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).

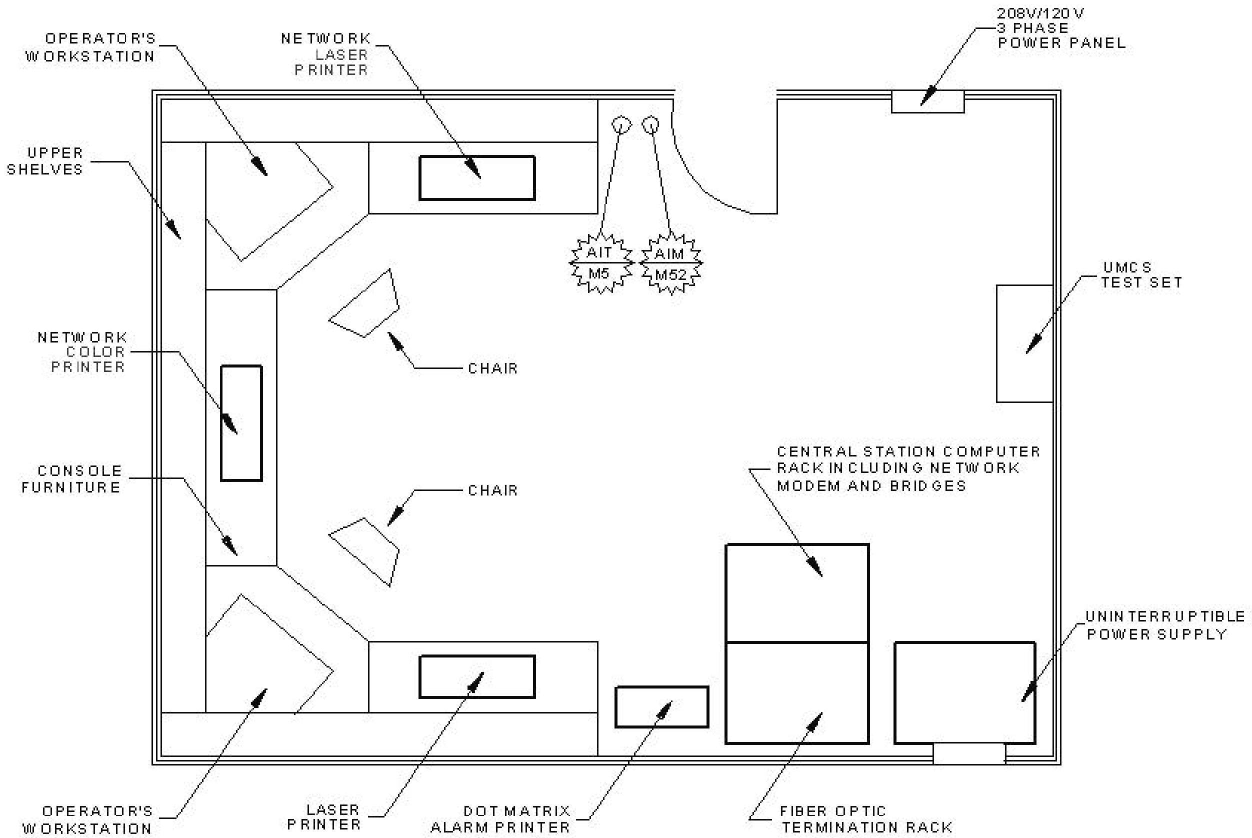

Figure 12-1. Typical Central Station or Island Station Equipment Room.

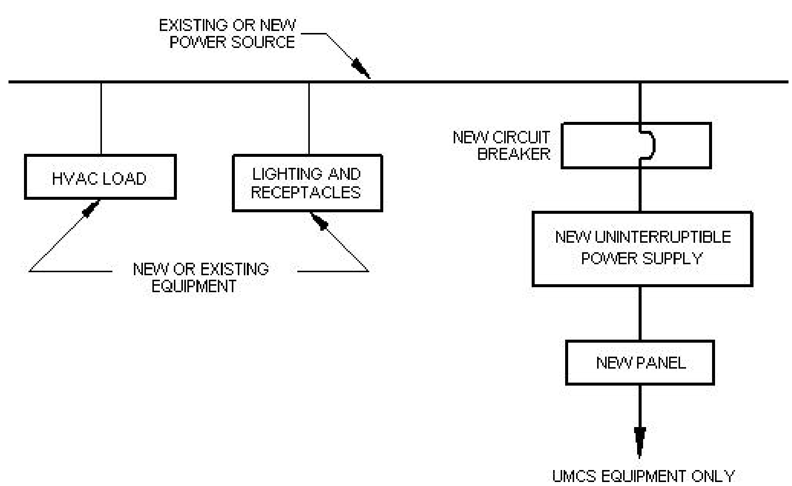

Figure 12-2. Typical Electrical Single-Line Diagram.

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													