CHAPTER 7

PROJECT IMPLEMENTATION

7-1. Sequence of events

a. The sequence of events necessary to implement an EMCS is described, but will vary depending on the project complexity and scheduling.

b. The sequence of events is divided into several categories.

(1) DD Form 1391 (FY —, Military Construction Project Data) preparation by others (para 7-2).

(2) DD Form 1391 validation (para 7-3).

(3) Information retrieval and design kickoff meeting (para 7-4).

(4) Buildings and systems selection (para 7-5).

(5) Field survey (para 7-6, 7-7, 7-8, 7-9, 7-10).

(6) Design (para 7-11, 7-12, 7-13, 7-14, 7-15, 7-16, 7-20, 7-21, 7-22, 7-23).

(7) Feasibility study (para 7-17, 7-18, 7-19).

(8) Preparation of contract documents (para 7-24, 7-25).

7-2. Preparation of DD Form 1391

The using facility will have prepared the initial list of buildings and systems considered candidates for inclusion in an EMCS as part of the DD form 1391 preparation. Site specific experience and available utility records will have been used in determining which buildings and systems offer the largest potential energy savings. This initial investigation will have determined which of the buildings were included as candidates in the project, based on current applicable agency guidelines relating to payback period, energy saved per dollar of investment, or other factors. This initial work will have been performed in sufficient detail for preparation of a DD form 1391 and supporting documentation.

7-3. DD form 1391 validation

The candidate buildings and systems list will be used by the designer to validate or amend the DD form 1391. The preliminary selection of buildings for inclusion in an EMCS in the preparation of the DD form 1391 is based on energy and economic analysis for all systems in a building. The final design selection of systems for inclusion in an EMCS is based on energy and economic 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.

7-4. Information retrieval

a. A necessary task in the implementation of an EMCS is to retrieve pertinent information related to the building and systems which are candidates for inclusion in the project. The information to be retrieved includes the following:

(1) As-built drawings for the buildings and systems in the initial list prepared by the facility engineer. The record drawings will always be verified by comparing them to actual conditions in the field.

(2) Equipment lists as a source in identifying large energy users. Equipment lists for the various buildings and systems may be available, separate from the as-built drawings. All equipment considered for inclusion in the EMCS will be field checked to ensure that the equipment is still being used.

(3) 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.

(4) Buildings or systems which are scheduled for shutdown or demolition will not be included in the project.

(5) 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.

(6) DTM type, routing, installation costs, site specific conditions, maintenance costs, and use will be coordinated with the facility communications officer.

b. One of the first activities which will take place is a predesign meeting with the following personnel in attendance.

(1) Government design representative.

(2) Architect-engineer design representative (where applicable).

(3) Facility engineer representative.
(4) Communications officer.
(5) Operations personnel (future operators)
(6) Other personnel as required.

c. This predesign 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.

7-5. Buildings and systems selection

a. Final selection of buildings and systems is required for final submittal of DD form 1391.

b. The list of candidate buildings will include those buildings and systems which have the largest equipment ratings or have operating requirements less than full time. The most likely candidates include buildings used less than 16 hours daily or less than seven days a week, and central chiller and boiler plants. Such buildings normally have office areas, classrooms, living quarters, test and shop areas, recreation facilities, libraries, and chapels. Housing areas will be considered for connection to the EMCS for electrical demand limiting and overall consumption reduction.

c. Buildings will be subdivided to identify quantities and types of systems with their associated occupancy schedules, equipment operating schedules, and required operating parameters. A detailed field survey is required to verify all information retrieved.

d. Hospitals will be carefully evaluated prior to inclusion into an EMCS. Functions such as demand limiting may not be possible in the hospital environment. An alternate solution is a stand-alone EMCS which can be connected to the basewide system for information exchange only.

7-6. Field survey

Specific requirements for performing the survey are in appendix B.

a. The field survey will include the following tasks:

(1) Verify information retrieved.
(2) Determine building and system operating schedules.
(3) Identify any equipment not documented.
(4) Record equipment nameplate data.
(5) Determine the location of the MCR.
(6) Determine need for intercommunications.
(7) Identify potential locations for FIDs, MUXs, PLCs, DTCs, and DTM terminations.
(8) Determine routing of DTM.
(9) Locate and identify sources for power for EMCS equipment.
(10) Perform a preliminary selection of applications programs.
(11) Prepare sketches of the installation of EMCS instrumentation and control devices.
(12) Prepare sketches of the installation of mechanical and electrical modifications.
(13) Determine the location of the utility metering, and EMCS interface requirements.

b. 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 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 of outside air, return, and relief air ducts.
(9) Size and type of outside air, return air, and relief dampers.
(10) Number and physical location of zones served by each air handling unit.
(11) Number, type, and locations of auxiliary equipment, such as pumps.
(12) Locations, type, and sequence of existing controls for each system.
(13) Location and type of existing starters for each piece of equipment.
(14) Location and type of existing local loop controllers.
(15) Location and type of available electric power for EMCS.
(16) Repair and replacement of existing devices, such as local loop controllers, and inoperable devices.
(17) Operate controls of each interfaced piece of equipment where possible.
(18) Operate controls affected by opposite seasonal conditions if possible.

c. Data Sheet. Data Sheet will be designed and prepared prior to the survey to aid in collecting all of the necessary information for calculating energy savings and costs to implement an EMCS.

7-7. Applications program selection

Applications programs will be selected for each system from the survey data. A summary of applications programs discussed in chapter 3 that can be applied to mechanical-electrical systems is shown in table 7-1.

NO.	HVAC SYSTEM TYPE	SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL
1	SINGLE ZONE AHU	X	X	X	X	X	X	X											
2	TERMINAL REHEAT AHU	X	X	X	X	X	X	X		X									
3	VARIABLE AIR VOLUME AHU	X	X	X	X	X	X	X											
4	MULTI-ZONE AHU	X	X	X	X	X	X	X	X										
5	SINGLE ZONE DX-A/C	X	X	X	X	X	X	X											
6	MULTI-ZONE DX-A/C	X	X	X	X	X	X		X										
7	TWO PIPE FAN COIL UNIT	X	X	X	X	X													
8	FOUR PIPE FAN COIL UNIT	X	X	X	X	X													
9	HEATING VENTILATING UNIT	X	X	X	X	X	X	X											
10	STEAM UNIT HEAT					X													
11	ELECTRIC UNIT HEAT	X	X	X	X	X													
12	HOT WATER UNIT HEATER					X													
13	STEAM RADIATION					X													
14	ELECTRIC RADIATION	X	X	X	X	X													
15	HOT WATER RADIATION	X	X	X	X	X													
16	STEAM BOILER										X								X
17	HOT WATER BOILER											X	X						X
18	DIRECT FIRED FURNACE	X	X	X	X	X		X											
19	DIRECT FIRED BOILER	X	X	X	X	X		X											
20	STEAM HW CONVERTER	X	X	X		X							X						
21	HTHW STEAM CONVERTER					X													
22	HTHW STEAM CONVERTER	X	X	X	X	X							X						
23	WATER COOLED DX COMPRESSOR	X	X	X	X											X			
24	AIR COOLED DX COMPRESSOR	X	X	X	X														
25	AIR COOLED CHILLER	X	X											X	X				
26	WATER COOLED CHILLER													X	X	X	X		
27	LIGHTING CONTROL	X																X	
28	DOMESTIC HW OIL/GAS	X																	
29	DOMESTIC HW ELECTRIC	X		X	X														

Table 7-1. Summary of applications programs.

7-8. Repair and replacement (existing devices)

Equipment and accessories required to provide building environmental conditions or process support must be in good operating condition. During EMCS operation, existing local loop controls must be operational in order for the EMCS to perform its necessary functions. Furthermore, during EMCS failure, the existing local loop controls must continue to function. The existing control devices that must be repaired or replaced as determined by a visual inspection and operational check will be noted during the survey The cost to perform this work will be estimated and entered for each building on DD Form 2290 (Energy Monitoring and Control Systems (EMCS) Building Summary Cost Estimating Worksheet), for future use in determining budget contingencies and operating and maintenance budget requirements. For Army, DD Form 2290 will be reproduced locally on 14 by 8½ inch paper. For reproduction purposes, DD Form 2290 is located at the end of the regular size pages. For Air Force, copies are available through normal publications/forms supply channels.

7-9. Identification of equipment modifications

a. The implementation of EMCS 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 entered in tables 7-2 and 7-3.

7-10. I/O points selection estimate

The survey will identify the applications programs for each system. The I/O summary tables for each system described in chapter 4 provide the starting point from which to determine the required number of points for each system. These I/O summary tables will be edited to delete those functions that are not applicable for each system. The points for each system will be counted using the edited tables. The number of I/O points, and associated EMCS instrumentation and controls costs for each system, will be identified and entered in on DD Form 2290.

7-11. EMCS configuration

a. The total number of I/O points estimated for all systems establishes a starting point for determining the EMCS size classification (large, medium, small, or micro). Point count alone is insufficient for determining which system classifications is selected. User requirements will be evaluated to determine if the need for MCR backup operation would indicate selection of a large system over a medium system for fewer than 2000 points, or if the need for color graphics and custom report generation would indicate selection of a medium system for fewer than 500 points. Conversely, a 2600 point system may be selected as a medium classification if no future expansion is anticipated, and MCR backup operation is not required. Where future additions to the system are planned, it may be more cost effective for the entire facility to initially procure the larger system. The selection of a larger EMCS may adversely affect the economic analysis, and may not be possible within current agency guidelines. This is an important decision and will be very carefully studied in the context of current and projected requirements. In facilities where there are multiple supervisory or operator locations, it is necessary to provide peripherals (printers or operator consoles) as described in chapter 2. The final system size to be documented in the contract drawings and specifications will be determined when the DD form 1391 is validated as part of the design process.

b. Once the classification of the EMCS has been established, the location of the MCR will be determined. The location of the MCR is influenced by the location of the physical plant operating personnel, availability of DTM, available space and power, and future applications. The MCR will not be located in close proximity to large electrical loads, rotating machinery or other sources of vibration, or in dirty air environments.

c. After the MCR location has been established, the placement and minimum required quantity of FlDs/MUXs, and DTM requirements and routing will be determined in order to complete the system configuration. The number of FIDs/MUXs is determined and entered on DD Form 2290 using guidelines described in chapter 5, section III.

7-12. Communications officer coordination

The DTM layout will be coordinated with the communications officer for his review and comments in accordance with the requirements of chapter 5, section III.

7-13. DTM configuration

DTM type and quantity to be provided by the contractor will be clearly defined in the contract documents. The DTM layout will be based on the guidelines shown in chapter 5, section III. DTM installation and maintenance costs, obtained from the communications officer, will be entered on DD Form 2290. Economic selection of DTM types using current cost data for DTM installation and maintenance. The configuration of the DTM and

number of links required will be based on the guidelines presented in chapter 5, section III. The number of wire lines and optical fibers per DTM circuit will be based on half duplex data transmission between CLT and FIDs and between FIDs and MUXs.

7-14. Intercommunications

The designer will determine whether the facility operating personnel require an intercommunication system in conjunction with the EMCS. Hand held FM transceivers may, in many cases, be used as an intercom system. An intercommunication system requires a dedicated pair of wirelines from the MCR to each intercom station, in addition to all other DTM, or requires the multiplexing of the audio communications onto the DTM.

7-15. Location and number of FIDs/MUXs

a. FID capacity varies among manufacturers, between the bounds of 64 and 512 points, and up to 64 points for MUXs.

b. The minimum number of FIDs/MUXs required and the maximum number of points will be determined in accordance with the criteria delineated in paragraph 5-14.

c. The location of FIDs/MUXs will be determined in accordance with the following guidelines.

(1) FID/MUX locations will be outside the equipment rooms and selected such that the ambient conditions are between 50 degrees F and 90 degrees F and 10 to 85 percent relative humidity. FIDs/MUXs located in areas exceeding these ranges will have enclosures with heating or cooling devices to provide the proper environmental conditions.

(2) FIDs/MUXs will be located within close proximity to equipment rooms in order to minimize field wiring.

7-16. Equipment modifications

a. The implementation of EMCS 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 6, section II. Sketches made during the field 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. The field data will be detailed enough to be used for the cost estimate, as well as for preparation of contract documents for those buildings and systems selected for the EMCS. The field data will identify existing equipment that will remain, be removed or replaced with new equipment.

7-17. Cost estimates

The cost estimate and energy savings calculations necessary to prepare an economic analysis can proceed after the contractor has completed the information retrieval and the field survey, identified the DTM type to be used, located the MCR, identified equipment modifications, selected applications programs, compiled I/O point estimates, and arrived at an EMCS configuration.

7-18. 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 made in accordance with the agency's current guidelines. The energy savings will be converted to equivalent Btu's for use in the economic analysis.

c. Energy savings for the applications programs selected for each system will be entered on DD Form 2290.

7-19. 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 on DD Form 2290 to develop the data required on DD Form 2289 (Energy Monitoring and Control Systems (EMCS) Systems Summary Economics Analysis Worksheet) for the entire EMCS. For Army, DD Form 2289 will be reproduced locally on 14 by 8½ inch paper. For reproduction purposes, DD Form 2289 is located at the end of the regular size pages. For Air Force, copies are available through normal publications/forms supply channels.

a. Identification of fixed costs common to all buildings is based on the EMCS size selected in paragraph 7-11. The fixed costs include all the central control equipment; hardware, system and command software; applications software; FID software; MCR constructions; training; documentation; and maintenance and service (for

the first year). The EMCS fixed costs will be entered in on DD Form 2289.

b. Identification of the fixed costs in each building: FID/MUX and DTM installation costs, and associated maintenance and service costs for the first year. These items will be entered on DD Form 2289.

c. Identification of maintenance costs for EMCS related equipment provided as part of the project. The costs for each building will be entered on DD Form 2289 for use in determining the EMCS SIR ratio.

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 the agency's current guidelines (i.e., ranking based on B/C or E/C ratios) for the source of funding used for the project.

f. Determination of the project SIR ratio or other payback requirements will be based on the agency's current guidelines. If the entire EMCS does not meet these guidelines, buildings or systems with the lowest ratios will be deleted. This elimination of buildings or systems may result in a reduction of points sufficient to require the use of the next smaller EMCS configuration (i.e., medium becomes small). There may also be special cases where certain buildings are added to the EMCS even though the ratios are below acceptable levels. The addition of such buildings may result in an increase of points sufficient to require the use of the next larger EMCS configuration (i.e., medium becomes large). In either case, a new determination based on the revised project configuration will then be made to verify conformance with the agency's current guidelines. This may result in revisions to the DD form 1391 reflecting changes to the project cost or scope.

7-20. MCR

a. The MCR will be large enough to accommodate the CCU/CCC, peripherals, associated equipment and accessories. All free standing equipment will have at least 36 inches front or rear clearance for maintenance purposes. Large and medium EMCS require a room of 400 square feet. Figure 7-1 illustrates a typical MCR layout for a large and medium EMCS. Note that the CCU/CCC, disk drives and magnetic tape drives are located in a separate room for purposes of security, environmental control and noise reduction. Glass partitions will be used, enabling the operator to have a clear view of the equipment. Small EMCS normally require a room of 100 square feet. A micro system requires wall space for the RCU and desk space for the operator’s console. 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. MCRs for large, medium, and small EMCS require raised floors and sound attenuating walls.

b. The electrical power service will be designed to furnish sufficient capacity to handle all the EMCS equipment, including any additional air conditioning and lighting. A PLC will be required for all MCR EMCS equipment. The PLC will be installed on the line side of the new electrical panel that will serve the EMCS equipment. The PLC will be rated to handle 125 percent of the estimated EMCS equipment load. A typical MCR electrical single line diagram is shown in figure 7-2.

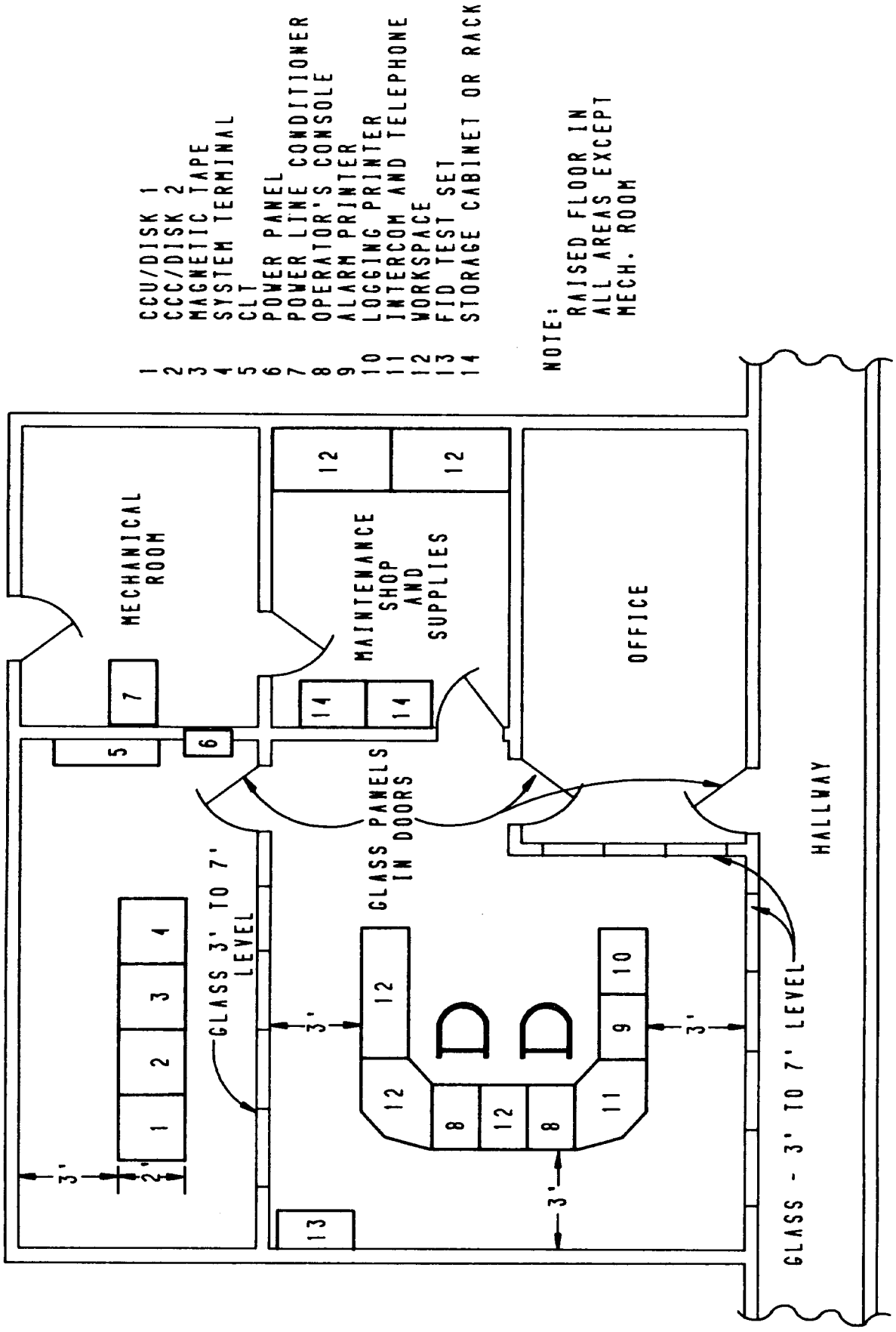

Figure 7-1. Typical large EMCS MCR layout.

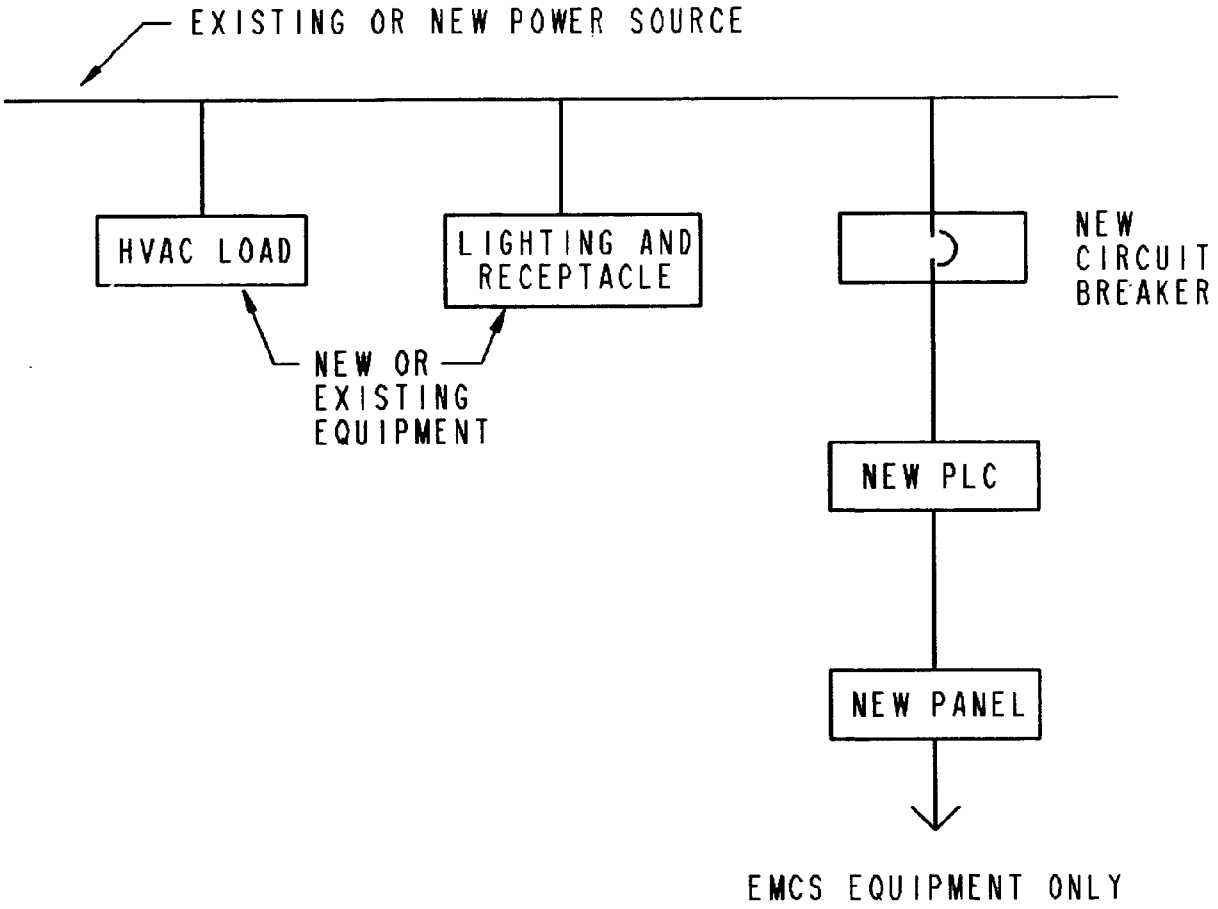

Figure 7-2. Typical electrical single line diagram.

c. Lighting design including size and placement of windows will be carefully planned. The MCR will have a lighting level of approximately 50 foot-candles with task lighting as required. Lighting design shall consider and plan for elimination of CRT screen glare problems.

d. The HVAC system for the MCR will be designed to provide year-round environmental conditions of 70 to 75 degrees F, 40 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 EMCS equipment. The HVAC equipment will be located outside the MCR and return air intakes will be located above the MCR equipment racks and consoles. Air will be supplied beneath each MCR equipment rack to ensure adequate cooling.

7-21. Instrumentation and control

(a) End-to-end system measurements for EMCS use must meet accuracies for specific applications as follows:

(1) Space temperatures with a range of 50 to 85 degrees F plus or minus 0.75 degree F for conditioned space; 30 to 130 degrees F plus or minus 1.0 degree F for unconditioned space.

(2) Duct temperatures with a range of 40 to 140 degrees F plus or minus 2.0 degrees F.

(3) OA temperatures with a range of minus 30 to plus 130 degrees F plus or minus 2.0 degrees F with a subrange of plus 30 to plus 100 degrees F plus or minus 1.0 degree F.

(4) Water temperatures with a range of 30 to 100 degrees F plus Or minus 0.75 degree F; the range of 100 to 250 degrees F plus or minus 2.0 degrees F; and water temperatures for the purpose of performing Btu calculations using differential temperatures to plus or minus 0.5 degree F using matched sensors.

(5) High temperatures with a range of 200 to 500 degrees F plus or minus 2.0 degrees F.

(6) Relative humidity with a range of 20 to 80 percent plus or minus 6.0 percent.

(7) Pressure with a range for the specific application plus or minus 2.0 percent of range.

(8) Flow with a range for the specific application plus or minus 3.0 percent, and flows for the purpose of Btu calculations to plus or minus 2.0 percent of range.

(9) Kwh and kW demand with a range for the specific applications plus or minus 1.0 percent of reading.

(b) When sensors are to be located outdoors, suitable weather shields will be used to protect against wind, rain, solar effects, and radiation from nearby structures.

(c) Switches for EMCS use will have the following characteristics and be applied as follows:

(1) Differential pressure switches will be used for status feedback from fans except at very low differential pressures, where the use of a vane type flow switch is more appropriate. Switches will have adjustable settings and be selected to have the switch setting in the middle half of the device's range.

(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) Metering used for EMCS will be applied as follows:

(1) Detailed application and installation requirements for the primary flow measuring device, and the secondary measuring element (differential pressure transmitter), are described in the ASME publication "Fluid Meters, Their Theory and Application". Flow meter size, location, expected flow rates for the summer and winter, and expected turn down ratio must be indicated. The length of straight pipe downstream of the flow meter will be no less than five pipe diameters, and not less than ten to twenty pipe diameters upstream. Note that these are minimum requirements and that the longest straight run of pipe available will be selected. A possible required straight run of 20 pipe diameters upstream of the flow measuring element may be reduced to 9 pipe diameters by the use of straightening vanes. Straightening vanes are composed of a multitube arrangement in a concentric bundle mounted in a spool piece with flanged ends for mounting into a pipe run. The secondary measuring element (differential pressure transmitted) will be as near the primary element as possible. Flowmeter inputs are required for BTU calculations in water and steam systems, and flow for consumption of fuel oil and gas. Calculations of the BTU valves must be accomplished by the EMCS.

(2) 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. The EMCS sliding window demand calculations do not require end of interval signals.

e. EMCS control devices, including relays, transducers, and electropneumatic devices, will be applied as described in chapter 6.

7-22. Wiring requirements

(a) Ml wiring will be in accordance with TM 5-811-2/AFM 88-9, chap. 2. Low voltage wiring in mechanical rooms and where exposed to physical damage will be in conduit for protection against physical damage. Low voltage wiring in concealed spaces where it is not subject to physical damage does not have to be run in conduit, where permitted by agency specifications.

b. Electrical disconnect means for EMCS controlled devices as required by NFPA 70 will be provided when there is not a disconnect within sight of the device location.

7-23. Transient protection

a. The EMCS electrical power supply, DTM, and I/O must be protected against transients from lightning and voltage surges by the EMCS supplier. Figure 7-3 illustrates typical shielding and grounding for analog measurements.

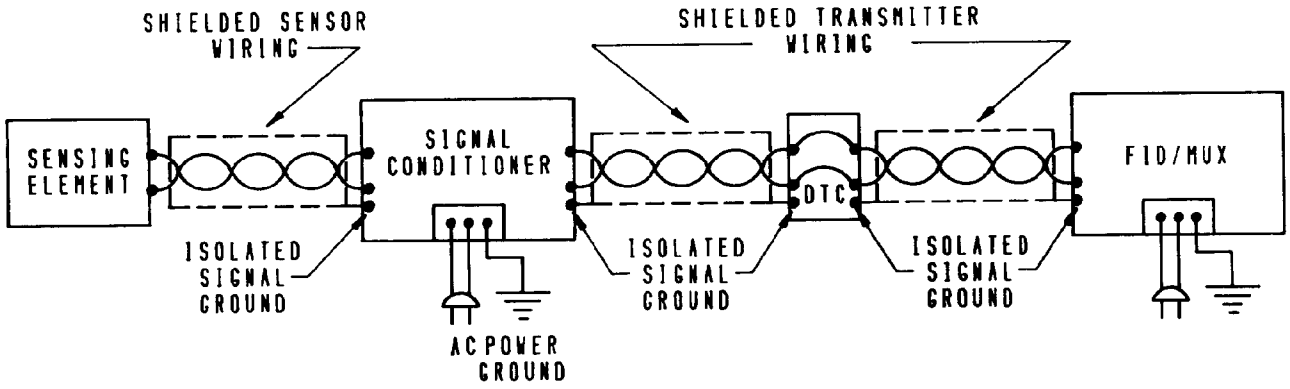

Figure 7-3. Typical shielding and grounding for analog measurements.

b. The transient protection provided as part of the equipment, to be effective, will be connected to a good ground with impedance as low as possible but in no event more than 3 ohms for the MCR, and no more than 25 ohms for the DTM and FIDs/MUXs. The installation of ground rods and their connections to building ground systems, poles, and radio towers will be designed in accordance with current guidelines. In cases where no grounding means is available, the designer will provide for installation of a grounding system in accordance with IEEE No.142.

7-24. Drawings

The drawings for a complete EMCS design will include all the requirements in the A/E scope of services (refer to appendix B for a copy of the standard scope of work and design checklists for EMCS). The drawings must include the following:

a. Alterations or additions required to create the MCR and provide the proper environmental conditions. A physical layout of the MCR is required, showing the CCU/CCC, peripherals, accessories, and storage space. Power sources, PLCs, HVAC, lighting, and fire protection will be shown in detail.

b. System configuration block diagram for the selected EMCS showing all MCR equipment and FIDs/MUXs.

c. Installation drawings for MCR equipment, FIDs/MUXs, PLCs and DTC.

d. DTM system configuration showing the network. Each DTM 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 EMCS will be shown with all sensor locations identified. Existing control devices being reused or replaced will be shown as existing devices.

f. EMCS interface control diagrams showing all interface devices such as relays, controllers, and sensors between the existing equipment and EMCS field equipment.

g. For each loop, one drawings sheet will show the sequence of operation for all systems to be interfaced to EMCS (including any necessary interocks), I/O summary tables, building layout, and schematic.

h. Floor plans for each building showing the location of all EMCS equipment, mechanical and electrical systems, instruments, and controls. The mechanical/electrical systems will be shown in sufficient detail to make the equipment arrangement clear. Source 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 FIDs/MUXs, PLCs, DTCs, and I)TM terminations will be shown. The A/E will identify equipment locations and expected operating rangers.

i. Parameters will include the summer/winter, day/night operating and alarm setpoints, and all other parameters required for the contractor to complete the entry of data.

j. For flow and Btu calcuations, system operating pressure, maximum and minimum temperatures and flows, maximum allowable pressure drop for sensor elements, locations or sensors, and size of existing piping.

k. Building occupancy and equipment start-stop times including summer and winter switchover schedules.

l. Details will be shown for mounting each type of sensing and control device. Temperature sensors in ducts will be shown with the sensitive portion of the element installed in the center of the duct cross section or location 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 at a 54-inch elevation from the finished floor. Where located on exterior walls or walls adjacent to unheated spaces, ¼-inch insulating blocks will be shown. OA sensors will be shown mounted in the OA suitably shielded and not in OA intake ducts. Care will be taken to avoid locating OA sensors near exhaust or relief openings. Temperature sensors in small diameter pipe 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.

m. Required modifications to the existing mechanical and electrical equipment for implementing the various programs will be shown on drawings (i.e., installation of disconnecting means, contractors, duckwork, piping, fans, pumps, and controllers). Sensors installed on insulated pipes or ducts will accommodate the additional insulating material thickness.

n. Identifications for each required nameplate of equipment tag to be furnished by the EMCS contractor will be provided.

7-25. Specifications

The specifications required for a complete EMCS design will include all requirements in the A/E Statement of Work in appendix B.

7-26. Construction period

A typical EMCS 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 EMCS 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 large, medium and small EMCS 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 FIDs and MUXs).