED WALL, ROOF, WINDOW, DOOR TYPES)

WALLS: (SKETCH CROSS SECTION OF WALL)

	COMPONENTS	R-VALUE
1.	OUTSIDE AIR FILM	0.17
2.		
3.		
4.		
5.		
6.		
7.	INSIDE AIR FILM	0.68
	TOTAL R-WALL =	
	U=1/R	

ROOF: (SKETCH CROSS SECTION OF ROOF)

	COMPONENTS	R-VALUE
1.	OUTSIDE AIR FILM	0.17
2.		
3.		
4.		
5.		
6.		
7.	INSIDE AIR FILM	0.68
	TOTAL R-ROOF =	
	U=1/R	

GLASS TYPE:	R-GLASS	
SLAB TYPE FLOOR:	SLF	
BASEMENT TYPE:	R-BASEM.	
OVERHEAD DOOR TYPE:	R-ODOOR	
PERSONNEL DOOR TYPE:	R-PDOOR	

UA ODOOR	=	ODOOR AREA		X DOOR "U"	=	
UA PDOOR	=	PDOOR AREA		X DOOR "U"	=	
UA WALL	=	WALL AREA		X WALL "U"	=	
UA ROOF	=	ROOF AREA		X ROOF "U"	=	
UA GLASS	=	GLASS AREA		X GLASS "U"	=	
UA SLAB	=	SLAB PERIM.		X SLF	=	
UA BASEM.	=	B-WALL AREA		X BASE. "U"	=	
INFILTRATION	=		X CFM	X DELTA (T)	=	

INDOOR HEATING SETPOINT. (DEG. F)	
DESIGN OUTDOOR TEMP. (DEG. F)	
DESIGN GROUND TEMP. (DEG. F)	

TOTAL UA (BTU/HR X T)	
DELTA (T)	
+ INFILTRATION (BTU/HR)	
TOT. HEATING LOAD (BTU/HR)	

Survey Form 8

- Appendix D - APPLICABLE FILES FOR DOWNLOADS (See Note Below)
    - PDF Files (9.63 MB, 9/10/98)
    - Microsoft Excel 97 Files (133 KB, 7/31/98)
    - CAD Drawings and Details (2.45 MB, 7/31/98)

NOTE: The downloadable files which make up Appendix D are intended to provide a user with additional information on TI 811-12. Each of the files are self-extracting ZIP files. If desired, download each file into an empty directory and then execute the file (double-click). Each file will expand into numerous files. The CAD files provided were developed using Intergraph's Microstation 95 software.