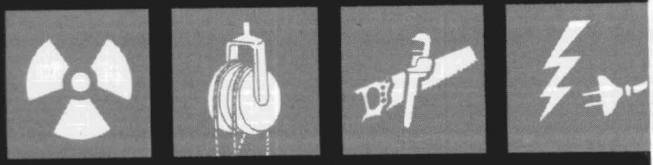
CECW-EC Engineer Pamphlet 415-1-261_4 Volume 4	Department of the Army U.S. Army Corps of Engineers Washington, DC 20314-1000	EP 415-1-261_4 Volume 4 1 December 1992
	Construction QUALITY ASSURANCE REPRESENTATIVES GUIDE Special Construction, Conveying Systems, Mechanical, and Electrical Features of Building Construction	
	Distribution Restriction Statement Approved for public release; distribution is unlimited.	

US Army Corps
of Engineers

EP 415-1-261_4
Volume 4
December 1992

Quality Assurance Representative's Guide



Special Construction, Conveying Systems, Mechanical, and Electrical Features of Building Construction

SUMMARY of CHANGE

EP 415-1-261 Vol 4
Quality Assurance Representative's Guide – Special Construction, Conveying Systems, Mechanical, and Electrical Features of Building Construction

This administrative revision, dated 28 November 2023—

- Transfers responsibility of this Pamphlet from CEMP-CE to CECW-EC
- Corrects the Pamphlet number from EP 415-1-261 to EP 415-1-261_4

DEPARTMENT OF THE ARMY EP 415-1-261_4
U.S. Army Corps of Engineers
CECW-EC Washington, D.C. 20314-1000

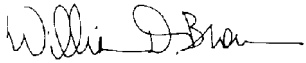
Pamphlet
No.415-1-261_4 1 Dec 1992

Construction
QUALITY ASSURANCE REPRESENTATIVE*S GUIDE
FOREWORD

This guide is one of four volumes reprinted with revisions from guides first published in 1964. The reason for their existence and continuance is to provide Quality Assurance Representatives (QARs), those with either quality control or quality assurance responsibilities, a reliable checklist type reference for each phase of construction.

QARs will find the information fundamental and appropriate to their role of controlling and assuring quality in accordance with the plans and specifications. The guide will, therefore, become a valuable reference to supplement the project plans and specifications. Its contents will also help refresh the memory of experience, training, and good old common sense. The use of knowledge with appropriate responsibility and authority will result in the decisions and actions so necessary for successful quality assurance. The objective is to produce quality products for our customers throughout the world.

FOR THE COMMANDER:



WILLIAM D. BROWN
Colonel, Corps of Engineers
Chief of Staff

EP 415-1-261_4 supersedes Volume 4 EP 415-1-261, December 1986

TABLE OF CONTENTS

Chapters numbered in the guides contain the same subject information as the numbered divisions in the specifications for both military and civil works construction projects. They are identified by specific volume as follows:

Chapter Number	Volume 1	Subject
1		General Reguirements.
2		Sitework: earthwork, underground utilities, paving, plantings, and railroads.
2	Volume 2	
		Sitework (continued): piles, levees, dams, relief wells, drilling, lock and dam gates, penstocks, revetments, dredging, jetty, breakwater, and groin construction.
	Volume 3	
3		Concrete
4		Masonry
5		Metals
6		Wood and Plastics
7		Thermal & Moisture Protection
8		Door & Windows Finishes
9		Finishes
10		Accessories & Specialties
12		Furnishing & Casework

CHAPTER 13A

X-RAY SHIELDING

INDEX

CHAPTER 13A

X-RAY SHIELDING

13A-01 GENERAL

a. This chapter covers specific information for the materials and construction of medical and dental radiation facilities.

b. Check for specific structural features which may be different than usual, such as:

(1) Recessed floor slab

(2) Closer wall stud spacing

(3) Blocking between wall studs

(4) Heavier steel bar joists for support of lead-lined ceiling

(5) Lead-lined floor above structural flooring

c. Make spot checks of the lead sheet and lead linings for specified thickness and uniformity.

d. During erection check for continuity of protection with specified laps, joint strips, patches and sleeves of lead.

13A-02 MATERIALS

a. Shop Drawings

(1) Check for conflicts between approved shop drawings, contract drawings, and specifications.

(2) Check for details of joints to make the required lead shielding laps or joint strips.

(3) Shielding of penetrations is crucial. Check for these requirements on the details of penetrations. Get clarification from your supervisor where no details exist.

b. Lead-Lined Materials and Equipment

(1) The grade of lead sheet specified indicates product quality, purity. Check label and make a close inspection for conformance.

(2) Masonry units for shielding are different than usual CMU and manufactured to provide a ½-inch mortar joint with extended lead liner to lap the lead liner of adjacent units.

(3) Approve surface texture of masonry when a plaster finish will be applied or for painted finish.

(4) For prefinished wall panels, check the labeling with inspection of the sample and representative units for contract requirements.

(5) Do the shop drawings detail the lead liner joints at corners of rooms for panel construction?

(6) Are the lead—lined lath segments designed to lap the lead at joints? Lap the lath?

(7) Check for type fasteners to attach lath.

(8) Lead lined gypsum wallboard is very difficult to handle and avoid damage. The ½—inch GWB is usually specified.

(9) Closely check door and frame and the other special lined items for proper labels and compliance with requirements.

(10) Is the lead liner in the door and frame the same and specified thickness as the wall its hung in?

(11) Check edges of prefinished door and all surfaces of unfinished materials for proper fit, alignment, and damage.

13A-03 ERECTION

a. General

Construction of x-ray shielded rooms requires close attention to contract requirements. The work will be performed in strict accordance with the following:

(1) Contract drawings and specifications.

(2) Approved manufacturer*s recommendations.

(3) NCRP Reports 33, 34, and 35.

b. Construction of X-Ray Shielded Rooms

(1) Lead shielding under 3MM thick will be installed in a single layer.

(a) Check for minimum 1-1/2 inch lap at all joints

(b) Check for minimum specified thickness.

(2) Lead shielding that is more than 3MM thick will be installed in two or more layers.

(a) Check for minimum 1-1/2 inch lap at all joints.

(b) Check for minimum specified thickness.

(3) Vertical wall shieldings will be erected on lead strips prior to the installation of floor linings in the shielded room.

(a) Check to see that lead strips project approximately 3 inches into the shielded room area.

(b) Check door sill lead shielding for extending 1 foot beyond each door jamb and 1 foot into shielded room area.

(c) Check for coat of asphalt paint on top surface of the sheet lead prior to application of concrete surface.

(d) Check to see that traffic and other work is not performed in the area until lead floor lining is protected from damage.

(4) Check for continuity of shielding at all built—in feature of walls, columns, outlet and junction boxes, ducts, conduits, and other wall penetrations.

(5) Lead—lined blocks installation

(a) Check for use of staggered block joints.

(b) Check for 1 inch tight lead laps, without soldering or burring.

(c) Check to see that no mortar is placed between the lead laps.

(6) Lead-lined panel installation. Use pilot holes drilled to receive lead-headed nails, to prevent distortion of butt jointed panels.

(a) Check to see that all joints are placed over supports.

(b) Check to see that all joints and covers are lapped or covered with 2 inch wide lap strips, or the joints are backed with 1-1/2 inch wide strips.

(c) Check finish molding strips for same finish as the panels.

(7) Lead—lined lath installation. Use pilot holes, as necessary, to prevent deformation of the fasteners and to prevent distortion of the lath.

(a) Check to see that lath is applied with long edges at right angles to supports and with lead linings placed next to the supports.

(b) Check to see if lath end joints are placed over supports, and staggered in alternate courses.

(c) Check to see that wall joints do not coincide with the ceiling joints.

(d) Check over lap of the lead extensions on adjacent sheets to provide an efficient lead lap.

(e) Check lath applied with long edges parallel to supports to see if it has blocking to support end joints.

(f) Check external corners for reinforcing by use of corner beads.

(g) Check securing of lath to wood supports with lead-headed nails 7 inches on centers.

(h) Check to see if nail heads are driven up flush with lath surface.

(i) For metal supports - check to see that lath is attached to wood furring strips, which are screwed or bolted to the metal supports at right angles.

(8) Lead-lined gypsum wallboard. Use drilled pilot holes for fasteners. Install the wallboards vertically, parallel with the supports and with the lead lining next to the supports. Provide blocking at all end joints.

(a) Check for use of 1-1/2 inch wide joint strips where joints will occur.

(b) Check for 1-3/4 inch X 1-3/4 inch corner joint lead strips.

(c) Check edges of wallboards for butt joints for fastening with lead-headed nails at approximately 8 inches on centers at joints, and 12 inches on centers at intermediate supports.

(d) For metal studs - check for use of 1 inch long screws.

(e) Check screw heads for ½ inch diameter lead disc covering, cemented to the surface of the wallboard, and made flush with the surface of the wallboard.

(f) If plastic is not used - check for finish ply of wallboard fastened with laminating adhesives. Nailing will not be permitted on the finished ply.

(9) Suspended lead-lined plastered ceilings. See contract drawings for erection details.

(a) Check insulated lath and continuous ceiling bars for specified support by steel hangers from the overhead structure.

(b) Check to see that lead side of lath faces up.

(c) Check to see that lead in the ceiling will lap lead in the wall by not less than 1-1/2 inches.

(10) Lead door thresholds. Install in accordance with approved shop drawings, and constructed as detailed on the contract drawings.

Check to see that lead surfaces in contact with concrete is painted with a coat of asphalt paint or latex material.

(11) Operator*s lead-lined protection screen. Locate and construct the screen in accordance with the drawings.

Check to see that details are complied with both in materials and installation methods.

(12) Lead-lined doors will have a clearance of 1/16 inch at sides and top, a minimum adequate clearance at bottom, lock edge beveled 1/8 inch, and hardware adjusted as required.

Check that warps or twist of lead door does not exceed 1/4 inch in any face dimension of door, including full diagonal, after door has been hung and finished.

(13) Viewing windows installed in doors. Secure windows with hardwood strips of same species as face veneer of door.

Check to see if stops are glued to the door on corridor side and fastened with prescribed screws or finish nails on room side.

(14) Check that no line-of-sight through lead louvers exists in installed doors. Fasten louvers with cadmium—plated or chromium-plated screws.

Check fastenings to insure that lead lining of door was not penetrated. Use lead lined plugs on one side for through bolting of door closer.

(15) Film cassette transfer cabinets in lead—lined partitions will have the entire cabinet, doors, and integral wall flanges lined with sheet lead of the same thickness as the partition.

13A-04 VERIFICATION

a. Survey Test

The contractor is required to hire a qualified expert to make the required radiation protection survey. Check for:

(1) Approved written survey procedures.

(2) Qualification of the expert.

(3) Defective areas which do not meet standard for which the room is to be used.

(4) CE approval of corrective action proposed for defective areas.

(5) Resurvey of areas affected by corrective work.

(6) The written report of survey.

b. Certification

The acceptable report of survey for each room will certify the protection provided to areas outside the room against radiation exposure

c. Designations

(1) Check for the permanently posted plague in each room which will contain specific information on thickness of the lead shielding.

(2) Verify this information to be correct as built.

(3) Information required may vary with the function of the room; check your specifications.

(4) Where the lead thickness within a room is different, each surface area will require its separate plaque with the as—built thicknesses noted.

CHAPTER 13B

PRE-ENGINEERED BUILDINGS

INDEX

CHAPTER 13B

PRE-ENGINEERED BUILDINGS

13B-01 GENERAL

a. Coordination of the Work

(1) This chapter covers the installation of pre—engineered buildings. Most such buildings require placement of foundations and ground level slabs on grade. Some designs require basements and/or crawl spaces.

(2) The placement of the foundations and slabs will require close coordination between site grading, placement of exterior and under the structure utilities, including vapor barrier, and under the slab drainage if specified.

(3) Testing of the water lines, drain lines, sewers, and gas lines will have to be accomplished prior to being covered by the foundation and slabs.

(4) Electrical lines and communication lines will either have to be coordinated with the placement of the foundation or the slabs.

(5) Seismic considerations required by a design and the seismic zone will have to be incorporated in the foundations and slabs. This will include seismic reinforcing steel in masonry and concrete, flexible joints where branch lines leave main drain lines under ground and seismic penetrations through foundation walls.

b. Verification of Dimensions

It is of the utmost importance that the foundations and slabs fit the pre-engineered building, and that such items contain the required hold down bolts or fastening plates. The contractor shall verify all dimensions and coordinate its dimensions with the approved shop drawings and contract drawings. The contracting officer will be advised of any discrepancy before Contractor performs any work.

13B-02 Materials

a. Submittals

(1) Shop drawings shall consist of the complete details necessary to join together the foundations, slabs and pre-engineered structure. The shop drawings will provide a complete list of equipment and materials, including manufacturer*s descriptive and technical literature. The shop drawings will provide the erection sequence, tie down arrangement, and joining together details.

(2) Shop drawings will show electrical, mechanical, structural, and architectural features included in the factory constructed units and how these units will be joined to the field installed components.

b. Manufacturer*s Representative

Check requirements for manufacturer*s representative supervising the unloading, storage, and erection of the pre-engineered structure. Metal building guide specification does not require a manufacturer*s representative.

c. Delivery and Storage

Equipment, parts, and units when delivered will be stored with protection from the weather, humidity, temperature variations, dirt, dust, or other contaminants Deliveries should be scheduled to minimize job site storage whenever possible.

13B-03 ERECTION

a. Foundations and Services

(1) Check Civil, Structural, Mechanical, and Electrical plans against approved shop drawings to insure proper orientation of building, that building will fit foundation and prepared slabs, and that all utilities required to be concealed are installed prior to foundation or slab placement.

(2) Check anchor bolt and other tie down location, size, and projections. Protect such tie down devices from damage from construction equipment.

(3) Study erection procedures. Insure that manufactured units and parts can be trucked to either erection location or to storage as required. Coordinate underground work, deliveries, and erection to avoid delay or unsafe working procedures.

(4) Work closely with CQC representative and the manufacturer*s representative to insure that parts and portions of the structure and utilities are fitted together without bending or overstressing the parts or connections.

(5) Check connection points for completeness of joining, required method of joining, and to make sure that all components are present at the joining.

(6) Check exposed details of joined areas to insure that required tolerances are met, that covers are provided as specified, and that meeting planes are aligned, smooth and not damaged as a result of shipping, storage, or erection.

b. Electrical and Mechanical

(1) Check shop drawings and contract drawings to insure that all required services, utilities, and equipment are provided and in the required location. Advise your supervisor if errors or omissions are encountered.

(2) Determine if field run electrical and mechanical runs are required to be installed prior to or after the pre-engineered units have been placed.

(3) Coordinate mechanical and electrical work with structural and architectural work to insure that such items are concealed and supported as required.

(4) Test utilities before concealment.

(5) Provide seismic bracing for electrical and mechanical equipment as required by the contract documents and the seismic zone.

(6) Check specified materials in exposed area to insure proper finishes.

(7) Check all outlets, conduits, pipes, and fixtures for firm attachment, required height, slope, and insulation required. height, slope, and insulation if

(8) Check all equipment and fixtures for ease of operating.

13B-04 TESTING AND CHECK OUT PROCEDURES

a. Check all joined together units for good fit, cover plates, joining strips, or caulking as scarified. Check contract requirements for wall end floor coverings such as wallpaper and carpets.

b. Insure that using personnel are provided specified training. Document the names and positions of user personnel trained

c. Insure posting of operating instructions and obtaining maintenance manuals for furnished or installed equipment.

d. Conduct specified acceptance tests on electrical and mechanical equipment. Obtain test results.

a. Operate all doors, windows, and movable partitions. Check for ease of operation, full opening and adjustment of hardware. Require correction or adjustment of all items not performing correctly.

CHAPTER 13C

SOLAR ENERGY SYSTEMS

INDEX

CHAPTER 13C

SOLAR ENERGY SYSTEMS

13C-01 GENERAL REQUIREMENTS

a. This chapter rovers the installation and testing of solar energy systems consisting of the following:

(1) Solar Energy System for Domestic Hot Water Heating (Liquid Collectors)

(2) Solar Energy System. for Domestic Hot Water Heating and Spate Healing (Air Collectors).

(3) Solar Energy System for Domestic Hot Water Heating and Space Heating (Liquid Collectors).

(4) Solar assistant Heat Pump System for Domestic Hot Water Heating and Space Heating (Liquid Collectors).

(5) Solar Energy System with absorption chiller cooling, Domestic Hot Water Heating, and Spare Heating (Liquid Collectors).

(6) Heat Rejection System, Fan Coil.

(7) Heat Rejection System, Extended Surface Radiation.

(8) Heat Rejection System, Pipe immersed in open water tank.

b. Work in this chapter will be coordinated with chapters 5A for Structural, 5B for Welding, 15A-G for Mechanical, and 16A and NEC-70 for Electrical.

c. The contract drawings indicate extent and general arrangement of the solar energy system. Approved shop drawings will provide necessary details for installation and erection of the system. The contractor is responsible for coordination and verification of dimensions. The contractor will inform the Contracting Officer of any discrepancy prior to performing any work.

d. Welders shall be performance qualified in accordance with Section IX, ASME Boiler and Pressure Vessel Code. Each welder shall place his identification symbol near each weld he makes, as a permanent record. Structural members will be welded in accordance with specification section: welding, Structural. Welding and non destructive testing procedures are specified in Specification Section: Welding Pressure Piping.

13C-02 MATERIALS

a. Submittals

(1) All materials or equipment are specified to comply with requirements of UL, ARI, or ASME. Proof of such compliance shall be submitted.

(2) Manufacturer*s certificate of compliance shall be submitted by contractor on construction of collector, performance data for collector and 30 day degradation test data.

(3) Shop drawings will consist of illustrations, schedules, performance charts, instructions, brochures, diagrams, and drawings necessary for the installation of solar equipment, associated equipment, and for piping, wiring, and related foundations. Shop drawings shall include details of storage device, air handling equipment, heat transfer equipment, liquid circulating equipment, and controls and instrumentation. Drawings will indicate clearances required for maintenance and operation.

(4) Spare parts data will be provided for each different item of materials and equipment specified.

(5) Operating and Maintenance Instructions will be provided for system start-up and operation and maintenance.

(6) Performance Test reports in booklet form will be provided. Each test report shall indicate the final position of the controls.

b. Delivery and Storage

All equipment placed in storage will be protected from weather, humidity, temperature variation, dirt, dust, or other contaminants

13C-03 ERECTION AND TESTING

a. Installation

(1) All work shall be installed as specified and indicated and shall comply with the applicable sections of HUD 4930.2 and NBSIR-76-1187 or NBSIR-78-1526, except as otherwise noted.

(2) Absorption water chillers shall be installed in accordance with Chapter 15G.

(3) Air Supply Distribution System shall be installed in accordance with Chapter 15B.

(4) Ductwork shall be sealed in accordance with Table 1-1 in SMACNA Low Pressure Duct Construction Standards.

(5) Automatic control equipment shall be installed at the location shown under the supervision of the control manufacturer and in accordance with the manufacturer*s instructions.

(6) Thermal Insulation shall be installed in accordance with Chapter 15C.

(7) Vibration isolation shall be provided for fans and air handling units in accordance with specification section: Air Supply and Distribution System (for A/C System)

(8) Check solar collector array for meeting approved shop drawings. Check to see that each solar collector will withstand the minimum indicated wind and snow load.

(9) Check piping for solar collector array for specified size, type of material, use of fittings to make turns and connections, specified support, automatic pressure and temperature relief valve specified. Check adjustment of valve for proper opening pressure and temperature.

(10) Insulate unprotected fluid-carrying lines and components in accordance with Chapter 15C.

(11) Cover plates for flat plate solar collectors shall be completely replaceable from the front of the collector without disturbing the piping or adjacent collectors.

(12) Protective cover plates shall be reinforced fiber glass, reinforce safety glass, acrylic or polycarbonate and shall withstand hail or similar impact loads.

(13) Check heating, air supply distribution and heat transfer systems to see that they are in accordance with approved shop drawings, plans and specifications. Advise supervisor of any deviation in equipment or installation.

(14) Check piping, valves, and accessories for meeting contract requirements and for type of service intended.

(15) Check expansion tank and liquid storage tanks for size and arrangement against approved shop drawings, plans, and specifications. Check for specified lining in liquid storage tank.

(16) Check for specified insulation with smoothing coat of finishing cement for tanks located inside of buildings.

(17) Check for specified insulation protective covering for underground tanks.

(18) Check for specified cathodic protection system for steel water tank. See Chapter 13D and 16B.

(19) Check hot water storage heater tank against approved shop drawings and contract plans and specifications. Provide insolation for interior tanks and insulation protective covering for underground tanks with cathodic protection as indicated.

(20) Exact location of automatic control devices will be as recommended by the control manufacture — see shop drawings.

(21) Dampers shall be sized and fabricated by the automatic control manufacturer, compare with shop drawings.

(22) Instrumentation for monitoring solar system performance shell be mounted so as to be easily readable.

(23) Check approved sequence of automatic controls, including shut off controls on high and low limits.

(24) Solar system*s automatic controls will be integrated with building*s automatic control system and the EVAC systems.

(25) Check specifications for painting and finishing requirements. Repair factory finished coatings where possible. Provide field painting of surfaces that were prime coated only at the factory. See Section Painting, General, of the Contract Specifications.

(26) Cutting or other weakening of the building structure to facilitate pipe installation will not be permitted without written approval.

(27) Horizontal supply mains shall be pitched up or down in the direction of flow as indicated. The grade shall be not less than one (1) inch in 40 feet.

(28) Tin antimony solder (95-5) shall be used throughout the collector loop and in the whole system when a silicone heat transfer fluid is used.

(29) Welding electrodes shall be stored and dried in accordance with AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

(30) Dielectric unions shall be provided between ferrous and non ferrous piping to prevent galvanic corrosion.

(31) Swing joints or offsets shall be provided on all branch connections, mains, and risers to provide for expansion and contraction of the pipe.

(32) Check branch line for pitch, as indicated. Connections shall be made to insure unrestricted circulation, eliminate air pockets and permit drainage of the system.

(33) Supply and return lines shall provide for expansion by changes in direction of run of pipe, by expansion loops, or by expansion joints as indicated.

(34) Check for strainers at the inlet of each pump, heat exchanger, heating coil, and cooling coil.

(35) Check that valves are installed where shown.

(36) Check valve stems to see that they have been installed either horizontal or above.

b. Cleaning of Pipe

(l) Prior to flushing piping, all metering devices and orifices shall be removed. Temporary by-passes shall be provided for all solar collectors, coils, heat exchangers end equipment.

(2) Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter.

(3) Strainers and valves shall be thoroughly cleaned.

(4) After the hydrostatic pressure tests have been made and prior to operating tests, piping shall be cleaned again by filling the system with clean water and an alkaline detergent. The solution shall be circulated at the indicated flow rate for a period of 48 hours. The system will be drained and flushed thoroughly with fresh water.

(5) The system shall be drained and dried before filling with silicone fluid.

(6) Fill system with specified fluid and necessary inhibitors added.

(7) The initial cleaning and final filling shall be supervised by a technically qualified representative of a reputable water treatment organization.

c. Testing

(1) Factory Tests:

Check shop drawing submittals to determine if required factory tests were made and recorded.

(2) Field tests shall be as follows:

(a) Piping – after cleaning, water piping shall be hydrostatically tested at a pressure equal to 1 ½ times the total operating pressure for a period sufficient for inspection of every joint in the system and in no case less than 2 hours. No loss of pressure will be allowed.

Leaks found during testing shall be repaired by replacing pipe or fittings. Caulking of joints will not be permitted.

Concealed pipes shall be tested in place before being concealed.

The system will be drained and dried before filling with silicone fluid.

(3) Balancing and adjusting - shall be in accordance with Specification Section: TESTING ADJUSTING AND BALANCING OF HVAC SYSTEMS.

Adjust flow through each collector by measuring either the pressure drop or the temperature rise across the collector.

Temperature measurement shall be made by means of platinum resistance or thermocouple measuring devices.

Pressures shall be measured through inlet and outlet pressure taps with U-tube manometers.

Balancing valves shall be adjusted and set for the indicated flow through the collectors.

(4) Performance

(a) After completion of pressure testing, cleaning, balancing and adjusting, and installation of all systems and prior to acceptance, tests shall be conducted to demonstrate that system and all components are operating in compliance with contract performance requirements.

(b) The tests shall be conducted by a competent experienced engineer and shall cover a period of not less than the specified days for each system.

CHAPTER 13D

LIQUID AND GAS STORAGE TANKS

INDEX

CHAPTER 13D

LIQUID AND GAS STORAGE TANKS

13D-01 GENERAL

a. Definition

This chapter covers material, equipment, and good workmanship practices for installation of liquid and gas storage tanks.

b. Approvals

(1) Review ENG Form 4268, Submittal Register, and insure that all material, equipment, and shop drawings are approved prior to preparatory inspections and prior to either fabrication or installation of foundation, tanks and associated equipment.

(2) Obtain any helpful manufacturer*s information.

c. Storage and Handling

(1) Insure that storage yard is placed in an area that will not require movement of stored materials for Installation of utility lines or other structures. Storage yard should be adequate in size and location for both storing, sorting, and retrieval of materials for erection.

(2) Insure that all materials are safely and properly stored to prevent damage.

(3) Reject damaged materiel and equipment. Have such items removed from the site.

(4) In handling heavy items use proper size construction equipment to lift the loads being handled. Use proper size slings, clamps, and chocking devices when lifting or moving materials.

(5) provide necessary storage yard drainage, dunnage, and working room for both equipment and personnel.

d. Coordination of Work

Continually check for interferences between structural, electrical, and mechanical features, especially utilities in the underground areas adjacent to the erection area.

13D-02 BULK STORAGE TANKS

a. Above Ground Tanks

(1) Determine that fabrication is in accordance with API standards (for Petroleum Products).

(2) Verify compliance with approved shop drawings.

(3) Examine foundation details.

(4) Observe installation of sand base (oiled sand for Air Force projects)

(5) Check thoroughly all welds for compliance with design and workmanship. Check specifications for required weld sampling. Reject welds not meeting these requirements. Check specifications for destruct and non-destruct testing requirements for welds.

(6) Examine certified mill reports for steel.

(7) Inspect interior of tank, sump, and pipes for cleanliness.

(8) Refer to Chapter 5B for welding.

(9) Determine orientation of tanks.

(10) Measure plate thickness.

(11) Insure nameplates or stamps on tanks.

(12) Witness testing of the bottom and top plate welds. Prior to testing, see that welded joint is well soaped.

(13) Insist that approved construction sequence is rigidly followed.

(14) Note tank foundation prior to assembly and welding of the bottom plates.

(15) Verify that tank foundation is not damaged during erection of tank.

(16) Assure that radiographic inspection is made and records substantiate the results.

(17) Inspect tank openings and fittings for location, size, type, and reinforcement.

(18) Make sure that rim seals provide firm and continuous contact between seal ring and tank shell at all times and under all conditions, from partial to full tank capacity, without binding or excessive wear.

(19) Insist that weatherhoods are provided over rim seals.

(20) Be certain that Zinc-coated or galvanized materials are not permitted where there is a possibility of their coming into contact with the fuels.

(21) Ensure that emergency venting requirements in API 650 are met.

(22) Electrical Grounding.

(a) Determine that electrical grounding has been installed.

(b) Require testing by an electrical inspector after grounding is complete.

(c) Check gasketed pipeline joint for electrical bonding of adjacent pipe.

(d) Check insulated pipe flanges to insure complete electrical separation.

(23) Insure that gage pipe column is plumb from top of tank to bottom.

(24) Float-operated liquid level guage should be checked for easy and accurate operation from an empty to a full tank. Cable and tape should be installed level and plumb to avoid friction or binding in protective pipe, pulleys, and guage-well cover ferrule.

(25) Tanks should be calibrated and a certified guage table prepared, as specified. Witness the calibration operations. In the industry, calibration and strapping are synonymous.

(26) Stairways, platforms, ladders, and safety guages should be examined for compliance with approved design and for conformance to safety regulations.

(27) Provide adequate ventilation and lighting during inside work.

(28) All required tests should be made as specified and witnessed by the inspector. A complete record of each test should be maintained.

(29) Check for requirement for dike to contain leaks and spills. Insure that containment area is built to required dimensions, and that joints of dike materials are constructed to prevent leakage to adjacent areas.

(30) Check for access ramps or steps over dike wells for access to storage tanks.

(31) Check for restoration work requirement to restore area outside of dike area after construction is complete. The work will be done in accordance with contract specifications.

b. Underground Tanks

(1) Check anchoring in locations subject to high ground water.

(2) Check shop drawings. Verify foundation bolt layout check bolts for proper length and diameter.

(3) See that tanks have been constructed in accordance with applicable standards and approved shop drawings.

(4) Ensure that pressure tests are performed. Check to see if vacuum test on the interstitialspace is require to be performed.

(5) Examine tank openings and fittings for location, size, type, and reinforcing.

(6) Inspect shop applied coating on tanks. Witness holiday test of coating. Repair coating and re-test to confirm quality of repair. Check certified reports or inspection reports provided by factory for compliance with contract specifications and approved shop drawings.

(7) Field-applied coatings on tanks.

(a) Observe removal of shop protective paint coating for conformance with specification requirements.

(b) Observe preparation and cleaning of tank surfaces to be coated.

(c) Require application of primer immediately after cleaning.

(d) Check application of enamel while primer is still “live”.

(e) Determine the needs for re-priming, or for primer removal and reapplication.

(f) Check use of manufacturer*s recommendations.

(g) Verify results of holiday testing and repairs to coating.

(h) Witness handling of coated tank to avoid damage.

(8) Check type of fuel resistant gaskets{Buna-N or cork).

(9) Examine coating of tie—down straps.

(10) See that all appurtenances are installed inside of tank. See that leak detection connections are installed on dual wall tanks.

(11) Witness cleaning of interior of tank.

(12) Witness tank calibration.

(13) Observe the use of flexible connectors or piping to tanks.

(14) See that tank slopes to low point or sump.

(15) Check specification requirements for installation of cathodic protection for tank and piping to tank. See section on cathodic protection.

(16) Check specification requirements for backfilling around tank and piping. Check to see that tank manhole is to the proper elevation. Clean out manhole after backfilling tank area. Check for paved area or gravel area around manhole of tank and tank area in general.

(17) Check to see that tank vent is installed to correct height and installed as shown on drawings.

(18) Check to see that fill line to tank is to given grade and protected from damage.

13D-03 PUMPS (Excluding water pumps)

a. General

(1) Determine that certified test curves are furnished for each type of pump. Determine that shop drawings are approved.

(2) See that operation, maintenance, and installation instructions are furnished.

(3) Note type of bearings. Check type of seal. Determine lubrication requirement and water cooling requirement.

(4) Verify adjustment of stuffing box glands and leakage of seals.

(5) Observe the direction of rotation.

(6) Pumps to motor alignment can be thrown out of allowable tolerance at couplings during bolting down of base plate or attaching pipe to the pump. Check coupling alignment after pump is set and piping is attached. If coupling is out of tolerance, the motor should be reset to eliminate the out of tolerance measurements at the coupling.

(7) Examine guard device over couplings.

(8) Note electric motor drivers under operations.

b. Positive Displacement Pump

Check by—pass or leak-off protection in the event of a closed discharge.

c. Centrifugal Pump

(1) Check type of casing and material.

(2) Check inherent self-priming features.

(3) Check facilities on top of casings.

d. Deep Well Turbine Pump

(1) Obtain and record the impeller clearance settings as made by the pump manufacturer*s service engineer.

(2) Check pumps for non-reversing ratchet or restrictor.

(3) Verify overhead clearance and openings in slab above for removal of pumps.

(4) Insure minimum submergence setting.

(5) See that vents are installed at the high point of all pumps.

(6) Note bowl serial number to assure correct assembly when field assembled. Inspect bowl alignment.

(7) Examine the check-valves installed between gate—valve and pump.

(8) Determine that pump setting is level and plumb.

13D-04 AIRCRAFT FUELING SYSTEM

a. General

(1) Insure provisions to avoid injury and damage to work in the proximity of hangars, parking aprons, and runways.

(2) Follow coordination between contractor and the air base.

(3) Avoid substitution for approved materials. Require all materials be submitted for approval.

(4) See that every effort is made to furnish an uncontaminated system.

(5) Check cleanliness of existing system prior to connecting a new installation.

(6) Evaluate effect of welding operations on existing system prior to commencement of work because of the extreme hazard involved.

(7) Inspect painted identification marking of fuel system.

b. Fuel piping

(1) Determine size, material, thickness, coating, and painting of pipe.

(2) Refer to chapter for Welding.

(3) Examine storage of piping and materials to prevent contamination.

(4) Check blanking ends of piping.

(5) Check for anchoring and expansion provisions.

(6) Require pneumatic testing with dry air.

(7) Inspect painted identification marking of fuel system.

(8) Note installation of valve numbering system.

(9) Require gasket material that is suitable for use with petroleum products.

(10) Observe types of pipe sleeves for pipe passing through concrete or masonry construction.

(11) Witness holiday tests of pipe coating.

(12) Compare pipe joint compound with type of product approved.

(13) Check to make sure that there are pressure relief valves or other means included to provide pressure relief between closed valves.

(14) Examine encasement or protective sleeves where lines pass under structures, railroad tracks and paved areas.

(15) Assure that the fittings and tools used for coupling hose to track or railway cars are non-sparking materials.

(16) Determine that fill connections are identified to indicate the type of fuel handled.

(17) Inspect the slope or pitch of the pipe.

(18) Look at low spots for drains and at high points for air releases.

(19) See that unloading couplings are below tank car or truck unloading connections.

c. Valves

(1) Check to determine lubrication or non—lubrication.

(2) Check type of material and pressure rating.

(3) Check valve boxes and extensions.

(4) Check for special valves.

(5) Check timing for POL Valves and sequence of operation.

d. Strainers

(1) Check for proper mesh size and non-corrosive basket construction.

(2) Strainers should not be placed in line before pig* is blown through lines and line has been blown clean.

(3) Strainers should be cleaned prior to acceptance from the contractor.

e. Gauges

(1) Inspect to see that scale range is as per contract requirement.

(2) Inspect size and construction.

(3) Inspect tank gauge and pump control.

(4) Inspect to see that loss liquid level pump control is set at same level as minimum submergence level of pump.

f. Filter Separators

(1) Check to see that filter separator has been approved.

(2) Examine type of filtering media for approval.

(3) Insure filtering media replacement after operations and tests.

(4) Insure that equipment is installed so that no dismantling is necessary to replace filtering media cartridge or strainers.

(5) Check requirement for spare filter media cartridges. Turn spares over to using agency at end of contract.

(6) Check water dump valve operations by slugging the filter with water.

(7) Secure, review, and maintain custody of the results of all tests performed.

g. Mechanical Equipment

(1) Check insulated joint on railroad track.

(2) Check covers of hydrant outlet pits for good balance and fit.

h. Operations and Testing

(1) Verify availability, in sufficient quantity of each product.

(2) Check cleanliness of products delivered from existing facilities for entry into the new system.

(3) Check use of the Government furnished tank trucks, meters, hoses, filter media, hose, cart, etc.

(4) Do not permit intermixing of fuel, in a dual fuel installation. Check requirement for a set of testing equipment for each fuel system.

(5) Require test reports and certification that system cleanliness standards have been met prior to turn over of a facility to the using agency.

(6) Witness all testing and see that a test data log is prepared by the contractor. A copy of this test data should be included in the job files.

13D-05 SEWAGE TREATMENT PLANTS

a. Sewage Bar Screens and Shredder

(1) See that bars are parallel to one another, equally spaced, and in the same place of travel as the rakes.

(2) Observe the adjustment of teeth on rakes for proper mating with screen along entire travel. Reject rakes with damaged teeth.

(3) Determine that manufacturer*s representative adjusts tension of sprocket chains.

(4) Notice rake wiper for efficient cleaning of rakes.

(5) Examine shock absorber for elimination of excessive wiper shock and smooth operation.

(6) See that complete assembly is set in concrete so that no water is bypassed between concrete and equipment.

(7) Require contractor to furnish competent engineer to instruct government representatives in operations and maintenance.

(8) Witness operational tests for equipment performance required by specifications.

(9) Obtain special tools, if required.

b. Grit Chamber

(1) Check elevator and level of proportional weir.

(2) Check rake travel to see that it is parallel with floor of chamber.

(3) Check rake clearance for agreement with approved shop drawings.

(4) Check sprocket chain tension and adjusting mechanism.

(5) Conduct operational test as required.

c. Settling Chambers (Sedimentation Tanks)

(1) Rectangular and circular sedimentation tanks.

(a) Assure that all embedded items are installed and are properly located.

(b) Examine elevation of concrete baffles and scum troughs.

(c) Observe and record all recommendations and settings made by manufacturer*s representative supervising installation of equipment.

(d) Evaluate adjustable weirs for elevation, level and range of travel.

(a) Note adjusting mechanism of chain drive for easy operation and for sufficient range to procure proper tension in chain.

(f) Inspect scum pipes for level and elevation.

(g) Require lubrication with recommended lubricants prior to initial start-up.

(h) View sprocket-wheel bearings for cleanliness, freedom from binding, and smoothness of bearing surface.

(i) Check sprocket teeth for defects and for meshing accurately with chain.

(j) See that shafting is level, plumb, and free from rotation.

(k) Check chain for damaged links.

(2) Rectangular Sedimentation Tanks.

(a) Examine skimming run supports for level.

(b) See that angle track is level and aligned with forward sprocket.

(3) Circular Sedimentation Tanks.

(a) Observe whether top of tank is level.

(b) Inspect skimmer arm, blade, and receptacle for rigid support and assembly. Verify blade clearance.

d. Dosing Chamber

(1) Check weirs for proper elevation.

(2) Check all siphon placement dimensions and position.

(3) Observe adjustment and operation of weir plates or stop planks.

(4) Verify location of trap opening pipe so that sewage does not discharge directly into it.

(5) Observe setting of bell with respect to top of main trap pipe.

(6) Assure that invert of vent and overflow pipe is above the maximum discharge level of the siphon.

(7) During preliminary testing of tank, check maximum and minimum discharge levels and the level at which the siphon stops operating (minimum drawdown level)

(8) Conduct operating tests as required.

(9) Contractor must furnish competent engineer, or superintendent, as necessary, to provide proper installation and adjustments, to conduct tests, and to instruct government representatives in proper operation.

e. Trickling Filter

(1) Check filter media for size and specified material.

(2) Insure that media material is protected from contamination is stockpiled prior to placement in filter.

(3) Reject filter media that has been contaminated with nonremovable materials such as oils, grease, soil, etc.

(4) Check placing of filter material.

(5) Assure against contamination after finished placement of filter media.

(6) Check underdrains, for uniform bearing over the entire bottom of each block. See that cross joints are staggered in adjacent rows.

(7) Check air ducts for blockages.

(8) Check that blocks in drainage channel are not moved by placement of filter media.

f. Distributors

(1) Fixed Nozzle.

(a) Check stability and caulking in joint of piping laid within filter.

(b) Note spray nozzles for effective and uniform distribution of sewage over entire filter bed.

(c) Assure furnishing of spare nozzles.

(d) Perform operating tests as required.

(2) Rotary.

(a) Assure uniform distribution of sewage over entire filter bed.

(b) Examine distribution arm flushing valve for tightness and freedom of operation.

(c) Replace nozzles that do not show uniform flow characteristics.

(d) Assure that distribution arms are level guyed.

(e) Inspect seal for operation and tightness.

(f) Witness operation of arms at minimum head for starting and for operation. Complete cycle through all heads to maximum. See that motion of arms is parallel to surface of media.

g. Sludge Digester

1) Check all embedded items for proper location.

(2) Evaluate all cover seals for gas tightness.

(3) Check overall inside diameter of tank of floating cover digesters for roundness and clearances.

(4) Examine cover rollers for clean bearings, ease of greasing operations, and alignment of rollers and guides.

(5) Inspect heating system piping for tightness, materials, and secure fastening.

(6) Assure that elevation of all cover rests are the same on floating cover digesters.

(7) Check sludge draw-off piping for location of rigid support.

(8) Assure that all heating system lines, gas lines, feed pipes, and supernatant lines are flushed prior to operation.

(9) Assure that all debris is cleaned from interior of structure.

(10) Check center post installation for plumbness and rigidity.

(11) Examine sludge mixes and scum breaker for operating ease and settings.

(12) Witness and record tests and adjustments made by manufacturer*s representatives.

(13) Refer to Chapter 5B for welding.

(14) See that all manholes and openings through covers are gas-tight.

(15) Note all sensing locations for thermometers and controls.

(16) Verify that speed of mixer is set by manufacturer*s representative or contractor.

(17) Observe setting of gas pressure regulating valve.

(18) Check the use of flexible hose with double unions, in cold water connection to heating system.

(19) Obtain any special tools required.

(20) Perform operating tests as required.

(21) Require contractor to furnish competent engineer for instructional purposes.

13D-06 WATER DISTRIBUTION

a. Pumps

(1) Be familiar with all pump manufacturer*s recommendations and with Hydraulic Institute*s standards. Assure that installation is in accordance with same.

(2) Assure that adequate foundation is provided.

(3) Verify the use of a direct drive pump when such is specified.

(4) See that pump can be dismantled without disturbing pipe connection or the alignment of pump.

(5) Assure that bronze parts are used where specified.

(6) Check freedom of movement of impeller and shaft.

(7) Assure that water-seal is provided with proper type and size of packing.

(8) Inspect for necessary air cocks, drain plugs, guages, and relief valves.

(9) Determine whether a gasoline engine is specified. Check out same. (Use check list for Generator Units, included in this chapter).

(10) Check controls to see that they function as specified.

(11) Assure that all gears, couplings, projecting set screws, keys, and other rotating or reciprocating parts are fully enclosed or properly guarded.

(12) Assure that all instruction books, tools, and pumps characteristic curves have been obtained from contractor.

(13) Examine Hydraulic Institute*s standard and NEPA Standard N5.20 or American Standard B58.1. See that tests are made in accordance with these requirements.

b. Water Tanks and Stand Pipes

(1) Check foundation construction against plans, specifications, and shop drawings. Be sure to compare approved shop drawings for foundation with fabricated column base plates and anchor bolt layout.

(2) Closely compare steel erection with approved shop drawings. Check the erection of steel with Chapter 5A Structural steel and Chapter 5B Welding.

(3) Examine the layout of valve chamber to see that there is adequate room for later maintenance of all parts.

(4) Make sure all required checks, gates, altitude valves, and pressure guages are installed.

(5) Affirm that the results of the hydrostatic test are satisfactory.

(6) Check the installation of such items as cathodic protection, lighting and grounding.

(7) Determine whether there is a complete shop coat coverage and that the tank receives the specified finish paint.

(8) Determine the PPM of chlorine in the system during and after the disinfection period. Prior to chlorination, internal brass parts, such as those in altitude valves, should be removed and later replaced after the chlorine has been flushed from the line.

c. Chlorine and Hypochlorite Feeding Machines

(1) Work to be performed in accordance with the manufacturer*s recommendations, and to conform with plans and specifications.

(2) Assure the workmen are skilled in this type of work.

(3) See that controls, gauges, meters, valves, injectors, and reliefs are installed as required.

(4) Check for proper piping installation. Know where emergency shut off valves are located on the chlorine supply lines and tanks.

(5) Make sure that all special tools, operating instructions, and manuals are provided.

(6) Perform operational tests as required.

13D-07 GENERATING UNITS

a. See that contractor has verified all dimensions.

b. See Chapter 15A for checking pipe and fittings, Chapter 16A for electrical features, and Chapter 5B for welding.

c. Determine that skilled workmen are being employed.

d. Assure easy access to all parts of the engine.

e. Examine fuel handling and storage facilities.

(1) Observe tank installation.

(2) Check manhole construction; observe for water—tight cover, and for the height of manhole cover.

f. Assure necessary access doors in equipment.

g. Check the water level.

h. Check for excessive vibration.

i. Observe adjustment of V belt drives.

j. When operating the engine, check for excessive smoke, overheating, etc. at this time also check to insure that adequate ventilation is present in the test areas.

k. Check day tank installation.

(1) Check mounting and method of supporting.

(2) Determine that high level cutoff switch is properly installed.

l. Assure that approved tanks are installed as specified.

(1) Assure that tanks are kept clean during installation.

(2) Check cleaning operation and its results.

(3) Examine priming and painting applications.

(4) Holiday test the tanks as necessary to assure a complete prime and paint job.

(5) Check voltage of holiday detector.

(6) Continually watch for abrasions.

(7) Carefully watch backfill operation, check compaction and watch for any possible damage to tank or piping.

(8) See that all bare places on exterior of tank are repaired with hot enamel.

m. Check the installation, anchorage, and support of all piping. This includes the exhaust piping and muffler.

n. Make sure that all pipes, valves, fittings, pumps, etc., for the fuel and lubricant systems are shipped to the job with ends closed. Check when installed to assure cleanliness, and continue to guard against the entrance of dirt and foreign matter into the equipment.

o. Assure the acid cleaning, the neutralization, and the drying of the interior of the fuel piping systems.

p. Note the requirement for expansion joints.

(1) Check type furnished.

(2) Check method of installation.

(3) Check for misalignments.

(4) Follow manufacturer*s instructions to determine range of movement for installing expansion joints.

q. Mufflers.

(1) Check type furnished and specified.

(2) Check method of mounting.

(3) Check treatment for rust resistance.

(4) Check noise level.

(5) Check drain hole.

r. Be alert for the requirements concerning auxiliary equipment such as silencer, special controls, trickle charges, filters, instrument board, static exciter, voltage regulator, auxiliary compartment, special tools, operating instructions and manuals.

s. See that required tests are made.

(1) Check safety circuit.

(2) Check governor.

(3) Check fly wheel.

(4) Check accessibility of brush rigging.

(5) Performance.

(6) Controls and interlocks.

13D-08 INCINERATORS

a. Make sure that construction is in exact accordance with approved shop drawings. Check dimensions very carefully.

b. Check construction and thickness of fire brick in furnace and flue connections. Watch for:

(1) Width of joints.

(2) Wall thickness.

(3) Handle of arches and circular linings.

(4) Size of baffle.

(5) Bricks laid on edge in hearths and floors.

(6) Installation of expansion joints.

(7) Bracing.

c. Check casting and bonding of refractory casting when same is used.

d. See that insulating brick is installed in specific location.

e. See Chapter 4 for Installation of exterior wall brick.

f. Assure that there is at least a 2" separation between exterior walls and fire brick lining of chimney. Check plans and specifications to see if different dimension is required for the separation for your specific contract.

g. Check chimney for:

(1) Cleanout door and frame.

(2) Concrete protective cap.

(3) Spark screen.

h. Assure the installation of a safety rail around charging throats and guillotine.

i. Check the installation for items such as:

(1) Dampers.

(2) Auxiliary burners.

(3) Test pipes.

(4) Instruments.

j. Determine if other equipment such as can-wash or forced-draft is specified and check same.

k. Require that all necessary operating tools; spare parts, operating instructions, manuals, and training have been provided.

l. See that unit is dried out in accordance with requirements.

m. Assure that operating tests are conducted and that results have been recorded. Obtain copies of all test records and certification that unit was properly constructed and is operating satisfactorily.

13D-09 FOOD SERVICE AND HOSPITAL EQUIPMENT

a. Require an equipment layout if there is any question of items fitting into place.

b. Require the installation of all trimmings, steam traps and fittings necessary for proper operation.

c. See that the equipment manufacturer*s name plate is in a conspicuous location.

d. Install back flow preventers when equipment has a water supply.

e. Determine that motors of equipment are suitable for voltage supplied.

f. Check the quality of workmanship in the fabricated equipment.

g. Check welds for smooth, ground off finish, and ensure freedom from imperfections and color differences.

h. Check for the substitution of spot welds where full welds are needed or specified.

i. Check the type of material used in fabrication and the type and quality of finish.

j. Check for burrs, projections, and fins.

k. Inspect for exposed screws, rivets, or bolt heads.

l. Check for ferrous fastenings where stainless types are specified.

m. All exposed piping is to be chromium-plated brass.

n. Completely check out the plumbing for equipment, using Chapter 15.

o. Check all dimensions and capacities of equipment.

p. Check equipment for specified controls.

q. Input for any breaks in coated metal, and make sure the metal is properly treated and protected against corrosion.

r. Determine that equipment with waste or drain surfaces is pitched to drain,

a. Inspect counter tops for:

(1) Defects.

(2) Corners being rounded, bullnosed, and equal in finish of the counter top.

(3) Closure at walls.

(4) Bracing.

t. Compare all guages of metals with guages approved on shop drawings.

u. Determine that all equipment is easy to clean.

v. Check equipment drawers for corrosion-resisting steel sides, roller bearings, and the amount of play.

w. Check size of drawer to see that they have the specified stop.

x. Check sliding doors for construction, size, type, and ease of operation.

y. Check all hardware for type of material and finish.

z. Inspect sinks for:

(1) Specified fixtures and trim.

(2) Overflow fittings.

(3) Special features required.

aa. Examine all hoods for:

(1) Corrosion resisting steel construction.

(2) Freedom from vibration.

(3) Method of hanging.

(4) Grease filters.

(5) Method of connecting to duct.

ab. Determine that each piece of equipment is continually protected and that it is cleaned prior to turn over to the using agency.

ac. Require an instruction book with each piece of equipment.

ad. Require special tools be furnished, if specified.

ae. Require operational tests for each piece of equipment. Make a record of your findings.

af. When specified, assure that an experienced engineer from the manufacturer*s plant is present to supervise the equipment installation and testing.

CHAPTER 14A

ELEVATORS

INDEX

CHAPTER 14A

ELEVATORS

14A-01 GENERAL

a. Coordination of Work

(1) This chapter covers the installation and testing of Electric Elevators and Hydraulic Elevators. See Chapter 16A and NEC 70—ARTICLE-620, for Electrical; Chapter 5A for Structural Steel; and Chapter 5B for Welding.

(2) The contract drawings indicate general layout and components of the elevators. Approved shop drawings will provide necessary information for installation of the particular elevator selected for the project.

(3) Elevator installation is a speciality trade. Elevator installation mechanics must have a minimum of two years experience on type of elevator specified. Close coordination is required between contractor*s CQC organization and the supervisor installing the elevator.

(4) Checks should be made to detect and avoid any conflict between the elevator layout and the structure. Conduits and pipes will not be run through the elevator shaft.

(5) In cases of hydraulic elevators, the installation must be started early enough in the construction period so that installation may be made of the hydraulic casing.

(6) 3-Phase inspections and meetings will be held with CQC representative and elevator installer representative to assure that quality work designed into the project is being obtained.

(7) When structural or load bearing members are to be field welded, welding and qualification of welders shall be as specified in section: Welding, Structural.

b. Layout

(1) The contractor must provide elevator equipment room layout drawings which must be reviewed and approved prior to installation of equipment.

(2) Check layout of elevator equipment room for space to maintain and repair the electrical and mechanical equipment.

14A-02 MATERIALS

a. Shop Drawings

(1) Shop drawings will provide necessary erection details. They will include a complete list of equipment and materials, including illustrations, schedules, manufacturer*s descriptive literature, performance charts, catalog cuts, installation instruction, brochures, diagrams, fabrication instructions, dimensioned layouts in plan and elevation showing the arrangement of the elevator equipment.

(2) Compare the shop drawings closely with the contract requirements contained in the plans and specifications.

(3) Become familiar with the shop drawing and contract requirements prior to each phase in particular for the preparatory meeting and initial inspection. Refresh your memory by referring to these documents as follow—on inspections are made.

b. Spare Parts Data

Prior to beneficial occupancy (B.O.) the contractor shall provide a complete list of parts and supplies, with the current unit prices and source of supply. This information will be turned over at time of B.O.

c. Operating and Maintenance Instructions

The contractor will furnish complete copies of operating instructions, maintenance instructions, operator training for using agency personnel, and will post where directed, framed instructions and wiring and control diagrams showing the complete layout of the entire system. Upon completion of testing he will provide test results in booklet form, showing all field tests performed to adjust each component, and all field tests performed to prove compliance with the specified performance criteria.

d. Storage and Handling

(1) Insure that materials are new, handled safely and carefully to prevent damages and are the source as approved.

(2) Reject damaged and nonconforming materials. Have damaged coatings repaired.

(3) Check for storage off the ground. Assure weather tight storage to protect finished materials, equipment, and panels.

14A-03 INSTALLATION AND TESTING OF ELECTRICAL AND HYDRAULIC ELEVATORS

a. See that structural steel framing and guide rails are plumb and secured as required.

b. See that contractor has checked equipment dimensions against the space available, and checked to see if shaft is plumb.

c. Compare the features of the delivered equipment with the approved shop drawings.

d. Check for required accessories such as fan, telephone, light fixtures, convenience outlets, wrenches, direction-light jewels, etc.

e. Provide steel casing larger than diameter of hydraulic elevator*s cylinder. The casing shall be accurately positioned, plumbed, and set to accept the cylinder. Prior to setting cylinder in casing, the entire outside surface of the cylinder shall be protected from corrosion by the application of double-wrapped layers of isolation material recommend by the manufacturer. The area between the casing and the cylinder wall shall be filled with dry sand after the cylinder has been accurately located. Seal top of casing. The work of boring the well and setting the cylinder shall be coordinated with construction of concrete pit.

f. Verify that ferrous metal meets salt-spray fog test, and that stainless steel panels are used where specified.

g. Make sure that protection guards are provided for moving parts, this includes shafts, keys, setscrews, belts, sprockets, and chains.

h. Check contract installation requirements against the manufacturer*s recommendations. Call to your supervisor*s attention any differences.

i. Check anchor bolts and conduits for proper location.

j. Check elevator mechanics and welders qualifications.

k. Carefully check all installations for stability, specified connections, anchorage, etc.

l. Determine the type of lubrication required, and examine equipment for same.

m. See that spare parts data is provided for each item of equipment.

n. Operate elevator to determine responsiveness. See that manufacturer*s name plate is in a conspicuous location. Check all control lights, both inside the cab and at elevator landings.

o. Check all safety features. Determine if contract requires a break-in period, operated by the contractor.

p. Installation or hoisting or lifting machinery may require that construction of certain floor and/or wall areas be deferred until installation is completed.

q. Guard open shaftways until doors are provided.

r. Inspect hoisting cables after installation for possible damage during the construction operation. For hydraulic elevators also inspect the hydraulic lifting device after installation.

s. Assure that required tests are performed in compliance with ASME AID.1 and that all data is recorded. Obtain copies of all tests with certification that the elevator are properly installed and are in proper operating condition.

t. Check certification by elevator inspector per AR 420—15. See that the safety certification is mounted in the cab and under glass.

u. Check contract requirements for homing of elevator after last call. Check specified door opening time. Check sequence required when a multi-elevator installation is made.

CHAPTER 14B

HOISTS AND CRANES

INDEX

CHAPTER 14B

HOISTS AND CRANES

14B-01 GENERAL

a. Coordination of Work

(1) This chapter covers the installation and testing of Hoists and Cranes. See Chapter 16A and NEC70-Article-620, for Electrical; Chapter 5A for Structural Steel; and Chapter 5B for Welding.

(2) The contract drawings indicate general layout and components of the cranes and hoists. Approved shop drawings will provide necessary information for installation of the particular hoist or crane selected for the project.

(3) Hoists and crane installation is a specialty trade. Major assemblies of the crane shall be shop assembled as completely as possible. Welders, welding operators and welding procedures shall be qualified or prequalified in accordance with AWSD1.1. Close coordination is required between the contractor*s QC representative, the crane and hoist contractor, and the manufacturer.

b. Verification of Dimensions

The contractor shall verify all dimensions in the field and shall advise the contracting officer of any discrepancy before performing any work.

14B-02 MATERIALS

a. Submittals

(1) Shop drawings shall consist of a complete list of equipment and materials, including manufacturer*s descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams and coordination details for proper function of unit.

(2) Spare parts data shall be furnished for each different item of material and equipment specified.

(3) Operations and Maintenance manuals and instructions will be provided.

(4) Performance Test Reports will be submitted, upon completion and testing of the installed system, in booklet form to prove compliance with the specified performance criteria.

b. Manufacturer*s Representative

The manufacturer*s representative shall supervise the installation, adjusting, and testing of the cranes and hoists.

c. Operator Training Instructions

A field training course shall be provided for designated operating staff members. The course will cover all items contained in the Operations and Maintenance Instructions.

d. Delivery and Storage

Equipment when delivered will be stored with protection from the weather, humidity, temperature variations, dirt, dust, or other contaminants

14B-03 ERECTION AND TESTING

a. Structural

(1) Check TM 5-809-10 to determine seismic considerations for your construction site. Review Chapter 13, Seismic Design of Buildings. Tell your supervisor if lateral restraints or hold down clamps are required but not provided for.

(2) Structural bolted connections shall be made with ASTM A325 bolts. A490 bolts or galvanized bolts shall not be used.

(3) The bridge rail shall be fastened to the top cover plate with welded clips. Bridge rail joints shall be bolted using standard joint bars. Rail joints shall be staggered. A positive stop shall be provided at the bridge rail ends to prevent creep.

(4) Provide structural trolley stops on the bridge to engage the trolley wheels, and locate to permit maximum trolley travel. Bumpers shall be the spring or hydraulic type for the bridge or trolley.

(5) Compare the name plate capacity of equipment with specified requirements.

(6) Check track for:

(a) Size of members.

(b) Method of supporting and anchoring.

(c) Stability and minimum sway.

(d) Being level and parallel.

(e) End-of-track stops or bumpers.

(f) The way wheels ride on track.

(7) Confirm that clearances are provided for required operation.

(8) Check welding and bolted connections of members.

(9) Insure that erection procedures for crane will not cause internal stresses, forced or improvised fits, misalignments, nicks of high strength structural steel components, stress-raising welds, and rough burrs.

(10) After crane is erected any damaged paint surfaces shall be cleaned and repainted.

b. Mechanical Alignment

All motors, couplings, brakes, gear boxes, and drive components shall be aligned when reinstalled, in accordance with the manufacturer*s tolerances.

c. Electrical Alignment

(1) The control system shall be aligned in accordance with the manufacturer*s instructions. Alignment data shall include the following:

(a) Timer settings

(b) Resistor tap settings

(c) Pot settings

(d) Test point voltages

(e) Supply voltages

(f) Motor voltages

(g) Motor currents

(h) Test conditions, such as ambient temperature, motor load, date performed, and person performing the alignment.

(2) A copy of the final alignment data shall be stored in control panel door.

d. Testing

(1) Check ease of operating equipment.

(2) Determine that all the various speeds can he obtained.

(3) Check if all safety devices such as lift switches, brakes, etc., have been furnished, connected, and function as designed.

(4) See that specified tests are performed and recorded.

(5) The contractor shall provide all personnel necessary to conduct the tests including but not limited to crane operators, riggers, rigging gear, and test weights. Tests will be performed in the presence of the Government representatives.

(6) Test sequence shall be in accordance to specified procedure.

(7) Test data shall be recorded on appropriate test record forms for retention for the life of the crane. Recorded values shall be compared with design specifications or manufacturer*s recommended values.

(8) Equipment monitoring. During load test, check for improper operation or poor condition of safety devices, electrical components, mechanical equipment and structural assemblies. Report all defects to test supervisor immediately.

(9) Check specifications for specific tests to be conducted.

CHAPTER 14C

MATERIAL HANDLING SYSTEM

INDEX

CHAPTER 14C

MATERIAL HANDLING SYSTEM

14C-01 GENERAL

a. Coordination of the Work

(1) This chapter covers the installation and testing of freight handling equipment, prefabricated chutes, conveyors, gravity rollers, power belts, and other devices for transfer of bulk or package materials. System includes associated components, hardware, control, and safety equipment.

(2) The installation of a material handling system requires close coordination between structural, mechanical, and electrical work. The CQC representative must insure that the material handling equipment is designed to fit into the space available; that it is delivered in time so as not to hold up the construction work, and that the necessary walls, columns, or roof areas are left open to allow entry into the structure of the material handling equipment.

(3) Shop drawing reviews must include determination if space is available for future maintenance, operation, and subsequent replacement of worn equipment. Location of anchor bolts, and connections for utilities must be checked and assured prior to placement.

(4) Seismic considerations required by the design and the seismic zone must be incorporated into the work. Carefully check contract requirements and shop drawings for the requirement for seismic bracing, supports, snubbers, and springs.

b. Verification of Dimensions

(1) Verify opening sizes and locations, anchor bolt size and location, foundation pads, equipment isolation and vibration elimination means. Check shop drawing requirements against contract drawings. Advise your supervisor if errors are detected.

(2) Verify structural clearances such as overhead beams and girders, clear span between columns, and wall spacing.

(3) Coordinate electrical and mechanical work to insure needed equipment clearances.

(4) Some automated material handling equipment will require close tolerance of concrete floors, so that the equipment can service the storage bins without tilting or leaning of the automated material handling equipment.

14C-02 Materials

a. Submittals

(1) Shop drawings shall consist of a complete list of equipment and materials, including manufacturer*s descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Shop drawings shall also contain complete structural, electrical, and mechanical layouts,

schematic diagrams, and coordination details for installation of the components and system.

(2) Spare parts data shall be furnished for each different item of material and equipment specified.

(3) Systems operating and maintenance manuals and instructions will be provided.

(4) Performance test reports will be submitted, upon completion and testing of the installed system, in booklet form, to prove compliance with the specified performance criteria.

b. Manufacturer*s representative

Check requirements for manufacturer*s representative to supervise installation, adjusting, and testing of the material handling system.

c. Delivery and Storage

Equipment, plates, and units when delivered will be stored with protection from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Deliveries should be scheduled to minimize job site storage whenever possible.

14C-03 Erection and Testing

a. Erection

(1) Check TM 5-809-10 to determine seismic considerations for your construction site, Tell your supervisor if required reinforcing or restraints are not provided for in the contract for the structure and the material handling system.

(2) Check shop drawings and contract drawings to insure proper orientation of the equipment and utilities servicing the equipment.

(3) Check anchor bolt layout, foundations, vibration eliminator and restraints.

(4) Install equipment in accordance with installation sequence shown in shop drawings and contract drawings.

(5) Compare the name plate capacity of the equipment with the specified equipment capacity. Inform your supervisor if variation in capacity is found.

(6) Insure that erection procedures for material handling equipment will not cause internal stresses, forced or improvised fits, misalignment, or damage to either the building or the equipment.

(7) After equipment is erected any damaged paint surfaces shall be cleaned and repainted.

(8) All motors, couplings, brakes, gear boxes, and drive components shall be aligned when installed at the site, in accordance with the manufacturer*s tolerances, for mechanical alignment.

(9) The material handling system shall be electrically aligned in accordance with the manufacturer*s instructions. Alignment data shall include all timer settings, test point voltages, supply voltages, motor voltages, motor currents, and test conditions such as ambient temperature, motor load, date performed, and person performing the alignment. Obtain a copy of the final alignment data.

b. Testing

(l) Check ease of operating equipment.

(2) Determine that all the various speeds can be obtained.

(3) Check if all safety devices have been furnished, installed, and are operating properly.

(4) See that specified tests are performed and recorded.

(5) The contractor shall provide all personnel necessary to conduct the tests. Tests will be held in the presence of the Government representative.

(6) Test data shall be recorded and evaluated by manufacturer*s representative. Verification will be given that units are installed and operate in the manner designed. Obtain copies of all test reports and data.

(7) Recorded values shall be compared with design specification or manufacturer*s recommended values. Inform your supervisor any improper values obtained during testing.

(8) During operating and load tests check for improper operation or poor condition of safety devices, electrical components, mechanical equipment, and structural assemblies. Report all defects to test supervisor immediately.

(9) Check specifications for specific tests to be conducted.

CHAPTER 15A
PIPING SYSTEMS

INDEX

CHAPTER 15A

PIPING SYSTEMS

15A-01 General

a. Coordination of Work

(1) This chapter covers piping for the water, gas, drainage, heating, fire sprinkler and refrigeration/air conditioning systems, and condensate (drainage) pipelines. Refrigerator/air conditioning piping includes refrigerant, condenser and chilled water pipelines.

(2) Drawings indicate general layout. Pipe and equipment space and schedule for installation must be coordinated between the various subcontractors doing the work.

(3) Check and eliminate interferences between electrical, mechanical, architectural and structural features, especially in equipment rooms, and above ceilings.

b. Layout

(1) The contractor will provide equipment and mechanical room layout drawings which must be reviewed and approved.

(2) Pipe sleeve layout drawings will be useful. Check for clearances and proper sleeve sizes to include the pipe insulation thicknesses.

(3) Check layout for space to operate valves.

(4) Check layout for space to maintain and repair piping, especially at equipment spaces.

(5) Check for sufficient space for required swing joints at branch connections.

(6) Check space for anchors and expansion loops.

(7) Check space for support of hangers for piping.

(8) Check space for slope in pipe lines. Remember that all piping systems carrying liquids must be drainable.

(9) Pipe lines should not pass thru footings; locate beneath footings before the footings are placed.

(10) Check equipment dimension to assure all equipment can be removed and replaced thru the doorways provided, once ceiling/roof is installed.

15A-02 Materials

a. Submittals

(1) These usually include information on compliance with specifications using labels, listings or certificates. Shop drawings are required for layout of mechanical rooms and should include the special support for heavy piping and fittings.

(2) The mechanical specialist will check submittals for compliance with requirements.

(3) After determining that the submittal is in compliance, use its descriptive information to check the material at delivery. You will use the layout drawings to check actual installation.

b. Storage and Handling

(l) Insure that materials are handled safely and carefully to prevent damage.

(a) Reject damaged materials.

(b) Have damaged coatings repaired.

(2) Insure proper handling for coated pipe; use wide belt slings.

(3) Check for storage off of the ground and weather tight storage when required.

(4) Store pipe and fittings to eliminate entry of dirt, etc.

(5) Refrigerant pipe is cleaned and capped at the factory. The pipe must remain capped in storage.

(6) Check for piping that is factory cleaned and purged with inert gas and capped. Check for gas tight capping.

c. Water Pipe and Fittings

(1) There are about 23 different pipe materials which can be selected for above ground cold water pipelines. Many are plastic materials. Plastic pipes cannot be used in water systems for buildings greater than two stories in height.

(2) Plastic type pipe cannot extend through the roof or through fire rated walls or floors.

(3) There are almost as many selections for above ground hot water pipelines. Check your specifications.

(4) Seamless copper water tube must be hard drawn: Type M above ground and Type L below ground.

d. Fuel Gas Pine and Fittings
comply with the Fuel Gas Code as given in National Fire Protection Association (NFPA) Standard No. V54.

(2) Check for permitted pipe options; either all or only steel, aluminum alloy, metal tubing and plastic materials may be specified.

(3) Check for specific materials required in insulating couplings.

(4) Aluminum alloy tubing and pipe is not permitted underground or at exterior locations.

(5) Plastic pipe is not permitted in or under the building and is permitted only underground outside of the building.

(6) Check the specifications for ambient temperature limitations to the use of plastic pipe.

e. Drainage Pipe and Fittings

These consist of the waste system, the stormdrains and rainwater conductors and the condensate drainage pipelines from air conditioning and refrigeration units.

(1) There are many optional pipe materials and use is dependent on locations in the building and in the drainage system.

(2) Suggest you use the pipe material submittal for identification or the pipe material table in the specifications.

(3) Check for drainage pattern type fittings as they are required in the wet pipe portion of the waste system.

(4) Hubless cast iron pipe cannot be used underground and may not be permitted in crawl spaces.

(5) Check for use of proper pipe and fittings in corrosive waste and vent systems.

f. Heating Pipe and Fittings

(1) Check for use of black steel pipe or copper tubing for low temperature hot water pipelines.

(2) Steam piping must be black steel: vent piping must be the same type.

(3) Check for use of Schedule 40, black steel, in high temperature pipelines of 2 inches and larger.

(4) Use welded joints for high temperature water pipelines over 3/4 inch diameter.

g. Refrigeration and Air Conditioning Pipe and Fittings

(1) Check the steel pipe or the copper or steel tubing and fittings for intended service. Refrigerant service rating is required for lines carrying a refrigerant.

(2) Check for galvanized steel pipe or hard drawn copper tubing for condenser water lines, except lines 4—inches and larger require black steel which must be coated and wrapped for underground use.

(3) Chilled water. Check the type of piping specified for chilled water lines.

(4) The drainage lines for condensate water are usually given in the plumbing section of the specifications.

h. Fire Sprinkler Pipe and Fittings

(1) Insure that materials are in accordance with approved submittals.

(2) The type system is designed to use a specific water supply and distribution for specific occupancy. More information can be found in National Fire Protection Association (NFPA) Standard No. 13.

(3) Contractor*s working plans shall be approved and shall be used when installing the system.

15A-03 INSTALLATION

a. General

(1) Laying underground pipe lines is covered in Chapter 2C, Volume 1 of the Construction Inspector*s Guide.

(2) Installation of exposed pipelines inside the building should follow building lines. The building structure cannot be cut or otherwise weakened for pipelines without written approval.

(3) Check for required slope in horizontal runs; liquid systems must be drainable.

(4) Check for drains at low points.

(5) Check for air cocks at high points.

(6) Check for required access to drains, air cocks and valves.

(7) Check for contact between dissimilar metals such as copper to iron or steel. Isolation (separation) will be required. Dissimilar pipe must be coupled with a dielectric connection.

(8) Are hangers proper style, size and at required intervals? Are ferrous hangers coated where used against copper pipe? Size hangers to encompass the pipe insulation.

(9) Are pipelines restrained from lateral movement at trapeze.

(10) Wall or floor supports must also restrain the pipeline from lateral movement.

(11) Check for support needs at each floor but not more than 15 foot intervals. Support is not necessary at the floor slab on grade hangers with “U” bolts or other type clips.

(12) Check for extra hangers or supports required at fittings and devices. A hanger is usually required within one foot of each change of direction.

(13) Suspended heavy pipelines must have proper support without overloading support points. This should be covered in the preparatory inspection by the contractor*s quality control representative. Be aware of:

(a) Excess loads on steel bar joints or beams.

(b) A hanger load or multiple hangers at the same location with more than 100 pounds of load.

(c) Check with your supervisor where you have a suspicious condition and he will request a structural evaluation.

(14) Check for required anchors and expansion loops or joints, especially on long pipelines. Also check for guides at the expansion points.

(15) Check for union or flanged connections at equipment and elsewhere in order to break and repair or replace piping, etc.

(16) Check for proper size pipe sleeves. Sleeves shall be large enough for the pipe insulation thickness when required.

(17) Pipe sleeves through waterproofing must have a clamping device to hold the flashing.

(18) Sleeves must protrude above finished floor surfaces in wet areas. Space between pipe and sleeve must be sealed.

(19) Check for proper fireproofing of openings between pipes and fire-rated construction.

(20) Check that escutcheons are used around pipes penetrating finished surfaces.

(21) Use soft drawn copper tubing, as permitted, when not using fittings.

(22) Steel pipe bending with proper equipment is permitted in sizes to 4-inch diameter. Bend radius must be at least 6 times pipe diameter.

b. Pipe Connections — Screwed

(1) Examine the threading operation for:

(a) Square cut pipe

(b) Proper reaming before threading

(c) Sharp cutters so that threads are not shaved

(d) Tapered threads - not running threads

(e) Thread run - not more than three threads should be exposed after connection is tight. The specifications may have a threading table you can refer to.

(f) Use of cutting oil - pipe shall be cleaned of oil and metal “filings”. This is critical for refrigerant lines.

(g) Protect floor surfaces — Use a sand box or other adequate protection under the threading/cutting operation.

(h) Plastic pipe and metallic tubing will not be threaded.

(2) Examine screwed pipe connections for:

(a) Use of approved thread lubricant or tape applied to male threads only. Some piping may not permit use of tape at screwed joints check for requirements

(b) Tighten connection, but do not overtighten to strain the fittings.

(3) Be alert for distorted valves. See that wrenches are used on the end of valves being screwed onto the pipes in order to prevent damage to the valve bore. If it is necessary to put wrench on the opposite end of valve from the end being screwed onto pipe, use a nipple that has been screwed into the valve.

(4) Do not screw pipes against the web of globe valves, or against the underside of seat rings of gate valves.

(5) Use threaded connections to angle stops at plumbing fixtures.

c. Pipe Connections — Mechanical

(1) Check proper alignment of flanges, couplings and gaskets.

(2) Check the gasket material, it must be compatible with the liquid or gas in the pipeline.

(3) Gaskets with high temperature water shall be metallic asbestos type.

(4) Do not use the drift pin or spud wrench handle to align flanges.

(5) Mechanical couplings and fittings must be compatible and manufactured by the same concern.

(6) Mechanical couplings are usually permitted on ferrous metal pipelines in the building for domestic hot and cold water systems.

d. Pipe Connections - Hub and Hubless Types

(1) Check for proper rubber gasket installation in the hub or bell. Spigot end must be pushed “home into the hub.

(2) When molten lead is used to make the joint, check for:

- Jute compacted into base of joint to seal the end, and center the spigot end in the hub.

- Depth of joint.

- Pouring the molten lead joint in a continuous operation.

- Caulking the lead with proper size irons.

- Caulking each joint at least three times around.

(3) Hubless joint uses a rubber sleeve with stainless steel band; the assembly must be approved by the Cast Iron Soil Pipe Institute (CISPI).

(4) Check for proper torque wrench set to 5 foot—pounds for tightening the stainless steel band in hubless joints.

e. Pipe Connections — Soldered

(1) Surfaces of the fitting and pipe must be cleaned to bright metal with an abrasive material before the joint is made.

(2) The 50/50 solder is half tin/half lead and can be used in drainage, waste and vent (DWV) pipelines. It is also known as soft solder.

(3) Silver solder is 95/5, 95 percent tin — 5 percent antimony, and must be used in all other pipelines.

(4) Core solder is not permitted.

(5) Joint must be well heated before solder is applied. Approximately 400F for soft solder and 1150F for silver solder.

(6) Check for use of a multiflame torch for uniformly heating joints where 2 ½ inch diameter and larger pipe are soldered.

f. Pipe Connections — Solvent Cement (Adhesive)

(1) For plastic pipe connections use compatible materials.

(2) Use in accordance with the pipe manufacturer*s instructions.

(3) Do not join different kinds of plastic pipe together.

(4) Only heat—fusion connection is used to join polyethylene pipe, tubing or fittings.

g. Pipe Connections - Welded

(1) Check for use of welding fittings.

(2) Making fittings by notching or mitering pipe is not permitted.

(3) Check for the approved welding procedures before welding begins.

(4) Check for the individual welder certification in the type welding each welder must perform.

(5) Welders must stamp each weld with an assigned symbol so that the individual*s weld can always be identified. Painted stamps are not permanent and may not be used to identify welds.

(6) Check welding of refrigerant pipe as the fittings and pipe must be filled with inert gas such as nitrogen, during welding. This prevents the formation of scale inside the pipe.

(7) welding for fire sprinkler systems must be performed in a shop and in accordance with NFPA 13 requirements. Jobsite welding is not permitted.

(8) Check Chapter 5B, Volume 3 of the "Construction Inspector*s Guide" for additional information on welding.

h. Fittings and Valves

(1) Check riser diagrams and floor plans on drawings for proper valve locations.

(2) Are valves proper type?

(3) Valves must be oriented with stems in horizontal position or above. Only the horizontal position is allowed for refrigerant pipelines.

(4) Check and globe valves have an arrow cast in housing to indicate direction of flow. Check these valves for proper orientation in the pipeline flow.

(5) Check for access to all valves. Are access locations marked on ceiling panels.

(6) Use dielectric connectors where required at locations where different metals connect together in the pipeline.

i. Pipelines

(1) Water pipelines.

(a) Are air chambers installed at fixtures?

(b) Are water hammer arrestors shown instead of air chambers? Check your riser diagrams on the drawings for locations and sizes of these arrestors.

(c) Are valves located as shown?

(d) Does the water service have a gate valve and drain at its point of building entry?

(e) Check for use of a backflow prevention device in each branch waterline connected to another system. Also check for the correct type device, especially where toxic fluids are involved.

(f) Check for a vacuum breaker at each fitting or fixture with hose connection. The vacuum breaker will prevent back-siphonage.

(2) Fuel gas pipelines.

(a) Avoid installation under buildings. Fuel gas service should be installed above grade on the outside. Do not install service pipeline in the trench with other utilities.

(b) Do not permit soldered joints. Use pressure- threaded joints for copper pipe.

(c) When piping is to be embedded in concrete, check for special requirements such as:

- Should be acceptable to the gas service company

- Check concrete mix for compatibility with pipe material. Certain additives and aggregates may not be compatible.

(d) Don*t embed gas pipelines in solid walls and partitions.

(e) Check for protective coating on underground metallic pipelines.

(f) Where piping must be buried under the building it should be encased in a gas tight conduit for its full length of run. Space between the pipe and conduit must be safely vented to the atmosphere. Check your details.

(g) Check for pipe slope and drains at low points.

(h) Check for required pipeline bonding and grounding in accordance with the National Electric Code.

(i) Check for shutoff valves as required.

(3) Drainage lines.

(a) Hubless cast-iron pipelines require support next to each joint.

(b) Hub type pipelines require support at 10 feet intervals and within 3 feet of each fitting.

(c) Check for required expansion joint at floors in plastic pipeline risers.

(d) Install cleanouts so they are flush with finish surfaces. Close each cleanout with a brass plug installed with graphite thread lubricant.

(e) Check the elevation of each floor drain before finished floor is placed to assure drainage slope.

(f) Check floor drain for type specified. Does it require a special item such as a sediment basket, a backwater valve or a self-priming valve?

(g) On roof drains check for the clamping ring to hold the metal flashing and for the cast iron strainer.

(4) Heating pipelines.

(a) Check for slope of at least 1 inch in 10 feet.

(b) Reducing fittings on horizontal lines must be eccentric type with bottom of pipelines flat for positive drainage flow.

(c) Check for proper branch line take off from the high temperature pipeline supply and return. Should be from the upper half of pipeline, at a 45 degree angle in direction of flow.

(d) Check for special piping from high temperature waterline air vents to funnel drain.

(5) Refrigeration and air conditioning pipelines.

(a) Refrigerant steel pipeline joints shall be welded.

(b) Refrigerant tubing of copper or steel shall have brazed joints.

(6) Fire sprinkler pipelines.

(a) The approved shop drawings will be your guide in checking the fire sprinkler system layout and pipe sizes.

(b) Check for possible conflict between final sprinkler head location and user items which would interrupt flow coverage or cause damage to the system.

(c) Review Chapter 3 of the National Fire Protection Association Standard 13 for supports, hangers, slope and drainage.

(d) Do not allow paint on sprinkler heads. Check heads for proper temperature rating indicated by color code or stamped numbers.

(a) Where required, outside connection shall be the size indicated and shall mate with fire department hose.

(f) Check for required sprinklers in concealed spaces.

(g) Check for special protection against freezing, corrosion and earthquakes, and for sprinkler head clearance from heat sources.

(h) Check electric power and alarm for:

- Electric power correction ahead of the main switch.

- Alarm tie-in with fire department, as required.

- Effective location of the local alarm.

15A-04 TESTING

a. Preparation

Testing is the responsibility of the contractor unless stated as a Government responsibility in the specifications. Check with supervisor for recommended presence of user personnel during certain testing such as sprinkler, etc. The system or portion of the system will be prepared for testing by the craftsman who installed the pipeline. The contractor*s quality control representative will be responsible for verifying the extent of test, the method and results which will be reported. The following items must be checked:

(1) Determine extent of test.

(2) Is pipeline isolated at limits of the test with valves closed and the plugs and caps tightly in place?

(3) Are pipeline valves open within the test area?

(4) Are pipelines adequately blocked and anchored for pressure tests? Pipelines should be in the permanent, fixed position before the test is permitted.

(5) Will joints be exposed for the visual or soap test requirements?

(6) When testing pipeline to be concealed, does extent of test include all of the affected pipeline.

(7) For a pressure test, have diaphrams or other internal parts of valves, regulations, etc. which may be damaged by the pressure been removed?

(8) Review the test method to be used.

(9) Inspect the test instruments and apparatus for proper type, calibration and operation.

(10) When flushing to clean the pipeline, check to determine that coils for heating, air conditioning and refrigerant lines are bypassed to prevent flushing—water from passing through coils.

b. performing Tests

(1) Water pipelines.

(a) Pneumatic or hydrostatic test shall be used.

(b) Check ambient temperature at beginning and end of test period for temperature differential and the correction factor for the final gauge reading.

(c) For the hydrostatic test, was the tested segment vented to ensure it was completely filled with water?

(2) Fuel gas pipelines.

(a) An air pressure test, similar to the waterline test, is usually made. Do not use oxygen.

(b) Refer to National Fire Protection Association (NFPA) Bulletin 565 test requirements for nitrous oxide and oxygen system test requirements.

(c) Check the gas system for leakage immediately when beginning the test using fuel gas.

(3) Gravity drainage lines.

(a) Is the test stack high enough to provide the 10 foot head for all of the tested line.

(b) Check each joint for leakage.

(c) The final smoke or peppermint test is made with all fixtures attached.

(4) Heating pipelines.

(a) Hydrostatic pressure testing is required. Usually 45 psig for four hours for low temperature waterlines.

(b) High pressure waterlines are tested at 1 ½ times design pressure.

(5) Refrigeration and Air Conditioning pipelines.

(a) Pneumatic pressure test used on refrigerant pipelines using dry nitrogen. Check each joint with soap solution.

(b) Refrigerant pipelines also are charged with refrigerant gas and joints checked for leaks with a halide torch.

(c) Refrigerant pipelines also require an evacuation test. Check the specifications for details.

(d) Check the hydrostatic pressure test on water pipelines for use of appropriate pressure and time requirements.

(6) Fire Sprinkler pipelines.

(a) Refer to Chapter 1, NEPA 13 for specific test requirements.

(b) Assure that feeder piping has been flushed before testing.

(c) Check for approved contractor*s test procedure and adequate monitoring of the tests by contractor*s quality control person.

(d) Check the adequacy of contractor*s required material and test certificates to be submitted after completion of tests.

(e) Test blanks used in the system during testing shall be approved type and each blank shall be numbered and accounted for at activation of the system.

15A-05 CLEANING ADJUSTING AND OPERATION

a. Cleaning

(1) Pipelines constructed with properly stored and protected pipe should need very little cleaning.

(2) Close ends of unfinished lines during work stoppages.

(3) On occassion, craftsmen temporarily place tools or other items in the end of pipes. This habit must be stopped.

(4) Check the specification for flushing requirements. Flushing may be ordered for dirty pipelines.

(5) The completed potable water system must be sterilized by chlorination. This process, as given in the specification, is required reading.

(6) Heating pipelines must be cleaned with a chemical solution after successful completion of the pressure tests. Check for proper solution, temperature and time.

(7) Fire sprinkler systems must be flushed and disinfected after testing.

b. Adjusting

(l) When beginning the operating phase each piping system must be closely inspected for necessary adjustment and proper operation.

(2) Adjust flow and flush valves.

(3) Check air cocks for leakage, clean and adjust as required.

(4) Condenser and chilled water pipelines must be balanced after testing.

(5) Check for heating system approved balancing procedure. This must be performed by a qualified engineer.

c. Operation

(1) Specifications require that user personnel be instructed in proper system operation. Make a note of the identification of these personnel for the record.

(2) Check the posted operating instructions. Are posting requirements met? Do they include the required diagrams, layouts end specific written instructions?

(3) Are pipelines coded as required?

(4) Check for required spare parts.

CHAPTER 15B

DUCTWORK

INDEX

CHAPTER 15B

DUCTWORK

15B-01 GENERAL

This chapter covers ductwork for air conditioning, heating, ventilating, and exhaust systems. The QA Rep must closely coordinate this chapter with chapter 15C, 15E, 15F, and 15G. It is important that the QA Rep have a thorough knowledge of the job plans, specifications, and potential obstructions in the area in which the ductwork is to be installed, including locations of fire rated walls that the duct must penetrate.

15B-02 SHOP DRAWINGS

a. It is the QAR*s responsibility to determine that all ductwork is approved well in advance of its actual need on the job.

b. Check all ductwork delivered to the site for conformance with approved shop drawings.

15B-03 DUCTWORK

a. Fabrication (See SMACNA Duct Manual appropriate to material and service requirements)

(1) Inspect for type, thickness and shape of sheet material, and fiber glass boards used for ductwork.

(2) Check workmanship and observe lock seams and breaks in ductwork for cracks of sheet metal ducts. Check fiber glass ducts for broken, or damaged edges, joints, and seams.

(3) Inspect all joint connections for correct type and adequately sealed to prevent movement and air loss.

(4) Make sure that the joints are neatly finished and that the duct is smooth on the inside. Any laps should be made in the directions of the flow of air. Internal insulation will be securely fastened and coated as specified.

(5) Provide adequate bracing and reinforcement of the larger ducts.

(6) Compare the radius of curved duct with the specification requirements.

(7) Slope ratio of transitions should be) Provide turning vanes and extractors to eliminate abrupt turns of air which cause appreciable turbulence.

(9) Check the need for and construction of splitter dampers. Make sure the operating mechanism is accessible; and if exposed in a finished room, the mechanism is to be chromium plated.

(10) Make sure that fire and/or smoke dampers are provided in ducts as required in accord with NEPA, and SMACNA fire damper guide. Check for fire-safety switch on return air ducts of circulation system.

(11) Check duct for the required test holes and covers.

(12) Check the fabrication of flexible connections.

(13) Make sure that equipment serviced by the ductwork is fully accessible for maintenance, repairs, oiling, cleaning, and for filter changing.

b. Erection

(1) Examine all fabricated ducts, rejecting any which are not smooth or any which are damaged.

(2) Examine duct hangers for specified material, thickness, and spacing.

(3) Check specification requirements for the need for stiffeners for wide ducts. Also check for need of trapeze hangers under wide ducts.

(4) Provide approved flexible connections between ducts and for fan units.

(5) Check rigidity and tightness of such field installed items as dampers and defectors.

(6) Provide access doors at all fire dampers, automatic dampers, coils, filters, heaters, thermostats, or at any item that requires servicing. Doors are to be airtight, securely fastened and accessible, and able to be fully opened. Refer to SMACNA and Specifications for size of access doors required.

(7) Inspect goose necks and rain hoods for method of fastening, flashing and bracing. Goose necks are to be turned away from the prevailing wind. Check specifications for screens on open end of goose necks.

(8) Provide proper size sleeves where insulated duct passes through wall openings.

(9) When obstructions cannot be avoided, the duct area should never be decreased more than 10 percent, and then a streamlined collar should be used. Larger obstructions require an increase in the duct size in order to maintain as nearly uniform velocity as possible.

(10) Before insulating metal duct, test duct for air tightness.

(11) All ducts, plenums and casings must be thoroughly cleaned of debris and blown free of small particles and dust before supply outlets are installed.

(12) Inspect duct break away collar at fire dampers for meeting SMACNA requirements.

c. Diffusers. Registers, and Grilles

(1) Insure that the contractor furnishes a schedule showing all air inlets and outlets.

(2) Inspect diffusers and registers for accessible volume control operator.

(3) Examine specification and installation for integral anti-smudge rings for diffusers.

(4) Check for loose or bent vanes.

(5) Inspect each item for fit, and see that gaskets are provided when required.

(6) Inspect for the proper operation of registers, dampers, and grille directional-controls.

d. Insulation

Insulation for metal ductwork is covered in Chapter 15C entitled, Mechanical Insulation. Chapter 15C covers pipe insulation, equipment insulation, and ductwork insulation.

e. Balancing and Testing

Balancing and Testing of air supplies is covered in Chapter 15F entitled, Ventilating, Air Supply and Distribution Systems.

CHAPTER 15C

MECHANICAL INSULATION

INDEX

CHAPTER 15C

MECHANICAL INSULATION

15C-01 GENERAL

This chapter covers field-applied insulation. Factory applied insulation is specified under the equipment, duct, or piping to be installed, as detailed in the specification.

15C-02 IDENTIFICATION OF MATERIAL

All packages or standard container of insulation, jacket material, cements, adhesives, and coatings delivered for use, and all samples shall have a manufacturer*s stamp or label attached giving the name of the manufacturer, brand, and a description of the material.

15C-03 SHOP DRAWINGS

a. It is the inspector*s responsibility to determine that all insulation related materials are approved well in advance of their actual need on the job.

b. After approval of materials and prior to insulating any pipe the contractor will submit for approval sample insulation boards, or approved standards, showing his proposed methods of mechanical insulation, including cut-a—way sections, insulation, coverings, and finish of completed work. Approved sample boards will be maintained by the contractor at the jobsite for the duration of the work.

15C-04 SURFACE BURNING CHARACTERISTICS

a. Check underwriters labels and test certificate of all insulating materials and accessories for not exceeding a flame spread rating of 25 or a smoke developed rating of 50, as determined by ASTM E 84.

b. Check specification for limitations on surface burning characteristic.

15C-05 MECHANICAL INSULATION

a. Ductwork insulation

(1) Distinguish between areas requiring flexible type insulation and those requiring rigid or semi-rigid type insulation.

(2) Check the type and thickness of insulation and requirements for vapor barrier.

(3) Check the method of fastening insulation to exterior or interior of duct.

(a) If metal pins are used, check the type and spacing.

(b) If wire is used, see that corners of insulation are protected from possible damage.

(c) Verify adhesive materials are correct, and area specified receives proper coverage.

(4) Make a careful check for breaks in insulation and vapor barriers.

(5) See that materials are fire—retardant or noncombustible as required by the specifications.

(6) When equipment casings are required to be insulated, check for proper application. See that application is firm.

(7) Where insulation is subject to mechanical damage, check for protection requirements.

(8) Check for continuity of insulation through walls and floor, if required.

(9) Check for proper sealing of insulation to diffusers, grills, and fire dampers.

b. Pipe Insulation

(1) Determine whether the material on the job has been approved for the particular piping being installed. Make sure insulations, vapor barriers, adhesives and sealers are noncombustible or fire retardant as specified.

(2) Note that heated water piping is insulated differently from chilled water piping and from combination chilled and heated water piping.

(3) Check thickness of insulation and of vapor barrier.

(4) Determine that insulation jackets which are exposed to view are paintable.

(5) Examine the requirements for the insulation of flangers, fittings, and valves, and assure compliance with the requirements.

(6) Check the lap and the sealing at joints.

(7) Be very careful to see that there are no breaks in the vapor barrier. Watch for later damages during construction.

(8) Check specification requirements for extending through sleeves in walls, floors, and ceilings; chilled water lines inside cabinets of fan coil units should be covered as required to prevent condensate dripping on floor.

(9) Make sure that pipe hangers are installed over insulation. Metal shields to be provided between hanger ring and insulation. High density insulation inserts shall be installed with a length equal to length of metal shield.

(10) Check for the neat termination and seal of insulation at the end of insulation.

(11) Know the special requirements for insulation and jacketing of piping exposed to weather.

(12) Check the installation, the width, and the spacing of the bands used on pipe jacketing.

(13) In chilled-water and hot—water combination piping check for vapor seal requirement on boiler piping.

15C-06 DUCTS NOT REQUIRING INSULATION

a. Site—erected casings and plenums constructed of factory insulated sheet metal panels.

b. Ducts shown to be acoustically lined, provided sufficient thickness of liner is specified.

c. Supply and return ducts in air conditioned or heated spaces, unless otherwise shown.

d. Return ducts in ceiling spaces when roofing is insulated. Ceiling space shall be defined as those spaces between the ceiling and bottom of floor deck or roof deck inside the heated space insulated envelope.

e. Supply and Return Ducts made out of faced fiber glass insulating board. Check on sealing joints between individual duct sections, thickness, and connections.

15C-07 INSULATION FOR RECTANGULAR AND ROUND DUCTS

a. Check flexible type insulation used on concealed ducts for specified minimum density, usually 3/4 pcf for rectangular ducts.

b. Check rigid type insulations used on exposed ducts for specified minimum density, usually 3 pcf for rectangular ducts.

c. Check for flexible type insulation specified for round duct, usually a minimum density 3/4 pcf.

d. Check for specified vapor barrier jacket on exposed insulation, either factory applied or field applied.

e. Check specification for requirement for factory applied or field applied vapor barrier on insulation on concealed duct.

f. Check rigid fiber glass duct installation method to insure accessibility for maintenance of coils, vanes, and fan motors used in the HVAC duct system.

15C-08 INSULATION FOR HOT EQUIPMENT

a. Check specification to determine if insulation is required to be rigid block or semi-rigid board.

b. Check for specified type of material and thickness of insulation being installed.

c. Form or fabricate insulation to fit equipment.

d. On round equipment insulation edges will be beveled to insure tight joints.

e. Check joints for being tightly butted, being filled with mineral fiber, or insulation cement.

f. Check specifications and manufacturers recommendation on spacing of bands. Spacing will not be less than 12 inches on centers.

g. Check for excessive use of wires in lieu of bands. Check for insulation corner protectors under wires.

h. Check hot ducts and equipment for specified finish

i. Check for continuity of insulation thru walls and floors.

15C-09 INSULATION FOR COLD EQUIPMENT

a. Check dual temperature equipment, which operates at 60F or below at any time, for insulation as specified for cold equipment. Check specification for pump insulation. It may vary from flexible, rigid, or semi-rigid type insulation. Check all other equipment for specified insulation..

b. Check insulation for thickness specified.

c. Check installation of vapor barrier.

d. Check drain pans under pumps for insulation underneath.

a. Check cold duct and equipment insulation. finish, in accordance with specifications.

15C-10 ABOVE GROUND PIPE INSULATION

a. Check contract specifications to determine type of insulation required on pipelines within the structure.

(1) Normally, domestic hot water, steam, condensate, hot water heating, heated oil, and water defrost lines are insulated as hot pipelines.

(2) Normally domestic cold water, interior roof drains, refrigerant suction lines, chilled water and dual temperature water line, air-conditioner condensate drain pipelines, exposed to weather drainage piping, and piping which operates at 60F or below at any time, are insulated as cold pipelines.

b. Check exterior piping for being insulated as required by specifications for piping exposed to weather.

c. Check specifications for areas which are to receive factory-applied vapor barrier jackets, field applied aluminum jackets, and field applied vapor barrier.

15C-ll PIPING EXPOSED TO WEATHER

a. Check to see that pipe is insulated and jacketed for applicable service. Note that vapor barrier is not normally specified for hot pipelines.

b. Check to see if specified jacket is aluminum.

c. Check to see if jacket is required to be factory applied or field applied.

(1) Check to see if aluminum jacket laps not less than 2 inches at all joints.

(2) Check banding requirements for the jacket.

(3) Check to see that horizontal joints are lapped downward to shed water, and that vertical joints are sealed with a water proof coating.

(4) Check specifications for special treatment of flanges, couplings, unions, valves, fittings and anchors.

15C-12 BELOW GROUND PIPE INSULATION

a. Check all below ground domestic hot water heating, heating hot water to 200F, dual temperature water, and chilled water piping for specified insulation. Generally the insulation is 1 1/2—inch thick cellular glass.

b. Cellular glass insulation.

(1) Check to see that bore surfaces of insulation are coated with a thin application of high strength gypsum cement, as recommended by manufacturer.

(2) Check to see that insulation joints are

(a) Staggered, one-half overlapping the next opposite half section.

(b) All joints are tightly butted and seated with bedding compound.

(c) Insulation secured with 2 stainless steel bands per section of insulation.

(d) Insulation termites at anchor blocks.

(e) Insulation is continuous thru sleeves and manhole.

(f) Backfill around and three inches above the insulation to be free of stones larger than 1/4 in any dimension.

(g) Insulation extends two inches inside of building*s interior and tightly butted, scaled, and vapor barrier coated to interior piping.

(h) Check for special insulation requirements for flanges, couplings, unions, valves and fittings.

c. Check finish of insulation for 2 coats of mastic with glass cloth or tape embedded between coats. Check for proper overlap at all joints.

(1) Check wet film thickness of both coats of mastic to meet specifications requirements.

(2) Check termination points to see that mastic and cloth or tape covers the end of of the insulation and extends along the base pipe as required by the specifications.

CHAPTER 15D

PLUMBING SYSTEMS

INDEX

CHAPTER 15D

PLUMBING SYSTEMS

15D-01 GENERAL

Definition. This chapter covers plumbing fixtures, materials, and good workmanship practices for plumbing systems.

15D-02 FIXTURES AND MATERIALS

a. Three Phase Inspections

Insure that all plumbing fixtures and materials have been submitted and approved prior to the Preparatory Inspections, fabrication, and installation. Obtain and review manufacturer s installation information. During subsequent Initial Inspections with contractor*s CQC representative, check to see that contract requirements and manufacturer*s recommendations were complied with during installation. Follow-up Inspections will be made as the installation of the plumbing systems progress throughout the facility under construction or renovation.

b. Storage and Handling

Insure that all materials and equipment are handled carefully, properly stored and protected to prevent damage.

(1) Reject damaged materials and equipment. Have them removed from the site.

(2) Inspect the plumbing fixtures upon arrival at the job site for conformance with contract requirements. Require adequate storage and protection from damage before and after installation. Insure that fixtures are installed in compliance with contract requirements and good plumbing practice.

(3) Withhold inventory payment for improperly stored and protected materials.

15D-03 COORDINATION OF WORK

Continually check for interferences between electrical, mechanical, architectural, and structural features especially in toilet and shower room walls, floors, and pipe chases.

15D-04 INSTALLATION

a. General

(1) Know how the plumbing system fits into the total job and where the specific items are to be installed. Prior to installing plumbing fixtures check to insure that all testing of water supply lines, vents, and drains have been completed.

(2) Check size, spacing, elevation, and location of wall and floor stub outs to receive plumbing equipment. Do not allow plumbing fixtures to be stained, or supply lines to be undersized. Insure that the stub outs are corrected as necessary prior to setting plumbing fixtures.

(3) Check location and firmness of the installation of specified equipment supports, holders, and tie down flanges.

(4) Check setting or attaching plumbing fixtures, for required seals, traps, grouting, and caulking. Check each fixture for alignment, height, anchorage and for plumbness.

(5) Check for use of chrome plating on exposed piping, valves, escutcheons, cover plates, and drains.

(6) Check for surge arrestors on lines having quick closing valves. Check for positioning of access opening to allow maintenance of surge arrestors and operation of control and shut off valves. Check for individual shut off valves at each piece of plumbing equipment.

(7) Check for connection of cold water piping to the right hand side of showers, lavatories, and sinks. Also make sure cold water is provided to toilets and urinals.

(8) Check for specified trim, materials, screws, and bolts.

b. Protection

(1) Keep trash and debris out of fixtures and drains. Check fixtures for damage during installation.

(2) Cover and protect fixtures after installation to prevent future breakage, staining, or other damage.

(3) Check workmanship on all bolting, grouting, caulking, shimming, and leveling after work in toilet and bath area after the work has been completed. All fixtures, whether wall or floor mounted, must be firmly attached in place to prevent damage to the fixtures and to the seals of the fixtures. Check to see that all materials and fixtures are sanitary anti-siphon units.

15D-05 PIPELINES. DRAINS. VENT STACKS, AND INSULATION

See Section 15A for water pipelines, fittings, valves, vents and drain lines. See Section 15C for insulation of pipe lines.

15D-06 CLEANING, ADJUSTING, AND OPERATING

a. Cleaning

(1) Inspect all surfaces for damage or stains. Replace or clean as necessary. Clean equipment before running water thru it.

(2) See that all grease, paint, plaster, spackle, spots and debris are removed. See that anchorage and seals are firm. See that equipment is still undamaged. Accept only properly working, and undamaged equipment.

b. Adjusting and Operating

(1) Flush, turn on, or otherwise run water thru system. Check flow, water levels, quietness of operation, and shut off capability. Check flow thru both fixtures and drains. Correct as necessary.

(2) Reject equipment that is damaged, does not properly operate, is not properly installed, and is not in new condition.

CHAPTER 15E

HEATING SYSTEMS

INDEX

CHAPTER 15E

HEATING SYSTEMS

15E-01 GENERAL

a. This chapter covers material, equipment, and good workmanship practices for the installation of heating systems.

b. The QA Rep should strive to obtain systems in accordance with the contract requirements that are safe, adequate, and neat, and which function properly with a minimum of routine maintenance.

c. In combination heating-cooling systems designed for year- round automatic air conditioning, coordinate material of this section with Section 15F, VENTILATING, AIR SUPPLY AND DISTRIBUTION SYSTEMS, 15G REFRIGERATION AND AIR CONDITIONING, AND SECTION 15C MECHANICAL INSULATION.

15E-02 MATERIALS AND EQUIPMENT

a. General

(1) Make sure that each piece of material and each item of equipment has been approved well in advance of its need. When the material and equipment arrive on the job, inspect them very carefully, comparing them with the approved shop drawing and samples. Check and record nameplate data on all equipment.

(2) Determine that there is adequate space in the room for proper functioning and maintenance of all the equipment.

(3) Reject all damaged materials and equipment and have them removed from the site.

(4) Check the electrical features of equipment and coordinate with the mechanical features.

(5) Determine that provisions have been made for access panels.

(6) Check the required controls and valves for compliance with contract requirements.

(7) Check specification provisions for necessary spare parts and tools for all of the equipment.

(8) See that operations and maintenance instructions are with equipment and are posted on the wall upon completion of installation.

(9) Require proper storage and protection of all materials and equipment.

(10) Check the noise level of all equipment.

(11) Verify requirements for the installation of flexible pipe connections and vibration eliminators for equipment.

(12) Check the installation of all equipment for compliance with manufacturer*s recommendations.

b. Boilers, Furnaces, and Accessory Equipment

(1) Examine pressure boilers for conformance with the ASME Code.

(2) Check for all necessary connections on the boiler.

(3) Check cast iron boilers, if field assembled, for tightness of joints.

(a) All joints shall be sealed.

(b) Reject cracked section.

(4) Inspect refractory furnaces built up on the job for materials and workmanship.

(a) Require expansion joints to be provided. Piping on both sides of expansion joints should be properly guided.

(b) Insure packing to prevent gas or air leakage.

(c) Reject all cracked, chipped or otherwise damaged brick and tile.

(d) Check plastic refractories for placement, thorough ramming, and consistency.

(a) Require refractories to be kept dry.

(f) Inspect for use of refractory mortar in construction of combustion chamber.

(g) Check for air circulation under the combustion chamber floors.

(5) Inspect the application of insulation after all joints are tightly sealed. Check material, thickness, and finish.

(6) Observe accessory equipment operation such as feedwater controllers, dampers, pressure and draft gages, flow and pressure recorders, soot blowers, water columns and boiler blowdown. Check the pressurestat differential.

(7) Check requirement for expansion joint in floor around boiler.

c. Fuel Burning Equipment

(1) Coal, Hand-Fired. Verify installation of grates and operation of dumping mechanism.

(2) Coal, Stoker-Fired. Confirm capacity and operation of feeder, grates, and ash removal.

(3) Oil burners. Check:

(a) Size and type of burner tips

(b) Location of electrodes to insure spark in oil spray cone

(c) Position of gas or oil pilot

(d) Clearances for removal of burner from furnace.

(e) Burner adjustments.

(f) Carbon dioxide in flue gas.

(4) Inspect gas burners for cleanliness, adjustments, position of pilot flame, and sensing element. Check regulator and controls.

(a) Blow out gas line before connecting to burner or regulator.

(b) Install regulator in vertical position.

(c) Pipe gas vents to the outdoors.

d. Draft Fans

(1) Check fans and drivers for anchorage, alignment, and rotation.

(2) Check accessibility of lubrication fittings.

(3) Inspect dampers for operation in compliance with contract requirements.

(4) Inspect bearings for smoothness and overheating.

(5) Check vibration and vibration absorbing mounts.

(6) Inspect insulation application to induced draft fan.

(7) Examine safety control interlocks and sic-flow switches.

e. Oil Storage Tank

(1) Check for Underwriter*s approval.

(2) Check tank capacity and calibration.

(3) See that tanks have the required openings and the means for proper anchorage.

(4) Check for tank heaters, when required.

(5) Examine paint coating and examine holiday testing.

(6) Check manufacturers instructions for proper installation.

f. Circulating, Condensate and Vacuum Return Pumps

Inspect for capacity and for method of mounting.

g. Miscellaneous Fittings and Equipment

Inspect drips, traps, valves, coils, elements, convectors, radiators, etc., as they are brought on the job, to make sure that they are of the correct capacity and that they have been approved.

15E-03 INSPECTION

a. Planning

(1) Check the availability of codes, reference data and manufacturer*s recommendations.

(2) Check with contractor for his detail layouts of equipment and piping which are normally made to coordinate work of the various trades.

(3) Compare nameplate data, piping markings, etc., with requirements.

(4) provide the proper spacing of equipment to make sure that there is adequate room fur piping, ductwork, accessibility for maintenance and that walls behind ductwork can be finished without duct removal. Check for adequate clearance for removal of air filters and strainers.

(5) verify how the heating system fits into the total job.

(6) Be sure that sleeves of the correct size and material are properly located in floors and walls before they are built.

(7) In spite of all attempts to insure that sleeves, inserts, boxes, and so on, are all in place before concrete is placed, oversights occur, and it becomes necessary to cut concrete. Any such operation should be approved by the supervisor before it is begun. A cut in concrete wall should be made from both sides of the wall to avoid spalling of the far surface.

h. Piping

(1) Compare piping workmanship with the check list of paragraph 15A-03.

(2) Check storage and handling against paragraph 15A-02b.

(3) Inspect for the required type and size of pipe.

(4) Examine the cutting of construction to install piping.

(5) Require provisions for expansion and contraction, and proper anchorage of pipe.

(6) Check the installation of mechanical expansion joints. Do not remove spacers until expansion joints are ready to be installed.

(7) Verify that the pitch of the horizontal runs are correct.

(8) Check the position of branch connections.

(9) Be sure that required valves are installed in the correct positions.

(10) Check the method and procedure of jointing pipes.

(a) On threaded joints, check for the use of tapered threads. See that graphite and oil, or an equivalent, are applied to the threads.

(b) On welded joints, check for compliance with approved welding procedures, inspect for defective welds; check type of material of the welding rod; make sure welders have been qualified and are stamping their welds. See Chapter 5 and Chapter 15A for welding inspection guidance.

(11) See that piping is properly aligned and that there is no strain on joints or on adjacent equipment.

(12) See that proper grade and alignment are maintained and that proper fittings are provided to eliminate air pockets and restrictions.

(13) Check for air valves at all high points and at the ends of mains. Check for drips and traps at low points. Examine the lines to make sure that condensate cannot accumulate in the lines.

(14) Inspect for required floor, wall, and ceiling plates. Check for type, size, material, and finish.

(15) Watch for the use and proper installation of eccentric fittings.

(16) See that interconnecting piping between boilers conforms to shop drawings and ASME Code. Watch for adequate valves and other special fittings. Cutoff valves shall be provided to isolate each boiler from the steam header.

(17) Be sure that lift fittings are provided where the gravity flow of vacuum returns is interrupted by a change to a higher elevation.

(18) Clean all supply and return lines before putting them into operation. Check whether contractor has cleaned all traps and strainers after pipe cleaning and before system operation.

(19) Check safety valve discharge pipe for number of ells (restriction).

(20) Check bent pipe for kinks, wrinkles or other malformations.

c. Pipe Insulation

(1) Know locations of pipes required to be insulated.

(2) See that insulation has been approved.

(3) Check width and type of material and the spacing of bands.

(4) Be sure that all fittings except unions and flanges are insulated.

(5) Be sure that insulation is being correctly installed. See section 15C Mechanical Insulation.

(6) Check for continuity of insulation through walls and floors.

(7) Check that proper thickness of insulation is being applied.

(8) On chilled-water and hot-water combination piping and boiler piping check for vapor seal requirement.

d. Hot Water Systems

(1) Note the installation of balancing valves or orifices in the return connection of each radiator or heating device.

(2) See that contractor balances system as required by plans or specifications.

(3) Insure that threaded openings are provided on converters. See that safety devices and temperature controls are furnished and are in working order. Check coil for tightness and clearance for its removal. Note drain pipe to outside atmosphere or floor drain from blow—off safety valves.

(4) Check for automatic and manual vents.

(5) Examine expansion tanks for size, conformance to code, protective paint coating, insulation, water level gage, drain and air charging valves.

a. High Temperature Not Water

(1) Check pumps for:

(a) Leveling, alignment, and stability on foundation

(b) Lubrication

(c) Seals for leaks

(d) Packing adjustment and type

(e) Pressure retention

(f) Correct rotation

(g) Seal coolant service installed.

(2) Insure that radiant heating coils are accurately placed, firmly secured, and absolutely tight under a hydrostatic test pressure of one and one-half times the operating pressure prior to encasement in construction.

f. Steam Systems

(1) Know details of the type of system required.

(2) Check the operation of supply valves to radiator and convector.

(3) Check radiator run-out for pitch.

g. Hot Air Heating

(1) Insure that contractor follows NFPA criteria for installation of oil or gas equipment.

(2) Be sure that return air has free passage to heater unit.

(3) Note damper setting balance of the flow of air.

(4) Check that flexible connections have been installed between furnace and duct system.

h. Heating and Ventilating Units

(1) Require that all component parts operate satisfactorily.

(2) Note access doors for tightness and clearance.

(3) Determine that noise level is within acceptable limits.

(4) Check flexible pipe connections and/or vibration eliminators.

(5) Check rotation.

i. Unit Heaters

Check:

(1) Air distribution

(2) Noise level

(3) Controls

(4) Clearances

(5) Rotation

j. Controls

Be sure that the controls are provided, as specified, that they are properly hooked up, and that they will perform the required operation.

k. Boilers and Boiler Plants

(1) General Requirements:

(a) Before rolling in, check the cleaning of ends of tubes and the surfaces of tube holes in drums and headers. Check to assure that new boilers exposed to weather are covered to prevent corrosion.

(b) See that tube-rolling is done by experienced workmen and that all precautions are taken to prevent either under or over rolling. At this stage of erection request technical assistance.

(c) Insure that the boiler inspector is notified when it is time for the hydrostatic test. Obtain Certificate of Inspection. Do not permit the installation of any baffles or the setting of refractories until after the boiler has passed inspection.

(d) Affirm that baffles of steel, refractory tile, or monolithic construction are installed gas-tight but with provision for expansion, and that they will resist dislodgment by "puffs".

(e) Insure that boiling-out operations for the removal of grease, oil, and other foreign matter are performed before boiler is placed on-the-line.

(f) Insure that space is provided for tube removal and cleaning and for general maintenance of all equipment.

(g) Check to assure that during periods of operation by contractor chemical treatment and blowdown are provided to prevent scale deposits and corrosion.

(2) Settings

(a) Be sure that all settings are constructed with provision for expansion and contraction of both the refractories and the pressure parts. See that expansion joints are sealed to prevent passage of air or gases but are flexible enough to maintain their seal under movement of the structure. Check the entire setting for leaks.

(b) Check solid refractory walls for plumb, level courses and dipped joints. Check grades of refractories used. Chipped, cracked, wet or broken refractory materials will be rejected.

(c) Insure that refractory tile and setting casings are constructed to prevent the escape of gases or the infiltration of air, and that they are installed in accordance with the recommendations of the manufacturer.

(d) Insist that all openings through setting walls are accurately located and of proper size. Check temperature of boiler setting surface against room temperature.

(a) Verify that pipe sleeves for draft gages are clean and flush with interior face of wall.

(f) Inspect uptake damper for correct location, bearing material, and freedom of operation when hot.

(3) Fuel Burning Equipment

(a) Correlate coal stokers with stationary grates for accurate placement and support of the grate bars. See that shaking and dumping mechanism will work freely under operating temperatures.

(b) Evaluate traveling and moving grates for alignment of running parts and guides, tightness of seals, and provision for expansion and contraction.

(c) Note lubrication and protection of motors, gears, and bearings.

(d) Examine all moving parts for operation under temperatures encountered and for loads specified.

(e) Insure that grate design and coal sizing are suitable for each other.

(f) See that stoker feeding mechanism is adjusted to distribute the coat evenly over the grates.

(g) Verify that pulverizers are constructed and installed as nearly dust-tight as possible. Be sure the equipment is firmly secured to foundation. Check units for proper balance and quiet operation at normal operating speeds.

(h) See if pulverizers are adjusted for proper coal fineness. Notice whether heat is applied to the coal in the pulverizer, or that temperatures are obtained prior to entrance of coal to assure satisfactory dryness of coal.

(i) Insure that burners are adjusted for efficient operation, minimum excess air, stable ignition at low rating, and no impingement on furnace walls. Use a boiler test kit when required.

(j) Evaluate the coal feeder for accurate and even operation.

(k) Examine the installation of access and inspection doors.

(l) View magnetic separators for location ahead of pulverizers.

(m) All safety precautions are to be observed in the installation of gas burners and piping. Arrangement of gas valves should be in accordance with ASA Standard Z 21.33.

(n) Burners should be arranged to permit ready inspection and servicing.

(o) Note location of pilot flame. Provision shall be made to facilitate manual lighting of pilot flame. Hand torch and receptacle should be provided for each boiler.

(p) See that mixing dampers or valves are adjusted to proportion air and fuel for the most efficient combustion with minimum excess air and stable operation of low rating, with no impingement on furnace walls.

(q) Compare all dimensions of the combustion chamber during construction for agreement with manufacturer*s approved shop drawings. Check all materials of construction for compliance with specifications and approved shop drawing. Take physical samples of all tile, insulating plastic, firebrick, etc., for future reference.

(r) Check type and capacity of heaters for grade of oil.

(s) Check relief of excess pressure in pumps.

(t) Test oil piping for leaks.

(4) Draft Fans and Ductwork

(a) See that induced draft fans are provided with cleanout doors.

(b) Verify the operation of dampers at high flue gas temperatures.

(5) Blow Down System

(a) Insist that work conforms to applicable codes.

(b) Observe location of vent and discharge lines.

(c) Require that piping provides for expansion and contraction.

(6) Combustion Controls

(a) Inspect equipment for type, capacity, installation, and operation.

(b) Be sure that operating devices are firmly secured to floor, foundations, or other supports and that they operate freely. They should have sufficient power to easily perform their duties.

(c) Check the location and stability of sleeves in setting walls, ducts or breechings for draft piping, thermometers and gages.

(d) Pipe, tubing, and wiring should run neatly and Parallel to the lines of building or structure. They should be firmly secured and have proper pitch. See that draft piping is provided with means for removing accumulations of ash and soot.

(e) Verify the operation of safety controls.

(f) Check that flame-sensing device is installed in position to sense both pilot and main flame.

(g) Determine that instrument panels are firmly anchored and set plumb. Be sure that wiring, tubing, and piping are neatly arranged in rear of panel. See that nameplates, indicating the function of each instrument, are mounted on the face of the pane.

(h) Secure a written statement from manufacturer*s representative to the effect that all equipment of the control system is properly installed and in perfect operating condition before acceptance.

(7) Economizers and Air Heaters

Check for tightness of tubes or plates and for evidence of erosion or corrosion whether integral with the boiler or separate units. Observe performance.

(8) Fly Ash Collectors

Check:

(a) Inspection and cleanout doors for location and adequacy

(b) Dampers for free operation under all temperature conditions.

(c) Discharge grates for leakage of either ash or air.

(9) Boiler specialties

(a) Verify all trimmings such as water column, steam gage, safety valves, blowoff valves, nonreturn valves, stop and check feed valves and vent valves for type and size. Inspect for installation and setting.

(b) Check that safety valve discharge piping is anchored so that it does not impose a strain on valve.

(10) Soot Blowers

(a) Determine operating pressure of steam operated unite.

(b) Note materials of elements and bearings.

(c) See that wall boxes are accurately and firmly set and that the operating heads are securely fastened. Insure that each element operates freely and that it may be removed without disturbing tubes or setting.

(d) Check clearance for the removal of soot blowers.

(e) Insure that drainage is provided to prevent moisture from being blown into the furnace.

(11) Check for correct location and installation of test holes in breechings and stacks to allow for periodic measurement of fly ash and other particulate matter for air pollution control.

(a) Inspect breechings for gage (thickness) of metal, supports, and insulation.

(b) Examine cleanout doors for tightness, location, and size.

(c) Check expansion joints for tightness and location.

(d) Check caulked joint at opening around breaching entering masonry chimneys.

(e) Check guys, bracing or other supports.

(f) Reject damaged or unsuitable brick and radial block. See that all courses are brought up together and bonded.

(g) In reinforcement operation inspect materials and accuracy of placement. Observe especially the lapping of bars.

(h) Evaluate the material and the setting of embedded items for securing ladders, platforms, cables, lights, doors, or other equipment.

(i) Check openings and locations of test holes in breaching. Check cleanout door for size and location.

(j) Check closing and latching of cleanout doors.

(k) See that firebrick lining covers the chimney area and that weep holes are provided at bottom.

(l) Check continuous-pour type concrete chimneys for a smooth, jointless exterior finish.

(m) Determine if ladders are sturdy, securely anchored, and provided with safety cages where required.

(n) Verify that metal vent cap, when required, is firmly secured and coated for prevention of corrosion.

(o) Identify requirement for obstruction lights and lightning protection. Check access to them for servicing.

(p) Insure that chimney is plumb, concentric, and has uniform taper from top to bottom.

(12) Boiler Feedwater

Check:

(a) Type of water treatment for:

- Water available.

- Pressures and temperatures to be obtained in boiler.

- Materials and installation.

(b) Scales, proportioning devices, and mixing valves for accuracy and operation.

(c) Installation of tanks and piping for types of material and supports, workmanship, and conformance with contract requirements.

(d) Pressure tanks for conformance with the applicable codes and ASME stamp.

(e) Control apparatus for the installation and operation of all components. Check should be done by the manufacturer*s service engineer. Refer to job specifications for necessary tests and reports required, and determine from service engineer the sequence of testing.

(f) Open heaters for the installation of pans, trays, plates, sprays, and other internal parts, as well as for the setting of the control for water level in storage compartment. Be sure that heater vent operates and that the heater reduces the oxygen content in the water to the specified amounts before acceptance. Checking should be done by manufacturer*s service engineer.

(g) Closed heaters for compliance with code governing unfired pressure vessels. Assure that clearance is provided for the removal of tubes. Evaluate performance.

(h) Thermometers and gages for accuracy and operation.

(13) Turbines.

(a) Inspect equipment for the pressures and temperatures to he applied. Compare with approved shop drawings.

(b) Examine all drains, drips, leakoffs, relief valves, and other required safety devices for operation.

(c) Insure that turbines are firmly secured to foundation, are accurately aligned with driven equipment, and operate without vibration.

(d) Check that piping is installed to impose no strain on turbine connections.

(e) Verify that provision is made for expansion when aligning couplings.

(f) Be certain that field—assembled turbines are installed by the manufacturer*s erectors only

(g) Reduction gears must mesh perfectly and operate smoothly and without noise or vibration. Check dwelling after turbines and gears are in perfect alignment.

(h) Evaluate the operation of governors.

(i) Check capacity and steam consumption under various load conditions.

1. Smoke Connections

(1) Examine the size and construction of stacks and flues.

(2) Check the clearance space between stacks, flues, and adjacent building materials.

(3) Inspect the method of supporting and anchoring all smoke connections.

(4) See that cleanout is provided which will allow cleaning of the entire smoke connection without dismantling.

m. Fuel Storage and Conveying

(1) Inspect overhead bunkers for capacity in conformance with specifications. See that all gates are installed dust—tight and that they operate freely. Note the sealing of spaces around top of bunkers and elevators.

(2) Be sure that silos are erected plumb and concentric.

(3) See that courses in tile, brick or block silos are carried up evenly, that horizontal joints are level, and that reinforcement is welded and thoroughly embedded.

(4) Tight joints and reinforcement bands for concrete stave silos must be pulled up tightly.

(5) Check continuous-pour type concrete silo for a smooth, jointless exterior finish.

(6) Determine whether pneumatic conveyers are installed with air and dust—tight joints.

(7) Examine materials and installation of mechanical coal conveyers.

(8) Insure that screw flights do not ride on bottom of trough.

(9) See that bucket, chain, and belt conveyor guides and bearings are carefully aligned.

(10) Evaluate skip hoists for capacity and proper installation, with particular attention to operation of the top and bottom limit stops.

(11) Make sure that housings for all conveyors and elevators are installed with dust-tight joints.

(12) Access doors and connections with chutes and discharge gates should be tightly fitted.

(13) Observe that chutes are installed with sufficient slope to insure free, gravity flow of coal.

(14) Check weighing lorries for capacity, accuracy of weight, and ease of operation.

(15) Verify that vibrating feeders are accurately positioned and adjusted for specified flow of coal.

(16) Be sure that coal crushers are securely anchored to foundation or supports and that grids are adjusted to proper coal size. Ascertain the direction of rotation.

(17) Check coal scales for accuracy of weight and for operation of component parts.

(18) Track and Truck Hoppers — Insure provision for removing water from pita. Inspect hopper grids for size opening and materials.

(19) Note flow of coal of entire conveying system, from unloading hoppers to boilers.

n. Painting

(1) See that equipment contains the correct finish. Watch for abrasions.

(2) Watch for miscellaneous ferrous metal items that are not primed.

(3) Require finish painting as specified.

(4) Identify all pipe runs as specified.

o. Testing

Witness that all required tests of heating equipment are accurately recorded. See that tests are performed by manufacturer*s representatives where required. Check tests and verify that tests meet all requirements before acceptance. Report unsatisfactory test results to the supervisor.

p. Operating Instructions and Guaranties

(1) See that equipment guaranties and instructions for the operation of equipment are furnished.

(2) Notify supervisor of the readiness of the construction for test and subsequent operation for instructing personnel.

CHAPTER 15F

VENTILATING, AIR SUPPLY AND DISTRIBUTION SYSTEM

INDEX

CHAPTER 15F

VENTILATING, AIR SUPPLY AND DISTRIBUTION SYSTEMS

15F-01 GENERAL

Since the ventilating system is largely dependent upon associated equipment, the QAR must closely coordinate this chapter with Chapters 15B, 15C, 15E, and 15G. The same importance of a thorough knowledge of job plans and specifications applies.

15F-02 EQUIPMENT

a. General

(1) It is the QAR*s responsibility, in concert with the quality control man, to determine that all equipment is approved well in advance of its actual need on the job.

(2) Check all equipment delivered to the site for conformance with approved shop drawings. Make sure the necessary rating and test certificates have been furnished.

(3) Closely examine material for any damages. Minor abrasions or rust spots must be cleaned and repainted to match original paint in appearance and in quality. Reject other damages.

(4) Be certain that approved vibration-isolators and flexible connections will be furnished as specified.

(5) Examine the mounting of each piece of equipment for secure installation.

(6) Check equipment for excess noise and vibration.

(7) Do not use dissimilar materials, especially screws, fasteners and flashings with different equipment bases and housing materials.

b. Fans and Air Handling Units

(1) Check rotation of fan before permanent power connection is made.

(2) Check method of drive. If belt driven, check means provided to adjust the motor.

(3) Check the type of motor enclosure.

(4) See that specified seals, sleeves and bearings are provided, and when lubricating type bearings are allowed provide accessibility for lubricating without dismantling fan or disconnecting duct.

(5) Provide a fire-safety switch on return air ducts of circulation systems.

(6) Check for pulley and belt alignment.

(7) See that adequate guards are provided for rotating equipment and belts.

(8) Check for installation of smoke detectors when required.

c. Power Roof Ventilators

(l) Provide service accessibility.

(2) Flashing at curbs must be water-tight.

(3) Discharged air is not to be directed toward air intakes.

(4) Check for required local disconnect switch.

d. Gravity Ventilators

(1) Examine installation for rigidity and weathertightness.

(2) Make sure units are oiled and properly adjusted.

(3) Check the actual freedom of rotation of the blades.

e. Dampers

(1) Backdraft dampers should be installed for each exhaust fan.

(2) Check the actual operation of the dampers. See that dampers do not rattle and that felt strips are provided for backdraft dampers.

(3) Assure that a separate frame is provided in openings on which the dampers will be mounted.

(4) Check for correct installation of fire dampers in accordance with SMACNA Fire Damper Guide.

f. Filters

(1) Make sure the proper type of filter is furnished and installed.

(2) Check thickness and method of mounting and supporting.

(3) Provide proper amount of adhesive and washing tank for viscous medium type filters.

(4) Inspect sealing strips.

(5) Provide accessibility for removal and replacement of filters.

(6) Assure that air stream is distributed uniformly over all filter areas.

(7) Observe electrostatic-type filters for operation of warning lights and door interlocks. Check ionizers for loose wires, sparking, and free access.

(8) Inspect automatic sprays for complete washing and spray coverage.

(9) On traveling screen type filters note the operation of screen and oil charge.

(10) On renewable roll media type filters inspect:

(a) Tracking of roll

(b) Media runout switch (c) Timer setting (d) Static pressure control

(a) Tension on media

(11) See that clean filters are installed upon completion of final tests.

(12) Check specifications regarding requirements for spare filters. This requirement is sometimes expressed as a percentage of the total of each kind required. Check on the transfer of the spares to the operating agency.

g. Screens

(1) Provide bird or insect screens if required.

(2) Check fabric material and installation of dissimilar materials.

(3) Check mesh size.

15F-03 DUCTWORK AND MECHANICAL INSULATION

See Section 15D for Ductwork. See Section 15C for Mechanical Insulation.

15F-04 DIFFUSERS. REGISTERS. AND GRILLES

(a) See that the contractor furnishes a schedule showing all air inlets and outlets.

(b) Inspect diffusers and registers for accessible volume control operator.

(c) Examine specification and installation for integral anti-smudge rings for diffusers.

(d) Check for loose or bent vanes.

(e) Inspect each item for fit, and see that sponge-rubber gaskets are provided when required.

(f) Inspect for the proper operation of registers, dampers, and grille directional-controls.

15F-05 BALANCING AND TESTING

General Check for any required certification of HVAC test and balance subcontractor/agent, prior to their arrival at site.

a. Cleaning and Adjusting

(1) All ducts, plenums and casings must be thoroughly cleaned of debris and blown free of small particles and dust before supply outlets are installed.

(2) Clean equipment of oil, dust, dirt, and paint spots.

(3) Replace sectional throwaway filters after ductwork is blown out and cleaned.

(4) Lubricate all bearings.

(5) Check tension on all belts and the adjustment of fan pulleys.

(6) Check that all fan and belt guards are in place.

(7) Install temporary filters for tasting purposes.

b. Testing

(1) Before insulating duct test it for air tightness.

(2) Contractor must provide necessary equipment for airflow measurements and coefficients for registers and diffusers.

(3) Review contractor*s method for recording test data, including comparison to the design air-flows.

(4) Test each outlet for the amount of air quantities required.

(5) Final air-flows must be recorded after all adjustments are made.

(6) If actual air flows result in objectional velocities or distribution, notify your supervisor.

(7) Check all dampers for proper operation.

CHAPTER 15G

REFRIGERATION AND AIR CONDITIONING

INDEX

CHAPTER 15G

REFRIGERATION AND AIR CONDITIONING

15G-01 GENERAL

This chapter covers Refrigeration and Air Conditioning for both the central and unitary type systems.

Since there is generally a duplication in the requirements for piping and ductwork for this subject and for plumbing and air handling, and since those areas have been covered in previous chapters, it will be necessary for the inspector to be very familiar with the piping area of Chapter 15A and the ductwork section of Chapter 15C.

When the work appears to be beyond the scope of the inspector, technical assistance should be requested promptly.

15G-02 PIPING

a. Refrigerator Piping

(1) Determine where copper or black steel will be used, and the type required.

(2) Make sure the piping and fittings have been approved.

(3) Check the method of installing piping. See Section 15A.

(4) Make sure piping is stored as prescribed in specifications.

b. Water Piping

(1) Check the type of piping required for chilled water and condenser water systems. See Section 15A.

(2) Determine weight and class of piping.

(3) Make sure the specified and approved piping, fittings and jointing materials are being used.

c. Installation

(1) Utilize paragraphs 15A-02 and 15A-03 as a check list for fabricating and installing piping. Watch specifically for workmanship, supports, and sleeves.

(2) Be especially careful to:

(a) Make sure the specified solder is used. Check soldering of joints.

(b) See that internal valve parts are removed from valves, and that valves are wet wrapped before soldering.

(c) See that joints are thoroughly cleaned before soldering.

(d) Check on the removal of excess flux and acid after joints are made.

(3) Make sure the proper type flexible connections are installed in the required locations.

(4) See that unions or flanges are installed at all equipment, at control valves, and at other points that will facilitate maintenance.

(5) Check carefully for the proper slope of all lines. Assure slope of refrigerant lines to provide movement of oil through the system.

(6) Check installation for improper configuration of piping. Make sure the installation conforms with the approved drawing. If there is any question about the requirement for the arrangement of piping and if there is no approved drawing, obtain the drawing before allowing the contractor to proceed.

(7) Make sure air vents are installed at high points in water lines and that drains are installed at low points.

(8) Do not allow gate valves to be installed where globe valves are required.

(9) Be sure balancing cocks are installed as required to permit proper balancing.

(10) Do not install swing check valves in vertical lines with a downward flow of water.

(11) Check for the installation of such required items as pressure gages, thermal elements, thermometer wells, etc.

(12) Provide adequate number and type of hangers. Hangers on uninsulated copper pipe must be electrolytically coated or made of solid compatible non ferrous metals.

(13) Check for the proper installation of oil traps and double risers in refrigerant lines.

(14) Check valves for pressure setting and discharge locations.

(15) Be sure that refrigerant system is evacuated prior to charging and accomplished according to job specifications.

(16) Make sure the system is charged with the required type and amount of refrigerant.

(17) See that the system is completely checked for leaks. Dry nitrogen must be used for pressure tests.

(18) Double check to see that there are no unnecessary oil traps.

(19) Vacuum should be broken by charging the system with dry refrigerant for which the system is designed.

d. Insulation

(1) Determine whether the material on the job has been approved for the particular piping being installed. Make sure insulations, vapor barriers, adhesives and sealers are noncombustible or fire retardant as specified. See Section 15C Mechanical Insulation.

(2) Note that heating water piping is insulated differently from both chilled water piping and combination chilled and heated water piping.

(3) Check thickness of insulation and of vapor barrier finish.

(4) Determine that insulation jackets which are exposed to view are paintable.

(5) Examine the requirements for the insulation of flanges, fittings, and valves, and assure compliance with the specifications.

(6) Check the lap and the sealing at joints.

(7) Be very careful to see that there are no breaks in the vapor barrier. Watch for later damages during construction.

(8) Check specification requirements for extending insulation through sleeves in walls, floors, and ceilings; chilled water lines inside cabinets of fan coil units should be insulated as required to prevent condensate dripping on floor.

(9) Make sure that pipe hangers are installed over insulation. Metal Shields to be provided between hanger ring and insulation. High density insulation insert shall be installed with a length equal to length of metal shield.

(10) Check for the neat termination and seal of insulation at the end of insulation.

(11) Know the special requirements for insulation and jacketing of piping exposed to weather.

(12) Check the installation, the width, and the spacing of the bands used on pipe jacketing.

15G-03 EQUIPMENT

a. General

(1) All equipment should be checked to see that it is approved before it is needed on the job. When equipment arrives on the job, it should be checked against shop drawing. During installation, the contractor*s work should be checked against the contract plans and specifications, the approved shop drawing, and the manufacturer*s recommendations.

(2) Be sure that no damaged equipment is installed.

(3) See that equipment is stored in a manner that will insure that the equipment be like new when installed.

(4) Be sure that all refrigeration equipment is installed strictly in accordance with the safety code for mechanical refrigeration.

(5) Check on space requirements for equipment. Obtain an equipment room layout drawing and make sure that adequate clearances are provided for maintenance and operation.

(6) Determine the need for access panels. A common error is the failure to provide the means for pulling condenser and chiller tubes.

(7) Make sure that all rotating parts, such as belts, chains, sheaves, shaft couplings, etc. are covered to protect personnel.

(8) Check the type of motors on equipment, the type of motor starter, heaters in the motor starters, and voltage of motor.

(9) Make sure all equipment is lubricated according to manufacturer*s recommendations. This includes motor bearings.

b. Condensers

(1) See that air flow is not obstructed and that wind deflectors are installed, if required, in air cooled condensers.

(2) Inspect water cooled condensers for leaks and proper flow.

(3) Check evaporative condensers for:

(a) Spray coverage.

(b) Float valve operation without chatter.

(c) Water level.

(d) Fan rotation and speed.

(e) Pump suction strainer.

(f) Liquid discharge line carried full size to first elbow, with a 12-inch to 18-inch drop to receiver.

(g) Mesh size of inlet screens.

(h) Pan, casing, eliminators, fan corrosion protection, and complete drainage.

(i) Provision for and adjustment of constant bleeding.

(4) For all season air cooled condensers manufacturers recommended installation should be adhered to. Check project plans, specifications, and manufacturers recommended installation to see if condenser flooding or air volume control is required.

c. Reciprocating Compressors

Check for:

(1) Oil, suction, and discharge pressures.

(2) Shaft alignment on direct-driven machines.

(3) Operation of high pressurestat, low pressurestat, and oil pressure failure switch.

(4) Proper level viscosity of oil.

(5) Installation of required gages.

(6) Amount, correct type, and dryness of refrigerant charge.

(7) Pressure holding ability upon pump-down.

(8) Isolator deflection and compressor vibration.

(9) Suction strainer screen mesh, and removal of startup belts.

(10) Unloader action.

(11) Compressor speed.

(12) Belt tension and alignment.

(13) Motor amperage under maximum load.

(14) Refrigerant flood back and oil foaming.

(15) Cylinder head overheating.

(16) Rotation.

(17) Automatic oil heater in crank case. Heater should work during shutdown.

(18) Loops in refrigerant piping as loops will permit oil to be trapped.

(19) Damage of equipment compressor — should not be run during vacuum tests.

d. Centrifugal Compressors

Check for:

(1) Alignment of compressor, drive and gear box.

(2) Suction damper or inlet vane operation.

(3) Safety control circuit operation.

(4) Purge compressor operation.

(5) Float valve operation, if furnished.

(6) Oil pump and cooler operation.

(7) Noise and vibration.

(8) Required gages.

e. Receivers

Check for:

(1) Location, if installed on the outside of the building. Do not place in direct rays of sun.

(2) Relief valves are adequate size.

(3) ASME Stamp.

(4) Drain, purge valve, liquid level indication, and shut-off valves.

f. Water Chillers

(1) Examine water drains, vents, and correct pass arrangement in direct expansion type chillers.

(2) Inspect for freeze protection safety devices.

(3) Check strength of liquid bleed-off at bottom of flooded chillers. Check adjustment of level control.

(4) Check tubes and shell in brine chiller for type of material.

g. Evaporative Coolers

Inspect for adequate spray coverage, non sagging media, water carry-through, correct water level in sump, and lack of float valve “chatter.

h. Unit Coolers

Check:

(1) For corrosion—protected pan and casing.

(2) Water defrost units for spray coverage with no carryover.

(3) Electric defrost units, for cycle timing in accordance with the job conditions.

(4) Hot gas defrost, for suction pressures and refrigerant charge in accordance with manufacturer*s recommendations.

(5) Drainage during defrost cycle.

(6) Cycle timing.

(7) That drain lines are properly trapped on the warm end.

i. Refrigeration Specialties

Check:

(1) Superheat setting of expansion valves and that bulb and equalizer position is in accordance with the manufacturer*s recommendations.

(2) Solenoid valve for vertical stem, correct direction of refrigerant flow, and manual opener disengaged.

(3) Unobstructed view of sight glass.

(4) Operation of evaporator pressure regulator under light load.

(5) Operation of hold-back value upon start-up.

(6) Float valves or switches mounted level and at a height which will insure correct liquid level in the evapoess before opening of refrigerant drier canisters.

(7) Airtightness before opening of refrigerant drier canisters.

(8) Drier; if it is the replaceable type, piping will be arranged to facilitate replacement — 3 valve bypass.

(9) Piping connections of liquid-suction heat exchanger.

(10) That direct expansion coils are installed as recommended by manufacturer.

(11) That pans of fan-coil units are protected against corrosion.

(12) That drain pans are installed under all units, or as needed, to collect condensate.

j. Package-Type Air Conditioners

Check the following:

(1) High-pressure cutout setting.

(2) Compressor hold-down bolts (for shipping) removed.

(3) Drip pan should be watertight and connected to open drain.

(4) Water regulator valve operation, if used.

(5) Installation of air filters and strainers.

(6) Operation of thermostat.

(7) Suction and discharge pressures of refrigeration compressors.

k. Washers

(1) Check the following features of the spray-type air washers:

(a) All nozzles discharging water spray.

(b) No water should carry over from eliminators.

(c) Eliminators must not rattle, and they must be removable for maintenance.

(d) Float valve should not “chatter” on opening or closing.

(2) Check the following features of the capillary—type washers:

(a) Media should not sag in frames.

(b) Wetting of all media.

(c) Water level is at correct height.

l. Humidifiers and Dehumidifiers

(1) Examine the humidifiers for supported coil and corrosion-protected pan.

(2) Check refrigeration type dehumidifiers for frosting of cooling coil and for water carry-over.

(3) Check absorption type dehumidifiers for the following:

(a) Solution level and temperature controls.

(b) No solution should carry over from eliminators.

(c) Regenerator duct must be drained of specified material, and correctly sealed.

(d) Damper operation, cycle timing, evidence of “dusting” of the desiccant, and regenerative temperatures.

m. Absorption Refrigeration Machine

Check the following:

(1) Cleanliness of all parts during erection.

(2) Proper materials.

(3) Access for removing tubes from absorber-evaporator and generator-condenser.

(4) Control operation, especially high and low-limit temperature cutouts or condenser water pump interlock.

(5) Operation of purge system.

(6) Unit to be fully charged with water and a nontoxic absorber after installation.

(7) Services of a factory representative for charging, testing, starting the plant, and providing instruction.

n. Cooling Towers and Ponds

(1) Check mechanical-draft cooling towers for unobstructed air intake, fan rotation and speed, belt tension, stacked fill, and weather protection of motor. (Do not allow open fan motors when totally enclosed motors are specified.) Insure that water—flow through outlet does not form a vortex which draws air in with the water. Check operation of water temperature control and drainage devices.

(2) Observe spray ponds for evenness of sprays and for water drift.

(3) Insure provision for an adjustment of constant bleed.

(4) See that mist eliminators are installed when specified.

(5) Insure the installation of over-flow and drain piping.

(6) See that the water is at adequate level after operation, and that spray-pump operates.

(7) Check belt alignment and tension.

o. Pumps

(1) Assure that manufacturer*s name-plates, equipment, serial numbers, or code stamps are not covered or hidden from view after installation.

(2) Check for anchorage of pump in compliance with contract.

(3) Check alignment of pump with motor and piping.

(4) Make sure that all gages and meters are provided.

(5) See that eccentric reducers, in lieu of concentric reducers, are used in suction piping, and that the flat side is turned up.

(6) Check for adequate support of piping around pump.

(7) Be sure check valve is installed in discharge piping.

(8) Check pump packing. Make sure adequate packing is installed to allow gland take-up.

(9) Check for excess vibration and flexible piping connections if required.

(10) Make sure that the pump motor is weatherproof when specified, and that it is connected to rotate correctly.

(11) Recheck oil sumps after operation, if applicable.

p. Insulation

(1) Check for:

(a) Proper insulation of chilled water pumps.

(b) Insulated converters and expansion tanks.

(c) Insulated condensate drain pans of air handling units.

(d) Protective finish over such items as pumps, converters tanks, fans, etc.

(2) Insure that all insulating materials have been approved and that they are of the specified thickness.

(3) Check the method of attaching insulation to equipment.

(4) Make sure that specified reinforcing is provided in adhesive plaster finish.

(5) See that corner angle beads are installed at the specified corners.

(6) See that the adhesive finish coat has smooth, pleasing finish.

(7) Check on the application of vapor barriers to see that they effectively seal out all moisture.

15G-04 CONTROLS

a. Review all control installations with approved control shop drawings, to assure that they are being installed in strict conformance with the drawings.

b. See that dampers are mounted securely on rigid supports, and that the correct bearings are provided on the blade axles.

c. Note damper motors while fan is on, and check linkage between damper and motor.

d. Examine valve operations for tight closing.

e. Examine electrical equipment for interlocking.

f. Check on the installation of all required alarm bells.

g. See that freeze—stats are installed as specified.

h. Check for proper electrical current and voltage in the control system. Carefully check the operation of solenoid valves.

i. Check that air compressor location will permit tank drain operation, and check for cycle time with all operating controls.

j. Verify clean elements in humidistats when the system is started.

k. Evaluate pneumatic systems for air—tightness, restrictions caused by flattening of the tubing, and cleanliness of the system.

l. Inspect electronic systems for grounded shielded cable, and location of amplifiers with respect to magnetic fields, such as large transformers.

m. View graphic panels for damaged plastic, dirt between plastic and back plate, lacing of control wires and access for service to all controls.

n. Verify control instructions, including sequence of operations, and control drawing furnished by the contractor when conducting final acceptance test. Check each function of the controls.

15G-05 TESTING

a. Submittals

Be sure the contractor obtains approval of test procedures and other pertinent information prior to testing.

b. Procedures

(1) Make a record of all tests, including such information as who attended, methods and procedures of test, results, and conclusions. Check specifications to determine that contractor is recording sufficient data to comply with requirements.

(2) Before tests are scheduled, see that contractor has proper tools, equipment, and instruments, and gages should be certified and pretested.

(3) See that equipment is thoroughly checked and prepared for tests.

(4) Make sure strainers and filters are clean immediately prior to test.

c. Types

(1) Check the testing of refrigerant piping. See that specified pressure is put on the lines. Make sure all joints are checked, and that leaks are detected, repaired, and retested until found satisfactory. Isolate all items which may be damaged by high pressure.

(2) See that hydrostatic test is performed on all water piping. Carefully check to see if there is a loss in pressure during the test.

(3) See that a performance test on the system is run for the duration specified. Make sure needed corrections and adjustments are made as determined during test. See that the contractor records all data required for the performance test.

(4) After successful tests, install a new oil charge in compressor. Change oil filters and socks, and provide new cartridge in refrigerant drier. (Oil charge is not required for factory sealed units)

15G-06 PAINTING

a. See that equipment is furnished with the correct finish. Watch for abrasions.

b. Watch for miscellaneous ferrous metal items that are not primed.

c. Require touching up, priming, and finish painting as specified.

d. Apply asphaltic varnish on all hangers and other items not to be painted.

e. Require piping identification on coding as specified.

15G-07 OPERATING INSTRUCTIONS AND GUARANTIES

a. See that equipment guaranties, schematic flow diagrams, and instructions for the operation of equipment are furnished and posted.

b. Arrange for future operating personnel to be instructed on the operation of equipment. Make a record of instruction periods, including any complications, instructing personnel, and personnel instructed.

CHAPTER 15H

FIRE PROTECTION SYSTEMS

INDEX

CHAPTER 15H

FIRE PROTECTION SYSTEMS

15H-01 GENERAL

a. Definition

This chapter covers materials, equipment, and good workmanship practices for Fire Protection Systems.

b. Approvals

(1) Review Eng Form 4288, Submittal Register, and insure that all material equipment, and shop drawings are approved prior to preparatory inspection, and prior to either fabrication or installation. Obtain any helpful manufacturer*s installation information.

(2) Insure that seismic restraints are shown on shop drawings.

c. Storage and Handling

(1) Insure that all materials and equipment are handled carefully to prevent damage.

(a) Reject damaged material and equipment. Have such items removed from the site.

(b) Have damaged coatings repaired.

(2) In handling heavy pipe use wide belt slings to avoid damage to pipe coatings.

(3) Check storage facilities for adequate weather protection, possible damage, and safety hazard.

(4) When outside storage is necessary, store materials and equipment above ground.

d. Coordination of Work

Continually check for interferences between electrical, mechanical, architectural, and structural features especially in ceiling area and along walls where fire protection system is to be installed.

15H-02 SPRINKLER SYSTEMS

a. General

(1) Assure that fire protection systems serving occupied buildings are not shut off for repairs without advance notice being given to proper authorities.

(2) Note valves and equipment proposed for location within reach of flood waters. Call to the attention of your supervisor.

(3) Do not take water from fire mains for domestic use.

(4) Identify painting and coding requirements.

(5) Check that sprinkler heads are not painted.

b. Materials

(1) Coordinate fire department hose connections for use with local fire department hose.

(2) Inspect pipe, fittings, and valves. Pipe that is properly reamed is free from burrs and fins.

c. Water Supply

(1) Evaluate plan of work to minimize interruption of water service.

(2) Insure that water line is located below local frost line.

(3) Block off ends of supply lines terminating in building or valve house.

(4) Be certain that pipe joints are left exposed until final inspection and tests are made.

(5) See that turns in supply line are braced, blocked or clamped.

d. Aboveground Piping

(1) Notice size of pipe. Check to insure all hangers are tight.

(a) Run parallel to building lines, with slope to drain.

(b) See that branch piping is off top of main.

(c) Where impossible to obtain an even slope, plugs should be provided at low points so that the entire system may be drained. Check for inspection test connections required by NFPA.

(2) See that no cutting of structural members for support or passage of pipe is allowed.

(3) Insure that holes through fire walls are provided with sleeves and plates. Sleeves will be provided where pipe passes through walls and floors.

(4) Check that installation of seismic restraints are installed as approved.

e. Sprinkler Heads

(1) Be sure that heads in accordance with NFPA 13 are installed in upright position with recommended clearance to roof or ceiling surfaces.

(a) When in pendant position return bends will be used if water is subject to sedimentation.

(b) Where subject to mechanical injury heads will be provided with approved guards.

(c) All heads will be new and should not be painted.

(2) Determine sprinkler head temperature ratings as proper for ambient temperatures anticipated in the area; e.g., near heaters, skylights, etc.

Notify your supervisor in instances where sprinkler head temperature ratings appear to be inconsistent with anticipated ambient temperatures.

(3) Spare heads should be provided and arrangements made to transfer them to the using service.

(4) Where sprinkler heads are shown to be installed in special hazard areas, such as electronic shops, confirm that installation will be in conformance with area usage.

f. Drains

See that valves or plugs are provided to insure drainage of the entire system. Assure that discharger from all drain valves is visible. They should be arranged so that wide open valve position under normal pressure will not cause any water damage.

g. Wet Pipe Systems

(l) Insist that piping layout is in strict accordance with approved drawings.

(2) Alarm check-valve assembly must conform with connection diagram.

(3) Observe installation of water—flow indicators for conformance with connection diagram.

(4) Confirm insulation and painting requirements.

(5) Check water flow alarm signal by using wet pipe type of inspector*s test connection.

h. Dry Pipe Systems

(1) Determine that piping layout is in strict accordance with approved drawings.

(2) Note dry pipe valve installation for conformance with connection diagram.

(3) Inspect installation of air compressors. Air supply line should include flexible connection and orifice plate. Check motor controller operation. If compressor is equipped with an air storage tank, assure that condensate water drain is provided at bottom of tank.

(4) Examine locations and operation of condensate chambers; i.e., drum drips.

(5) Check water flow alarm signal time and dry valve trip test time by using the dry pipe type of inspector*s test connection.

(6) Where dry pipe valve accelerators are provided, check for proper operation.

i. Deluge Systems

(1) Confirm that piping layout is in strict accordance with approved drawings.

(2) Examine installation of deluge valve assembly.

(3) Inspect and test releasing devices.

(4) Check tripping devices both manual and automatic. Check provisions to insure against accidental water damage.

(5) Insure that contractor provided portable test units in good working order.

j. Sterilization

Witness dosage, distribution, retention, and final flush-out.

k. Alarm Facilities

(1) Check installations to insure that all alarm devices have been provided and are in operating condition.

(2) Be sure that electric power for alarm signals is taken from the house current supply line ahead of the main switch.

(3) Examine alarm system for tie-in with local fire department.

(4) Check alarm to insure that it can be heard above normal noise levels.

l. Testing

(1) Review test procedure for adequacy, and witness all tests.

(2) Protect dry pipe valves against damage during the tests.

(3) In testing extensions to existing system, insure that self-indicating blanks are used. Remove upon completion of tests.

(4) Insure that all sprinkler contractor*s certificates covering materials and tests are properly executed.

(5) Insure that flushing and hydrostatic tests are made in accordance with the accepted tests specified in Standard 13 of the National Fire Protection Association.

(6) Insure that all lines and controls are properly painted, color coded, indentified, tagged, and with directional flow markings.

(7) Check with supervisor to assure user/fire marshall is present as needed durin the test.

15H-03 PIPING. INSULATION. AND INTERIOR ELECTRICAL

See Section 15A PIPING SYSTEMS, Section 15C MECHANICAL INSULATION, and Section 16A INTERIOR ELECTRICAL.

CHAPTER 16A

INTERIOR ELECTRICAL

INDEX

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CHAPTER 16A

INTERIOR ELECTRICAL

16A-01 GENERAL

This guide has been prepared to assist the quality assurance representative in obtaining the quality assurance of interior electrical installation required by the contract specifications. It is recognized that specialized technical aspects of this subject may require the services of an electrical engineer or technician. When the work appears to be beyond the scope of the QAR, assistance should be requested promptly from the immediate supervisor.

During the Preliminary Inspection of each phase of work, make an inspection of materials prior to installation for conformance with specification, plans, and approved shop drawings. ENG Form 4288, Submittal Register, which lists approved materials is essential to this inspection. Components for interior electrical work will be inspected before they are installed and energized. Initial Inspection and followup Inspections will follow work as required by ER 1180-1-6.

16A-02 GENERAL REQUIREMENTS

a. It is the intent that the electrical installation shall conform to the applicable rules of the current National Electrical Code)NEC)*, except where expressly modified by the plans and specifications. This requirement can be found in the general section of the project specification for INTERIOR ELECTRICAL. The appropriate edition of the code will be listed in APPLICABLE PUBLICATIONS. A copy of the applicable NEC should be readily available to the general inspector, and he should be readily available to the QAR, and he should be prepared to use it as a reference and an authority. However, the NEC is a minimum standard intended to assure a safe installation. Frequently, Corps of Engineers project specifications require a higher quality installation than that which is required by the minimum standards of the NEC. A substitution or change to the requirements of the project specification proposed on the basis of being “Okay under the Code” should not be casually accepted. NEC paragraph references in the text of this guide are to assist the QAR in using the Code and to lend authority to his demands for features not spelled out in the project specification.

b. Watch job conditions at all times to assure that the electrical work is done at the proper time in relation to other parts of the building construction.

c. Determine the existence, extent, and classification of hazardous locations as noted in the contract documentation. If such locations exist, the installation therein should be strictly in accord with appropriate sections of the NEC. Do not approve any doubtful material or workmanship (NEC 500 - 503). Do not fail to seek advice if needed.

*National Electrical Code (NFPA No. 70-84). Text references are to the 1984 edition. Copies can be obtained from the national Fire Protection Association at Batterymarch Park, Quincy, MA 02269 for $15.00.

d. Inspect materials and equipment and approved shop drawings. If materials are in accord with approved shop drawing but appear to be contrary to specifications, inform your supervisor.

e. Examine both contractor and government—furnished equipment for damage in shipment. Promptly report defective equipment to your supervisor and accept or reject such equipment, as directed.

f. Shop inspection by a Government representative may have been required for some equipment and material. Copies of reports of such shop inspections should be on hand before acceptance of material or equipment.

g. Storage of electrical equipment will be done per manufacturers requirement and in dry locations, free of dirt, dust, and corrosive fumes, with protection from physical damage. Storage of switchgear, engine generator units, and government—furnished equipment will usually require indoor storage. Temporary heaters may be required or specified to keep equipment free from effects of condensation. Equipment installed during construction phases should be protected from dirt and moisture. A requirement for this protection may be found in special conditions of the contract (ALSO NEC 110—11.)

h. Require the contractor to furnish all layout drawings required by the specifications. Electrical contract drawings should be reviewed and compared with architectural, structural and mechanical drawings for possible interferences. Examples of this are:

(1) Are the wall switches located with proper respect to door swing?

(2) Does location of wall outlets conflict with installation of baseboard heating units, casework, cabinets or lockers?

(3) Are there interferences with other building construction, such as pipes, ducts, overhead doors, sliding doors, accessibility, etc.? Especially check equipment room layout.

(4) Is relocation of ceiling lighting outlets required, especially in utility and boiler rooms, to avoid interference with mechanical equipment?

(5) Will transformers, bus duct or switchgear be subjected to moisture from overhead floor inadequate?

(6) Have suspended ceilings been lowered, making lighting fixture clearance from floor inadequate?

i. Temporary electric service will generally be required during the construction period for lighting, power, and sometimes heat. The contractor should make early arrangements for such service to prevent construction delays; and temporary installations will be located so as not to interfere with operation of existing facilities or permanent construction.

The contractor should arrange for frequent inspection and rehabilitation of temporary installation during the course of the contract to keep it in good repair (NEC-305).

j. Adherence to the requirements of Corps of Engineers Safety Manual, *EN 385-1-1, is a general provision requirement for all Corps of Engineers administered projects.

(1) Temporary open wiring should be guarded or isolated by elevation. Types NM in dry locations and/or NMC in damp locations (Romex) are suitable for temporary wiring when guarded or isolated by elevation (EM 385-1-1, paragraph 15D-01 and NEC 320, 336)

(2) Portable and extension cords shall be an Underwriter*s Laboratory (UL) listed type for the usage. Hard service cords Type S, SJ, SJO, SJT, SJTO, STO or ST are recommended for this service. Types NM or NMC are not approved as portable cables or covers (NEC 400).

(3) Ground fault circuit protection for construction sites is required on all 120 volt, single phase, 15 and 20 Amp receptacles per NEC 305-4.

k. Use by the contractor of equipment and facilities permanently incorporated in the structure should be carefully watched to see that circuits and equipment are not overloaded and that all work is left in essentially new condition. All protected safety and working lamps used for temporary lighting shall be removed when construction is completed, and new lamps shall be installed in permanent light fixtures (Project Specification: Lamps.)

l. ENG Form 4288, Submittal Register was prepared and included in the contract specifications prior to bidding the work. This list of required equipment will insure timely approval and will alert the QAR if the contractor has not procured all equipment. Generally, electrical construction materials and equipment must be built and tested according to UL requirements. Listed materials and equipment will bear the UL label. The Electrical Constructions Materials Directory is available form UL Inc., Publications Stock, 333 Pfingsten Road, Northbrook, IL 60062.

m. Check shop drawings for all equipment having electrical connections to be sure that rough-in conduits and circuits are correctly sized and located.

n. Manufacturer*s representatives are sometimes required to assist field and contractor personnel in the installation, assembly, testing and/or initial operation of electrical equipment. When Government Furnished Equipment is involved, be sure advance arrangements for such services are coordinated by Resident Engineer and contractor so that the representative is on hand when needed because usually the number of days are designated in the contract and an overrun will result in an additional cost to the Government. Maintain complete record of all adjustments and tests made during installation and startup, and of any peculiarities of the equipment which may be of use to those responsible for its operation and maintenance. Turn copy of record over to your supervisor for delivery to the using agency. Retain a copy of all records for the job file.

o. The using agency should be required to witness tests. The presence or absence of the using service personnel should be noted on the test report.

p. Fire ratings of structures shall not be compromised by electrical installations (NEC 300-21).

16A-03 GROUNDING (NEC 250 and Project Specifications: Grounding)

a. Drawings and Specifications

Drawings and Specifications should be examined carefully to determine the nature and extent of the grounding system and the requirements for separate grounding of equipment and structures. Automatic Data Processing (ADP) , Communications and Health Care Facilities may have special or seperately derived grounding requirements.

b. Visual Inspection

Visual inspection should be made of all ground-system conductors, connections and electrodes as the work progresses. Ground resistance test: The resistance of all electrodes must be tested to assure resistance to ground of 25 OHMS or less (Job specifications or NEC 250-84).

c. Grounds to Metallic Water-Piping System

Grounds to metallic water—piping system should be made on the street side of the meter. Where this is impracticable, full size jumper connections should be made around any piping system elements which can be removed (NEC 250-112).

(1) Make sure that when the water piping system is used for a ground, the water pipe is a metallic pipe and that no insulating fitting has been interposed in the pipe between the ground wire connection and earth. (NEC 250-81). An additional ground electrode shall supplement the connection to the water pipe system (NEC 250-81 or NEC 250-83).

(2) Where metallic water main is not available, driven ground electrodes will be provided in conformance with specifications (NEC 250-83, and Project Specifications: Ground Rods).

(3) Interior metallic water piping shall always be grounded (NEC 250—80(a)).

d. Bolted Connections

Bolted connections should be examined to make sure that they are tight and that contact surfaces are cleaned and dry. Contact surfaces will be metal-to-metal. Painted surfaces should be cleaned to bare metal (NEC 250-75).

e. Exothermic Welding Connnections

Exothermic welding connections will be made in strict accordance with the manufacturer*s instructions and will employ the proper type and size of mold for the type and size of connection made.

f. Metallic Enclosures

Metallic enclosures for ground wires shall be electrically continuous from the point of attachment to cabinets or equipment to the grounding electrode and shall be securely fastened to the ground clamp or fitting (NEC 250-92(a)).

g. Incoming Service Conduit

Incoming service conduit must be grounded by logs, pressure Connectors or clamps. Locknuts and bushings are not acceptable for grounding service conduit (NEC 250-32, -71(a) and -72).

h. Grounding Connection

Ground clamps for connection to water pipe or grounding electrode should be compatible with the pipe or electrode and UL approved for the purpose (NEC 250-115)

i. Ground Rods

(1) Check size, length, and material of ground rods or electrodes against contract drawings and specifications (NEC 250-83, Project Specification: Grounding)

(2) If suitable water pipe is not available, and if ground rods cannot be driven to a minimum depth of 8 feet, other means of establishing a ground must be utilized (NEC 250—83 and C 250-84)

j. System Neutral and Equipment Grounds

Grounding electrode conductor should be joined to grounding electrodes as shown on drawings (NEC 250-112). Some special electronic facilities may require additional isolated grounding electrodes and conductors (Project specification: Grounding.)

k. System Neutral

System neutral (Grounded circuit conductor) should be grounded (connected to the grounding conductor) on supply side of the service disconnecting means (main service switch(es). This connection should be made within the service entrance equipment enclosure (NEC 250-23; 250-50) (Project Specifications: Grounding.)

l. Multiple Connections

The connecting of more than one grounding conductor to an electode by a single clamp is prohibited, unless the clamp or fitting is of a type of specifically designed and approved by the Underwriters* Laboratory for such use (NEC 250-115).

m. Grounding Resistance

Grounding resistance should be verified by instrument measurement (Job Specification or NEC 250-84.)

n. Electrical Continuity

Electrical continuity should be verified throughout system, usually by visual inspection.

16A-04 WIRING METHODS (NEC 300)

a. Rigid Metal Conduit. Intermediate Metal Conduit (IMC) and Electrical Metallic Tubing (EMT)

Check to determine requirements and limitations on use of rigid conduit, IMC, or EMT and special finishing or coating material (Steel with zinc coating or galvanizing is standard) other materials may be allowed or required (Project Specifications: Wiring Methods; NEC-345, 346, 347, and 348.)

(1) The project specifications generally require the service entrance raceway to be rigid metal conduit (Project Specification: Aerial Service.)

(2) Check size of installed conduit against plans and specificatins and determine adequacy for number and size of conductors to be installed. Refer to tables in NEC (Project Specifications and NEC 345-7, 346-6, and 348-6 and Tables in Chapter 9.)

(3) Check minimum size of conduit permitted by specifications for both electrical system and communication system (Project Specifications: Telephone and Sig. System Raceways and NEC 345-6, 346-5, 347-11 and 348-5.)

(4) Check to be sure that all required conduits are in place before on—grade slabs are placed. Check stub-up locations against equipment shopdrawings.

(a) Generally, for slab-on-grade construction conduit must be placed under the slab and must be rigid type. (Check plans and specifications)

(b) Check project specifications for requirement that for stub-ups, couplings be installed at finished floor level for free standing equipment (Project Speficification: Conduits.)

(c) Exposed conduit should be installed so that bent portion of stub-up will not extend above floor level.

(d) Be sure that all buried conduit has been surface treated as required by specifications (Project Specification: Conduit and Tubing Systems.)

(5) Inspect for damage and deformation of conduit systems (Project Specifications: Changes in Direction and NEC 345-10, 356-10, 347-13 and 348-9.)

(6) Is conduit system to be installed concealed or exposed? Check project specification and plans.

(7) Check for the use of the proper type of conduit fittings, i.e., concrete-tight, rain-tight cast fittings; expansion joints (NEC 345-9, 346-9, and 347-6 and 348-8).

(8) Check for installation of sleeves for future work in foundation walls and floors during correct stage of construction.

(9) Check maximum number of bends in any single conduit run. Do not exceed:

(a) Electrical System -4 (90 Degree) bends, including those bends located immediately at the outlet or fitting (NEC 345-11, 346-11, 347-14, 348-10.)

(b) Communication System - Check project specifications for requirements. Generally, not more than 3 (90**N**) bends.

(10) Make sure that all the conduit required for circuits involving equipment furnished by other sections of the specifications and approved shop drawings, as well as the electrical sections, is installed prior to placing of concrete, closing the walls, ceilings, etc.

(11) Check for bushings on ends of conduit. Bushings are not usually required on EMT fittings, because EMT connectors should have smooth internal surfaces (NEC 345-15, 346-8, 347-12).

(a) Check for use of insulating bushings and double lock nuts (NEC 373-6(c).

(b) Check for use of double locknuts for circuits over 250 volts to ground (NEC 250-76b).

(c) See that locknuts, bushings, couplings, and connectors are made up tight to insure ground continuity (NEC 250-92(b).

(12) See that field cuts of conduits and EMT are made square, ends reamed or filed, and cleaned of oil and filings, (NEC 345-8, 346-7, 348-11: Project Specifications).

(13) Use of running threads is not permitted at couplings (NEC 346—9).

(14) Correlate location of conduit terminations against approved shop drawings, equipment and building plans.

(15) Tubing and conduit should be securely fastened in place at intervals required. Means of support provided should be in accord with specifications and NEC requirements (Project Specifications, NEC 348-12, 348-12, 347-8, 346-12, 345-12.)

(16) Exposed conduit runs are to be installed parallel o perpendicular to walls and structural members. Vertical conduit runs should be plumb (Project Specifications: Conduit and Tubing Systems.

(17) Conduit runs in wet areas shall be mounted so that there is at least 1/4″ air space between it and the wall or support surface (NEC 300-6(c)).

(18) Minimum radius of bends of conduit should be in accordance with table in the NEC (NEC 346-10, 348-9, 345-10). This table is based on utilizing conductors with 600-volt insulation. For cables with higher voltage ratings, and special cables such as telephone cable, consult manufacturer*s recommendations for minimum radius of bend.

(19) Check for supporting of vertical raceways at each floor level of multi-story buildings (Project Specifications).

(20) Install galvanized pull-wires in empty conduits when required by designs or specifications.

(21) Verify the use of corrosion-resistant materials in areas where corrosive influences exist (NEC 300-6: Project Specifications).

(22) Require means for prevention of entrance of foreign matter in conduits during construction (Project Specifications).

(23) Use UL listed flexible conduit, standard or liquid tight, for connections to motors installed on slide rails, resilient mounts, those subject to vibration, and elsewhere as specified (NEC 350, 351; Project Specifications). Minimum size is ½" except as allowed in NEC 350-3, and a bonding jumper may be required.

(24) In areas classified as hazardous, be sure that installation is strictly in accord with Project Specifications and applicable NEC articles 500 through 517. All questions should be referred to qualified personnel. For Class 1, Division 1 areas, the following items should be carefully verified:

(a) Only threaded steel IMC or threaded rigid metallic conduit, or MI cable with approved connectors can be used, (NEC 501-4(a) and threaded joints must be up wrench tight, (NEC 500-1), unless a bonding jumper is installed.

(b) At least five full threads must be engaged at each threaded joint (NEC 501-4(a). All field made threads must be tapered (NEC 500-1)

(c) All fittings, fixtures, boxes, and enclosures must be specifically involved. An Underwriter*s approval seal is generally affixed to the equipment. If not, secure other firm verification of approval.

(d) Explosion proof fittings, boxes and enclosures have screw or ground joints at openings. Be sure that surface of ground joints is clean, unscratched and smooth, so that the mating surfaces make intimate contact throughout their area. Covers must be tight and gaskets are not to be used.

(a) Be sure that all required seals are installed in the correct location and that they are of the correct type (NEC 501-5 and 502-5) . Be sure seals are the correct type of the application, vertical or horizontal.

(f) Check the mounting method of equipment to be sure that no holes have been drilled into the interior chamber of an explosion proof enclosure.

(g) Be sure that all flexible conduits bear the Underwriter*s listing seal for the hazard involved.

(h) See that proper approved type sealing compound has been installed in all sealing fittings. Follow manufacturer s recommendations (NEC 501-5(c)2).

(25) Where rigid non-metallic conduits is installed under the specification, it should be installed in accordance with NEC 347 and all special requirements of the Project Specifications.

(26) Provide conductor support in long vertical conduit runs (NEC 300-19).

(27) Pull wires are provided and are of type specified.

b. Cable Systems

(1) Mineral, insulated metal sheathed cable, Type MI, will be installed in accordance with Article 330 or the NEC and Project Specification requirements.

(2) Metal clad cable Types MC and AC (commonly called "BX") should be installed in accord with Project Specification requirements and Articles 333 and 334 of the NEC. See that insulating bushings or equivalent protection are provided between the conductors and the armor at terminations.

(3) Non-metallic sheathed cables, Type NM and NMC commonly called “Romex", should be installed in accord with Project Specification and Article 336 of the NEC.

(a) Type NM cable must not be used when non-metallic sheathed cable is installed in the cells of masonry block walls which are exposed or which are subject to excessive moisture or dampness. This includes exterior masonry walls. In dry, noncorrosive locations, type MN may be used. NMC is applicable in wet locations (NEC 336-3).

(b) See that nails will not be driven into cable. Protecting plates may be required (NEC 300-4).

(c) See that ground wire is properly fastened at terminating points and outlet boxes. Attach to each box of fitting by securely fastening the wire to the intended screw or with an approved grounding device (NEC 25C-114).

(d) See that cable is secured as required by the National Electrical Code, within 12” or every cabinet, outlet box of fitting and otherwise at intervals not exceeding 4 ½ feet (NEC 336-5). See also NEC 370-7(c) for support of cable entering non-metallic boxes.

(4) When authorized by the Project Specification, service entrance cable. Types SE, and USE should be installed in accord with NEC 338.

c. Busway Systems (NEC 364; Project Specifications.)

(1) Support busways at specified intervals (NEC 364-5; Project Specifications.

(2) Install sway braces when needed to limit lateral movement of busway (Project Specifications).

(3) Busway position, vertical or horizontal, will determine whether plugs are installed on the sides or on top and bottom. If plans do not indicate desired position, determination of appropriate location should be made.

(4) Install busway runs securely in straight alignment, parallel to floors and walls, with sufficient space either above and below, or on both sides, to permit installation, operation and servicing of bus plugs.

(5) Check to be sure that types of duct furnished are in accord with specification. Check conductor metal, enclosure type, duct type, wall flanges, and fire stops.

(6) Ground duct housing (NEC 250-33).

(7) Vertical riser sections up to 6 feet above the floor must be unventilated type (NEC 364-6).

(8) Check plug-in features and tap off devices against specification.

(9) Check on trolley busways, trolleys, brushes, contact rollers, and flexible cables for no binding and good contact.

(10) Component sections to be legibly marked with voltage and current ratings and manufacturer*s name (NEC 364-15).

(11) Installation and furnishing of busways usually require that the contractor verify field dimensions. Be sure that timely ordering of busway is not delayed.

(12) Provide for expansion as required by the manufacturer.

d. Continuous Rigid Cable Supports or Cable Trays

Cable trays are installed to support cables. Only certain specified cables may be installed and loading of support is limited. Cable trays should be installed in accordance with Project Specification and NEC 318. Tray system with cable installed must not downgrade fire barriers (NEC 318-5(g), 300-21).

e. Wireways

Wireways or inclosed troughs are installed to house and protect wire and cable. In general, wires of the building wire type, such as TW, may be installed in approved wireways. The installation should be made in accordance with Project Specification and NEC 362. particular attention should be paid to NEC 362-5, which limits the number of conductors approved for wireway installation.

f. Auxilliary Gutters

The gutters commonly used for interconnecting large panels and switches fall under this article. Installation should comply with NEC 374.

g. Underfloor Duct Systems (NEC 354, 356)

(1) Install underfloor raceways of steel construction parallel with floor construction, and in straight alignment.

(2) Check to see that sufficient setting depth is available for junction boxes. These are the deepest elements of underfloor raceway systems.

(3) Check for tight joints between underfloor raceway sections and at junction boxes to keep water out of raceway systems (NEC 354-13, 356-9).

(4) Inserts of both the preset and after-set type will be mechanically secured to the underfloor raceway and set level with the floor (NEC 354-14, 356-10).

(5) Splices and tapes in underfloor raceway systems will not be made in outlets at inserts, but only at junction boxes to keep water out of raceway systems (NEC 354-13, 356-9).

(6) provide markers at ends of underfloor raceway runs, but the plans and specifications may require more (NEC 354-9, 356-8)

(7) Install end caps at ends of all underfloor raceway systems (NEC 354-10).

(8) Check tap-off locations to cabinets, panel boards, and receptacles against drawings.

(9) Verify from shop drawings relative positions of services in compartments. To be uniform throughout system.

(10) Check cross-sectional dimensions for adequate size (NEC 354-5, 356-5; Project Specifications).

(11) Be sure that grounding continuity is maintained at all connections in the system (NEC 250-75).

h. Movable Partition

Movable partitions, and similar enclosures unless specifically listed as raceways, cannot be used as enclosures for general wiring conductors. Instead raceways (such as conduit) must he installed: or else cable (such as type MI) appropriate for the application must be installed. See NEC restrictions for kitchen vent hoods (NEC 410-9).

i. Conductors (NEC 310)

(l) Check type of insulation and jacket, conductor material, conductor size and stranding in each circuit (Project Specifications and NEC).

(2) Observe pulling of wires and cables to detect damage to sheaths, jackets and insulation. This damage is usually caused when runs are “paid out” in a debris-laden area and then stepped on, or by raceways having sharp edges or contamination. Pulling-eyes or cable-gripping devices will be required for large cables.

(3) Install all conductors of a circuit, including neutral, in same raceway in conformance with NEC limitations (NEC 300-20; 215-4).

(4) Connections and joints will be clean and tight, with listed pressure-type connectors, and made in junction and outlet boxes, not in raceways (NEC 110-14, 300-15).

(5) Connectors, lugs and clamps used to connect copper and aluminum conductors must be suitable for use with the conductor material to prevent galvanic corrosion (NEC 110-14). Aluminum conductors must be covered with antioxidant before connection.

(6) Use only white or natural grey identified conductors for the grounded circuit conductor. Neutral (white or grey) conductor of the wiring system will be insulated throughout (NEC 200-7). Conductors having white or grey identified coverings shall only be used as the grounded circuit conductor except as allowed in exceptions 1 thru 3 in NEC 200-7. Generally, use the same white color for the entire system grounded conductors.

(7) When a grounding conductor for equipment is run with circuit conductors it shall be bare, or green covered (NEC 250-57(b)). Project specifications may require insulated conductors.

(8) Enforce color coding of conductors of branch circuits when required by project specification.

(9) Branch-circuit conductors within 3″ of a ballast within the ballast compartment shall be recognized for use at temperatures not lower than 90 degree C (194 degree F) (NEC 410-31).

(10) Check that branch circuit wiring is not undersized. Specification may require increased wire size when runs from panel board to center of load equal or exceed 100 feet for 120 volt circuits or 230 feet for 277 volt circuit.

(11) See that correct fixture wiring installation is made (NEC 410-22 to 34).

16A-05 OUTLETS

Check for requirements of cast boxes in exposed work, exterior work, wet locations, and hazardous locations (Project Specifications)

b. Require hub-type cast boxes when specified (Project Specifications)

c. Check size of junction and pull boxes (NEC 370-6, 18, 20).

d. Do not permit overcrowding of boxes with excessive number of conductors (NEC 370-6).

e. Check identification requirements of power and control conductors at terminals and in pull boxes and junction boxes. Fenders should be tagged to indicate electrical characteristics, circuit number, and panel designation (Project Specifications).

f. Check for boxes to be securely and rigidly supported (NEC 370-13). (Project Specifications: Boxes and Supports.)

q. Fit concealed boxes into walls and ceilings. On noncombustible construction, the front edge of box should be within 1/4 inch of finished surface, and on combustible construction flush with finished surface or project therefrom (NEC 370-10)

h. Any masonry or dry wall work required for installation of outlet, pull, of junction boxes is to be done by skilled workmen. The masonry section of the specifications requires the cutting of block for fitting installed items. Electrician should not be permitted to chop away masonry or dry wall work. Coordination is necessary between the electrical trade and masons and carpenters to effect a suitable installation. (Project Specifications).

i. Check for air space between box and wall or supporting surface in wet locations where surface-type units are used (NEC 300-6).

j. Are outlets that are exposed to the weather a weather-proof type (NEC 370-5 and 300-6, Project Specification).

k. Pull and junction boxes shall have free access (NEC 370-19).

l. Floor outlets shall be of required type and properly located.

m. Light outlets in mechanical and equipment rooms are located to suit servicing and maintenance and extend below ducts.

16A-06 DEVICE PLATES

See that device plates are of specified material and finish and that all surfaces are in contact with wall (Project Specifications and NEC 410-56). On surface mounted boxes the plates should be compatible with the box and without overhanging corners. Also, NEC 380-0. Plates should be plumb and not dished or bowed.

16A-07 RECEPTACLES

a. Check all receptacles to be sure that specified voltage, ampere, color, slots, etc., are furnished. Also be sure that plug is furnished if specified (Project Specifications).

b. Be sure that grounding continuity is maintained between grounded metal box and receptacle and that bonding jumper is installed when required or approved bonding type receptacle. Some designs require ground wire from panel to receptacle (NEC 250—74).

16A-08 WALL SWITCHES

a. Check wall switches for proper ampere rating, voltage rating, and type. Usually "A-C only" is required. AC only switches are marked "AC" or "AC only" on yoke, never "AC/DC." They can be used for alternating current only (Project Specification and NEC 380-14).

b. Wall switches will be in hot leg of circuit, not in neutral, and should be installed with the "on" position "up" (NEC 380-6)

c. Check for requirements of installing pilot lights on switches (Project Specifications).

16A-09 SERVICE EQUIPMENT

a. Check to be sure that the proper type of enclosure is furnished (such as drip-proof, totally enclosed, etc.) (Project Specifications.)

b. Standard NEMA (KS-1) designations are used to describe various enclosures for switches. The designations are as follows:

Type 1 — Indoor — General Purpose

Type 2 — Outdoor — Dusttight, Raintight and Sleet (Ice) Resistant

Type 4 - Indoor/Outdoor - Watertight and Dusttight

Type 5 - Indoor Dustproof

Type 7 - Class I, Groups A, B, C and/or D — Indoor Hazardous Locations - Airbreak Equipment

Type 9 - Class II, Group(s) E, F and/or C - Indoor Hazardous Locations - Airbreak Equipment

Type 12 - Indoor - Industrial Use, Dusttight and Driptight with Knockouts "Weatherproof" is defined in the NEC as so constructed or protected that exposure to the weather will not interfere with successful operation (NEC 100) and raintight, rainproof or watertight equipment can fulfill the requirements for weatherproof.

c. Check whether fusible-type or circuit-breaker type of service switch is required (Project Specifications)

d. Check that the service-switch enclosure is bonded to the ground system (NEC 230-62, 63).

e. Check voltage rating and ampere rating of switch. Also circuit breaker trip and fuse sizes and interrupting capacities (Project Specifications and Plans)

f. Check ground fault protection of service equipment when required by NEC 230-95, or Design.

g. Check meter location when specified.

16A-10 LOAD CENTER TYPE PANEL BOARDS

Load center type panelboards are sometimes authorized for less critical applications compared to regular panelboards. Compliance with Project Specifications, Federal Specifications, and NEC 384-13 through 19 is required.

16A-11 PANELBOARDS

a. Be sure to inspect plug-in panel board devices to determine tightness of fit.

b. Check loads on panels to be sure of approximate balance among the phases. This is best done by use of clamp-on type ammeters on feeders while panel is carrying its normal load (operational test)

c. Be sure the panelboards typed directory is properly filled out so that area and devices served can be quickly identified (Project Specifications).

d. Circuit-breakers: switches, and fuses in panelboards should be inspected to determine that they have correct number of poles, proper voltage, current-rating, and proper interrupting capacity. Refer to contract drawings and project specifications.

e. Check panelboards for inclusion of blanked-off spaces for future circuit breaker installation. Space to be adequately sized for the rating of future circuit breaker. Also see that spare breakers required are in place in addition to blanked-off spaces.

f. Check mounting height of top switch or curcuit breaker. It should be less than six feet six inches.

16A-12 CABINETS (NEC 373; Project Specifications)

a. Check on size of gutter space. A minimum of 5 inches is required for panelboards with thru feeders. Load centers should be in accordance with NEC 373-6(a).

b. Telephone cabinets are to be checked for inclusion of backboard painted with insulation varnish.

c. Compare size of telephone cabinets against contract drawings.

d. Mounting is to be rigid and independent of the support by conduits. In damp locations, there should be 1/4 inch minimum air space at back of panel (NEC 373-2).

e. Connections to conduits are to be tight, assuring electrical continuity (NEC 250-71 through 79)

f. Look for special features of construction and installation for areas other than normal, such as hazardous, wet, exposed to fumes, etc. (NEC 110-li).

g. Examine for galvanized metal construction.

h. Check mounting height of panelboard cabinets. Distance from the highest position of top switch or circuit-breaker to floor should not exceed 6 feet, 6 inches (Project Specifications)

16A-13 FUSES (NEC 240-6 and 8)

Inspect for the following:

a. Specified voltage rating.

b. Specified amperage and interrupting rating.

c. Non-renewable cartridge types for over 30 AMP capacity (Project Specifications)

d. Are dual element time-delay fuses or current limiting fuses with special “reject” holders required? (Project Specifications)

16A-14 UNDERGROUND SERVICE CONDUITS (NEC 230-30 and 31)

a. Check detail requirements of plans and specifications (Project Specifications).

b. Check requirement for painting or coating of conduits (Project Specifications)

c. Check method and location of termination of conduit ends and grounding (NEC 230-55).

d. Seal building ends of raceways entering from UG distribution system (NEC 230-48).

16A-15 AERIAL SERVICE

a. Locate the splice between service drop and service entrance (NEC 100) conductor at a level lower than the service entrance fitting (head), and bend conductors to form a “drip loop” at the entrance fitting. These precautions will prevent entrance of water into the service equipment (NEC 230-24).

b. Support aerial service-drops on buildings, providing required clearances from ground, building openings, and from roof where service crosses roofs (NEC 230-24).

c. Service-drop cable type is to be in accordance with specification requirements (NEC 230-22 and 23; Project Specifications)

d. If connections are aluminum to copper, insure that the type of connectors specified (usually tinned bronze) are utilized and that anti-oxidant compound is properly applied, if specified.

16A-16 MOTORS

a. Check motors for conformance with NEMA classification standards. NEMA classification is according to mechanical protection and methods of cooling. Installation should be made in accordance with project specifications. Dripproof and/or splash-proof motors when specified shall be installed with ventilation openings faced down to exclude moisture, dirt, etc.

b. Check motors to see that proper terminal connections are made for the operating voltage. A connection table should be securely attached to the motor by the manufacturer if several alternate connections are possible.

c. Be sure motor revolves in direction correct for driven device, Usually an arrow is placed on fans and pumps to show correct directions of rotation. Motor rotation and speed must be verified before connection to the load e.g. pumps, fans, etc.

d. Check reversing types of motors and multi—speed motors to insure that direction of rotation and speed of motor corresponds to setting of control.

e. Make ground connections of motor enclosure through conduit system or by separate grounding conductor (NEC 430-141, 142)

f. Check motor against specifications and UL listings for class of insulation, starting torque characteristics, class, and design. Assure high efficiency motors are used where indicated.

g. Check motors for proper voltage. When 208V, three-phase is specified, do not permit substitution of 230V, three phase and vice versa. A 200 volt rating is the correct name plate rating for application on 208 volt system. Proposed substitutions should be referred to an electrical specialist.

h. Note conditions of windings; to be free from moisture and dust. See that appropriate provisions are made to protect equipment prior to turn-over of project.

i. Motors should be operated under connected load to determine following operating characteristics:

(1) Voltage and current to detect possible overloaded conditions

(2) Speed of motor

(3) Direction of rotation

(4) Overheating

(5) Vibration

(6) Abnormal sounds or odors

If connected load is not possible, refer to the Resident Engineer. This normally can be done in conjunction with test driven equipment.

j. Connect motors subject to vibration, and motors on adjustable slide basis, with flexible conduit. Liquid-tight or explosion-proof flexible conduit may be required by installation conditions. Bonding jumpers may be required (Project Specification; NEC 349, 350, 351, 501-4(a)).

k. Motors installed in hazardous locations are to bear an Underwriters Laboratory nameplate, indicating the classification of areas in. which the motor is listed for use.

1. Check lubrication requirements of motor prior to motor operation (Manufacturers Instructions).

16A-17 MOTOR CONTROL

a. Check with the contractor to assure that all motor controllers required by all sections of the specifications have been ordered. Quite often, controllers are not ordered due to disputes between subcontractors. The QAR should insure that the prime contractor has made necessary arrangements to insure timely procuring of motor controllers.

b. Check motor controllers for:

(1) Horsepower, voltage and current rating of least equal to the rating of the motor which it controls.

(2) Automatic control devices such as thermostats, float or pressure switches directly used as motor controllers, should be adequately rated.

(3) Magnetic-coil voltage rating same as the control-circuit voltage (may be different from the motor voltage)

(4) Selection of proper motor overload heaters; based on the nameplate full-load current of the motor, ambient temperature of controller location, temperature-rise limit of motor. Refer to instruction sheet pasted on inside cover of motor controller. Determine if automatic or manual reset is required for overload protection (NEC 430-34) (Project Specifications.)

(5) Requirements for furnishing reduced voltage starters. (Project Specifications.)

(6) Excessive humming or noise under operating conditions.

(7) Requirements for furnishing pilot circuit devices such as “Hand — Off - Automatic” selector switches, pilot lights (Project Specifications.

(8) Note three-phase motors are provided with the overload element in each ungrounded conductor (NEC Table 430-37).

(9) Be sure control enclosure is as specified in Project Specifications and is suitable for conditions of installation.

(10) Spare interlocks, if specified.

(11) Shipping blocking has been removed.

(12) Control and safety devices should be wired into the “hot leg”, not the neutral leg of the control circuit. If motor is connected to a grounded power supply, control power circuit should also have a grounded conductor. The control power should be disconnected from all power sources by its disconnect means (NEC 430—74).

16A-18 MOTOR DISCONNECT MEANS

a. Disconnecting means that open all ungrounded conductors will be provided for motor driven equipment installations. By locking provisions or by being “in sight” the disconnect(s) will provide protection for persons working on control, motor, and driven equipment (NEC 430-101 thru 113).

b. Ratings of switches are to be checked against contract specifications.

16A-19 LAMPS AND LIGHTING FIXTURES

Lighting fixtures should be examined for:

a. Chipped porcelain, cracked glass and plastics, bent louvers, over-all finish, detachable sockets on RLM dome fixtures (when specified) and “push type” sockets on open fluorescent fixtures (when specified). (OCE standard fixture drawings.)

b. Required lamp type, wattage, and color characteristics.

c. Ballasts for fluorescent and mercury-vapor lamps suitable for circuit voltage and of high power-factor type; overload protection for ballasts, if specified ballasts should be suitable for low temperature operation. Ballasts for fixtures to be recessed in fire rated or insulated ceiling construction may be required to be “low loss” type to bold ambient temperature down.

d. Plumb installation and horizontal and vertical alignment.

e. End-caps, canopies, louvers, side panel guards, globes in place and tight-glass side panels, if specified. Acrylic plastic lens when specified.

f. Aiming of floodlights and all other adjustable fixtures.

g. Lamps that are to be installed for the project shall be new, and installed just prior to completion (Project Specifications)

h. Storage battery powered emergency lighting sets should be checked against applicable Federal Specification for requirement of Underwriters listing and other features. They should be permanently installed strictly in accordance with project specifications and NEC Article 700.

i. Emergency lighting circuits should be installed in accordance with project specifications and NEC Article 700. Circuit wiring should be kept independent of all other wiring (NEC 700-17).

j. End-to-end mounted flourescent fixtures must have Underwriters approval for mounting end-to-end (NEC 410-31) when used as raceways.

k. Required characteristics specified.

l. Grounded properly.

16A-20 EQUIPMENT CONNECTIONS

a. Refer to applicable paragraphs of this chapter.

b. Check plans and specifications for any special features.

c. If Government-furnished equipment is involved, insure the timely availability of all connection drawings.

16A-21 TRANSFORMER STATIONS (NEC 450)

a. Dry Type Transformers

Check enclosure for indoor or outdoor service. Install so that air circulation will not be restricted around the transformers. Close-to-ceilings installations should be avoided.

b. Transformer Taps

Connect to produce specified voltage under normal load.

c. Liquid-filled Transformers

Check to see that they are filled to proper level. Level mark is indicated on transformer.

d. Nameplate Data

Check against specification requirements and approved shop drawings (NEC 450-11).

e. Accessories

Check liquid-filled transformers for compliance with specifications or with specified standards. Such include: Connections for sampling, draining and filtering of insulating liquid; level gage; thermometer; pressure and vacuum gages; external tap changer; provisions for jacking, rolling and lifting; provisions for pole, platform or slab mounting; provision grounding of case and windings; and alarm devices actuated by abnormal liquid level, temperature or pressure; and automatic control devices for operation of forced air or other oil cooling equipment which will permit operation of transformers at higher-than-normal ratings.

f. Bushings

Check to see that bushings are free of moisture, dust, chips and cracks.

g. Insulating Liquid

Check against requirements. Non-flammable fluid insulated power transformers are generally required indoors.

h. Grounding

Check grounding connections of metal housing, neutrals of primary and secondary winding to the grounding system (NEC 450-9 and 250-26).

i. Ventilation

See that ventilation is adequate (NEC 450-45)

16A-22 SWITCHGEAR (NEC 384)

Switchboard and Free-Standing Panel Installation - Check for:

a. Level floor location for gear and any roll—out equipment.

b. Anchor bolts and floor plates in proper location. Consult approved shop drawings and contract drawings.

c. Conduit entrances and wiring trenches in proper location.

d. Bus duct connection provisions suitable for duct attachment.

e. Ground bus connections brought to proper location. Consult approved shop drawings.

f. Plumb and level installation of gear.

g. Installation in accordance with manufacturer*s instructions.

h. Blocking removed from instrument and relays.

i. Adjustments made where required, taps and plugs at proper settings. Consult manufacturer*s installation instructions.

j. Fuses in place and of proper type -voltage, current, interrupting capacity -current limiting.

k. Indicating lamps with proper color caps in place.

l. Furnishing of spare fuses and lamps and any operating handles or cranks.

m. Manufacturer*s instruction books, wiring diagrams. etc., delivered to responsible individual accepting installation. Make a list and have it signed and filed.

n. Terminals marked in accordance with approved shop drawings and specifications.

o. All wiring connections made up tight.

p. If switchgear is to be installed in any hazardous locations, check the specifications and drawings for any required special constructions features.

q. Check for sufficient clearance between back of switchboard and wall. Minimum of 30 inches required if equipment or wiring is accessible only from back. Additional clearance may be required (NEC 110-16 and 34).

r. Check to be sore switchboard frame is grounded.

s. Check to be sure conduit stub—ups have coupling installed at floor level if required by Project Specifications.

t. Check to be sure that proper phase relationship and identification of connections including instrumentation has been accomplished.

u. Special requirements, such as seismic.

16A-23 ENGINE GENERATOR SETS

a. See Chapter 130 for installation of sets.

b. Inspect for overall compliance with the specifications as to type and rating of components -kva, kw, horsepower, rpm, voltage -and in particular as to the following:

(1) Engine will be suitable for operation on the fuel specified.

(2) Voltage ratings of starter, battery, and battery charger will be the same. Voltage regulator may need to be reset if nickel cadmium batteries are furnished.

(3) Check spare parts provided with unit to see that the supply is complete and that they fit the unit furnished.

(4) Installation should be in accord with NFPA 30, 31, and 37, as required by Project Specifications. Check for proper calibration of gagestick.

(5) That ventilation is adequate.

(6) See that operation and maintenance manuals are posted in engine room.

(7) Check operation of transfer switches.

(8) Check governor operation.

(9) Check cranking cycle for reset.

(10) Check to determine that emergency shut—down prevents recycling.

(11) Required field tests have been satisfactorily completed.

(12) Check automatic transfer switch, lab test reports, operation and settings.

16A-24 ELEVATOR INSTALLATIONS (NEC 620)

a. See Chapter 14A for installation features.

b. Check voltage rating of hoisting machinery.

c. Provide safety interlocks as specified and check operation.

d. Record all performance of specified tests.

16A-25 MISCELLANEOUS SYSTEMS (NEC 720, 725, 760, 770, 800, 810)

Include several types of audible and visual paging systems, nurses call, central dictation, intercommunication systems of loudspeaker and telephone type, fire alarm systems, clock systems and supervisory systems, and often these which combine more than one function in a single system. Products of different manufacturers of like systems may differ greatly. Manufacturer*s installation instructions will be rigidly adhered to. The following will apply to all systems generally:

a. Master sets and main or central station equipment and switchboards of miscellaneous systems will be so placed as to be easily accessible for operation and maintenance in locations having adequate ventilation.

b. Generally, component parts of miscellaneous systems will be products of one manufacturer.

c. Wiring between system components may be of special character. Inspect for requirement for use of optical fiber cable, shielded cables, twisted pairs, and isolation of any system from another.

d. Check installation of miscellaneous systems equipment to see that the proper type and sizes of fuses have been used, that leads are connected to proper terminals and that the equipment is designed to operate on the available supply voltage.

16A-26 TESTS

a. All Testing

(1) When testing of any electrical equipment or system is required, advise the electrical inspector or engineer and obtain his assistance. The following paragraphs cover a wide range of testing and it will be your responsibility to obtain assistance when such testing is beyond your capabilities or knowledge.

(2) Unless otherwise specified, testing should be performed by the contractor when the inspector is present. All arrangements for test should be made by the contractor. For tests of major equipment and high voltage cables, the contractor should also notify the manufacturers so they may witness the tests.

(3) The Using Agency should be notified when any unusual testing is to he performed so that they may be present to witness the test. Using Agency cooperation should be obtained well in advance for any tests which may affect their facilities or operations.

b. Precautions

Precautions should be taken to insure that test voltages are applied only to equipment or circuits under test, and that all instrument and control circuits are disconnected during the test. Verify that all electrical equipment can be LOCK-OUT/TAG-OUT.

c. Electrical Tests

Electrical tests should not be conducted under ambient conditions unsuitable for testing, such as excessively high humidity conditions.

d. Records of Tests

Records of tests should be complete, including ambient temperatures and weather conditions, circuit designation and extent or wiring systems tested, name and serial number of the machine tested, and signatures of those witnessing the tests.

e. Description of Tests

(1) De-energized operational testing will determine that moving parts do not bind, rotating parts work freely and are not obstructed by foreign materials, that they are lubricated as required, and that such limits or stops as may be necessary to restrict the motion of moving parts are in place and functioning.

(2) Operational testing will show that the equipment performs all functions for which it is designed in accordance with the design and manufacturer*s specifications.

(3) Continuity testing will determine that circuits are continuous through out the circuit.

(4) High potential testing will determine that the insulation has sufficient dielectric strength to withstand the surges to which it might be subjected and to insure freedom from pinholes and any other possible damage.

(5) Megger tests will determine that the wiring system and equipment is free from short circuits and grounds and will measure the insulation resistances of the circuit and/or equipment under test.

f. Megger Tests

Megger tests of insulation resistance should be made when specified and approved if satisfactory.

g. Method of Testing

(1) High-potential field tests should be made in strict compliance with the applicable standards listed in the specifications and with the recommendations of the manufacturer of the equipment.

(a) Tests should not be repeated unless the necessity for repetition has been determined by an electrical engineer or specified.

(b) Make only after all safety precautions relative to grounding of the test equipment have been checked.

(2) Insulation resistance and high-potential tests of wiring systems should be made when required between one conductor and ground with all other conductors and sheath or conduit connected to the same ground. Tests should be made on each conductor in this manner. Windings of rotating equipment and transformers should be connected together and tested to ground.

(3) Rotating equipment operational tests should include an inspection for alignment with driven machine, proper lubrication, freedom from excessive vibration in operation, proper direction of rotation, voltage and current drain check against motor nameplate ratings, check of R.P.M. and excessive heating.

(4) Rotating equipment operational tests should include an inspection for alignment with driven machine, proper lubrication, freedom from excessive vibration in operation, proper direction of rotation, voltage and current drain check against motor nameplate ratings, check of R.P.M. and excessive heating.

(5) Switch and manual motor starter operational tests should include an examination for proper operation, alignment of contacts and contact pressure.

(6) Motor-starter operational tests should include manually operating the armature or plunger and contact-bar to determine that movement is free, contacts are in alignment, contact pressure is adequate and that auxiliary contacts function properly. The starter should be energized from all control points and the operation of all control-circuit interlocks should be checked.

(7) Reduced voltages starters should be checked for correct sequence and timing of application of incremental and full voltages.

(8) Variable and adjustable speed motor controls should be checked to see that operating speeds corresponds to the position of the speed control device.

(9) Circuit-breaker operational tests for large air circuit-breakers operating and test positions under manual operation and through control circuits from each control point. Checking of breaker mechanisms for alignment; freedom of motion and adequate pressure of contacts; tripping, devices; inspection

to insure that breaker cannot be moved from operating position while closed. Indicating lights, targets, annunciators and alarms should be observed for operation in connection with associated circuit- breakers, control switches and other operating devices to insure that the signal indication corresponds to the switch position of the indicating device.

(10) Protective relays should be checked to see that time and current settings have been made as specified.

(11) Operational tests of relays should include: Checking of operation at specified current or voltage and time values. Checking of peak current of instantaneous elements; checking of differential elements for operation only under condition of proper direction of power flow.

(12) Rod electrodes should be tested for resistance to ground. If resistance is greater than the specified resistance, or maximum of 25 ohms, additional rods or longer rods should be installed. Consult specifications (Project Specifications: NEC 250-83).

(13) Miscellaneous systems, for intercommunication, paging, clock-control fire alarms, etc., shall be given operational tests at all operating points to demonstrate that they will perform all specified functions. In particular, it shall be demonstrated that sounding devices are audible under normal ambient sound-level conditions in areas for which coverage is specified, that false signals cannot be transmitted over fire alarm systems specified to be of the non-interfering type, that reserve—power attachments for clock system will operate for the specified length of time, and that all special features and accessories specified for each system have been incorporated therein.

(14) Engine-generator tests include, but may not be limited to, the following:

(a) If diesel engine driven, reference is usually made to MIL-STD7058. This publication details electrical test requirement. Be sure all factory or shop tests have been completed as specified.

(b) Demonstrate starting of all units from all manual control points and from automatic control as specified.

(c) Demonstrate voltage and frequency regulation are held within specified limits under all load conditions.

(d) Establish load requirements for testing of units. Either connected load or created load such as obtained with salt water rheostat or other satisfactory method. Determine who will furnish load banks, if required.

(e) Engine-generator tests should incorporate full load tests. Specifications will at times required 110% load testing for a limited time.

(f) Satisfactory operation of transfer switch installation in accordance with specifications requirements should be demonstrated.

(g) Operational check of all safety controls should be made. This will include operation of safety stop switches, operation of high water temp, low oil pressure, over—speed, and any other safety circuit required by the specifications.

(h) Demonstrate full load continuous operation without overheating of the engine.

(i) Be sure all field tests specified are performed and recorded.

(15) Transformers should be checked for shipping damage, leakage, proper voltage and tap settings, grounding, and for signs of water in the oil.

(16) Service equipment should be tested for ground fault protection as specified and NEC 230-95.

(17) Operational test should be made on all switches, dimmers, lighting, battery units and miscellaneous equipment.

CHAPTER 16B

EXTERIOR ELECTRICAL

INDEX

CHAPTER 16B

EXTERIOR ELECTRICAL

16B-01 GENERAL

This chapter covers exterior electrical distribution systems, aerial and underground, and transformer stations.

Make an inspection of materials prior to installation for conformance with specifications, plans, and approved shop drawings. ENG Form 4288, Submittal Register, which lists approved materials, is essential to this inspection. Components for distribution systems will be inspected before they are installed and energized. Initial inspection and follow-up inspections will follow work as required by ER 1180-1-6.

16B-02 AERIAL DISTRIBUTION

a. Wood Poles

Note: If concrete or steel poles are provided be sure that the poles meet the strength and other criteria provided in the specifications.

(1) Check strength (class), length, conditions, and treatment of poles against design requirements. (A current edition of ANSI Standard 05.1, "Specifications and Dimensions for Wood Poles," should be available to the inspector). Be sure that certification of compliance with applicable AWPA preservation specification has been submitted.

(2) Be sure that contractor*s provisions for storage and handling of poles are in accordance with specification requirements.

(3) Usually, specifications require poles to be full treated rather than butt treated. The preservation specification should be checked for verification.

(4) Poles should be turned, chamfered, trimmed, roofed, gained, and bored prior to pressure treatment. When field boring or gaining is necessary, additional preservation should be applied to bared surfaces.

(5) Examine type of handling tools.

(6) Be sure that gains have been made for all cross- arms.

(7) A site check of the pole line route and pole locations should be made to be sure that pole lengths furnished will be suitable to carry all intended circuits (including communications) and still maintain required vertical and horizontal clearances from the ground and other obstructions. (A current edition of ANSI-C2, National Electrical Safety Code, should be available to the inspector.)

(8) Be sure that the depths of pole holes are equal to minimum specification requirements, and that the width of each hole is adequate for backfilling and tamping in 6—inch lifts when required by the specifications. Surplus earth should be piled around the pole and tightly tamped to assist in drainage away from the pole and to compensate for shrinkage of the backfill.

(9) If design requires numbering of poles, see that this is done correctly.

(10) See that the grading of pole tops is even.

(11) When it is necessary to shorten a pole, see that the cut is made at the top and that it is treated with hot preservative.

b. Crossarms

(1) Check material meets specification requirements.

(2) Verify wooden crossarms use proper preservation treatment.

(3) Examine fastening.

(a) Inspect installation, bolting, setting angle, number, type and length of crossarm and secureness obtained.

(b) Check vertical spacing of multiple crossarms.

(c) Check pin hole spacing.

c. Hardware

(1) Be sure that all ferrous hardware (braces, bolts, lamps, pins, nuts, washers, screws, etc.) is standard pole line galvanized hardware.

(2) Be sure that all hardware is of the specified strength size and length.

(3) Be sure crossarm pins are of the specified strength and height.

(4) Bolts should not protrude more than approximately 2-inches or less than 1/8-inch beyond the nut.

d. Insulators

(1) Check furnished insulators against specification requirements.

(2) Inspect for damage.

(3) Check types and spacing of pins.

(4) Determine location of guy insulators.

e. Conductors (Aerial)

(1) Compare furnished supports with plans and specifications:

(a) Stranded or solid.

(b) Copper, aluminum, or combinations of copper and steel of aluminum and steel sized according to the specifications.

(c) Bare, weatherproof covered, or insulated conductors. Insure that insulation meets the project specifications.

(d) If messengers are used to support cables check to see that the are sized, attached and grounded properly.

(2) Check during installation:

(a) Tree trimming.

(b) Line Sag and Tension are within the specified requirements of the contract or NESC.

(c) Handling Watch for methods which will produce twists, kinks, abrasions, or cuts.

(d) Method of dead ending.

(e) Connectors and treatment of conductors at connectors or splices.

(f) Armor rod and/or armor tapes on aluminum conductors at supports.

(g) Tie wires and methods of securing conductors to insulators.

(h) Installations requiring racks and utilization of same.

(i) Horizontal and vertical clearance between conductors (ANSI C2).

(j) Installation and location of drip loops.

(k) Connectors on service drops - If dissimilar metals are connected be sure that approved connector is used.

(l) Dead ending with approved clamps with strength not less than that of the conductor.

(m) Area requiring special protection.

(n) Requirements for neutrals.

f. Giving

(1) Compare the type of guy with its intended use.

(2) Check type and size of anchors against ground conditions.

(3) Check materials to be used especially in areas where anchor rod corrosion may be a problem.

(a) Check for protective thimbles and thimble eye bolts.

(b) Examine three-bolt clamps at guy terminals.

(4) Check during installation:

(a) Anchor distance from poles (Anchor and guy strength is based on 1 to 1 slope. If the distance between pole and anchor rods has to be decreased, strengths must be increased)

(b) Location of guy insulator if required.

(c) Point of attachment on pole.

(d) Installation of rock anchors.

(e) Location of expansion anchors and log anchor rods.

(f) Need for additional guys.

(g) Installation of guy protectors.

(h) Gaining of poles for push braces.

(i) Identification of primary phases stamped on all transition poles and at all substations entering and leaving.

(j) Length of anchor rods.

(k) Grounding and bonding of guys when specified.

(l) Guy markers are in place.

g. Transformers

(1) Check method of mounting:

(a) Determine capacity of transformer or banks of transformers.

(b) See if method of mounting is similar to adjacent connected system, and notify supervisor of deviation.

(2) Check materials:

(a) Conformance with applicable ANSI and IEEE Standards.

(b) Primary and secondary voltage rating, kva capacity, and taps.

(c) Applicable ANSI and IEEE Standards for accessories of different capacity transformers, such as thermometers, liquid level indicators, liquid sampling devices, external tap changers.

(d) Transformer hangers for rigid mounting on the crossarms.

(e) Transformer bushings for rigid mounting with no evidence of cracks of chips.

(f) Transformer tanks for pin hole leaks.

(g) Impulse test certification if required by specification.

(3) Check during installation:

(a) Correct tap setting.

(b) Even distribution of weight of transformer banks.

(c) Mounting, crossmans, braces, wiring on pole mounting of H frame mountings.

(d) Primary and secondary connections.

(e) Grounding of transformer tanks.

(f) Rating of protective fuses.

(g) Accessibility of fused cutouts on pole.

(h) Type of electrical connections.

(i) Fused cutouts and lightning arrestors installed on the primary side of each transformer supplied from an exterior distribution system.

h. Primary and Secondary Fuse Cutouts

(l) See that approved type is used. Is it indicating or dropout; enclosed or open?

(2) Check current and voltage rating and short circuit interrupting capacity against design requirements.

(3) Be sure fuse links are of the capacity and delay specified and that they do not exceed the capacity of connected conductors. (Capacity tables for conductors may be found in NFPA Handbook 70, National Electrical Code).

(4) Check connection points of line conductors and load conductors.

(5) Examine type of bracket. Be sure bracket is secure, clear of adjoining structure, and convenient for operation.

i. Lightning Arrestors

Check:

(1) Location.

(2) Voltage rating and type against specification requirement.

(3) Mounting bracket.

(4) Grounding connectors.

(5) Ground resistance prior to energizing the line.

(6) Arrestors are not used as insulators to support conductors.

j. Pole Top Switches

(1) Compare switches with approval, making sure that correct current and voltage rated ones are used.

(2) Assure that contact surfaces will operate under ice conditions.

(3) Watch arcing horns for contact during operation.

(4) See that operating rods are provided with an insulator in the rod if specified.

(5) Make sure operating handle is equipped with lock and keys. If interlocking keying is specified, be sure it is furnished. Check out interlocking.

(6) Examine location of operating handle for convenience and safety.

k. Grounding

(1) Check type of ground conductors against design.

(2) Inspect exothermic welded ground connections for size rod, connector and powder charge against manufacturer*s recommendations.

(3) verify that ground rods are properly spaced relative to the pole.

(4) Examine mechanical grounding connectors.

(5) Check connectors to aluminum conductors. Connectors must be approved for aluminum.

(6) See that grounding conductors are protected from mechanical injury.

(7) Determine and record ground resistance; also determine need for additional ground rods.

(8) Record driven depth of ground rods.

(9) Insure that all noncurrent carrying metal parts on pole are grounded when specified.

(10) Check for separate grounding conductors and rods for lightning arrestor and equipment when required by specifications.

l. Street Lighting

(1) Examine all street lighting components.

(a) Check lighting bracket.

(b) When inspecting fixtures watch for:

- Light diffusing pattern.
- Open or enclosed type.
- Gaskets to protect the globe.
- Film cutouts on series systems.
- Free access for maintenance.
- Insulating transformers.

(c) Inspect regulator for kw rating, input voltage, and output current.

(d) Verify protector and control equipment voltage rating.

(2) Check during installation:

(a) Height of fixture.

(b) Lightning arrestors and fused cutouts installed on each phase of the supply to the protector.

(c) All ferrous surfaces hot dip galvanized.

(d) Each fixture will be secured with required number of through bolts of correct size.

(e) All metallic poles or standards.

m. Underground Risers

(1) Examine conduit clamps for size and number.

(2) Check duct seal at the conduit terminations.

(3) Look for listed insulated bushings at the conduit termination.

(4) Check cable terminations.

(5) Inspect during installation:

(a) Lag screws used on the conduit clamps.

(b) Cable supports to eliminate weight on the cable terminations.

(c) Metallic conduit below grade has approved protective finish as required.

(d) Stress cones on shielded cable.

(e) Safe climbing space.

16B-03 UNDERGROUND DISTRIBUTION

a. Duct System

(1) Check:

(a) Materials

(b) Method of encasement

(c) Painting

(d) Duct supports and spacers for size to maintain duct spacing.

(2) Check during installation:

(a) End bells and bushings at duct terminations.

(b) Ground bushings at all conduit terminations.

(c) Strength of concrete and presence of reinforcing steel where required under roads, paved areas, etc.

(d) Compacted subgrade.

(e) Spacers and spacing between ducts and minimum concrete cover all sides of ductbank.

(f) Spacing between electric and signal ducts.

(g) Alignment and grade of conduits, especially during encasement with concrete.

(h) Staggering of conduit joints.

(i) Adapters for joining dissimilar types of duct (see that they are not field fabricated)

(j) Changes in direction made with factory fabricated devices.

(k) Ducts secured in the forms.

(l) Ducts pitched to drain.

(m) Duct plugs used during construction and on all spare ducts.

(n) Cleaning of ducts.

(o) Seal duct entrances into manholes.

(p) Cover over ducts.

(q) Pull wires in place.

(r) Minimum curve radius of duct line in accordance with specification.

(s) Installation of marker if required by specifications.

b. Manholes, Handholes. and Underground Vaults

(1) Verify size according to specifications.

(2) Check that duct entrances are located to avoid sharp cable bends or sufficient space is allotted to permit a reverse cable bend.

(3) Determine strength of concrete.

(4) Check quantity and size of reinforcing steel.

(5) Check strength of cover and frame, marking of cover, and machine finished joint between frame and cover.

(6) Be sure that approved cable racks, pulling irons, steps, ground rod, etc., are provided in the specified quantity.

(7) Check during installation:

(a) Sequence of concrete placement (Construction joints are undesirable between the base and walls.)

(b) Seal around duct entrances and plug unused ducts.

(c) Pull irons are located opposite duct entrances.

(d) Waterproofing.

(e) Sump or drain.

(f) Quantity and location of cable racks, hooks, and insulators.

(g) Ground rod and ground cable.

(h) Grounding of cable racks and lead cable sheaths.

c. Primary Cables

(1) Inspect splicing kits and methods.

(2) Check qualification of cable splicer.

(3) Check cables for insulation, shielding, stranding, jacket or sheath and voltage rating.

(4) Examine potheads and pothead compounds.

(5) Check during installation that proper cable limits, pulling techniques and equipment are used to prevent cable damage.

(a) Type of pulling compounds: Verify that the compound is compatible with the cable and does not affect the flame retardation of the cable.

(b) Setup of reels (Do not kink).

(c) Cables sealed for pulling.

(d) Abrasion to sheaths on manhole frames.

(e) Even tension used in cable pulling.

(f) Cable routing in manhole.

(g) Splicing or terminating of cable.

(h) Conductor identification tags.

(i) Stress cones at splices and terminations.

(j) Ground shielding at splices and potheads.

(k) Abrasion or damage to cable by dragging on ground.

(l) Fireproofing cables in manhole when specified.

(m) Required tests.

d. Direct Burial Cable

(1) Verify cable burial depth.

(2) Check protective covering or armor. Check manufacturer*s designation for use. Compare material with approval data.

(3) Check during installation:

(a) Type of bedding and covering (should be smooth and free of stones and sharp objects)

(b) Use of untreated plank over cable when specified.

(c) Method of laying.

(d) Weaving of cable in trench.

(a) Radius of bends.

(f) Splices (minimization).

(g) Use of approved splicing kits.

(h) Installation of concrete cable markers with letter and arrow or tape markers as specified..

(i) Concrete encased conduits with bushings under traffic crossings.

(3) Spacing between cables.

(k) Compaction over cables.

a. Potheads

(1) Check size of the conductors or cables.

(2) Check stuffing box or wiping sleeve.

(3) Verify that compound is approved and installed as required.

(4) Make sure that installer is a qualified splicer.

(5) Check stress cones.

(6) Test compound for correct pouring temperature.

f. Transformers in Fenced Enclosures

(1) See that ferrous materials are protected with galvanized finish or are painted per specifications.

(2) Insure transformers, potheads, fused cutouts and lightning arrestors conform with the electrical characteristics specified and/or approved.

(3) Check installation of primary and secondary cabling for stress cones, waterproof connections, and insulators.

(4) Check during installation:

(a) Swing of gates.

(b) Drainage of transformer pad.

(c) Elevation of transformer off pad.

(d) Grounding of all noncurrent carrying metal within the enclosure.

(e) Grounding of the fence and gate.

(f) Proper grounding of primary (e.g. surge arresters) and secondary (e.g. neutral) equipment.

(g) Space available in transformer enclosure

(h) Bonding of all metal conduits terminating in the transformer enclosure to the ground system.

(i) Proper warning signs affixed to enclosure fence.

(j) Welds on fence structure are protected in accordance with specifications.

g. Pad Mounted Tranformers without Fenced Enclosures

(1) See 16B-02g, and 16B-03f.

(2) See that tamper proof enclosure has not exposed bolts, nuts, or fittings, the removal of which would give access to live internal parts and that meters, valves and other accessories are within locked enclosure or otherwise resistant to tampering, and that ventilation openings are so protected that a wire cannot be inserted to contact a live part.

(3) Verify that accessories, such as lightning arrestors, switches, gauges, etc., are furnished as specified.

h. Testing General discussion with the contractor on LOCK-OUT/TAG-OUTprocedure before any testing.

16B-04 CATHODIC PROTECTION

a. General

(1) Cathodic protection is provided to preserve underground or underwater metallic structures including submerged interior surface of water storage tanks from corrosion. Corrosion takes place at points where electrical current leaves the metal and travels through the ground or electrolyte to another metal or to a different place on the same pipe or structure. Corrosion is arrested when an electromotive force is impressed on an underground or underwater metallic structure in such a way as to make the entire structure cathodic with respect to the adjacent soil or water.

(2) Cathodic protection can be provided as described above or in the following manner: Sacrificial galvanic anodes are used having a difference of potential with respect to the structure to be protected. The anodes are made of a material, such as magnesium or zinc, which is anodic with respect to the protected structure. The galvanic — anode system is designed to deliver relatively small current from a large number of anodes.

(3) In addition to the following, complete the CP Acceptance Criteria during the Quality Assurance inspection.

b. Shop drawings

(1) The following items, if required in the work, must be approved prior to installation:

Anodes	Electrical boxes
Conductors	Splicing materials
Rectifiers	Anode Hanger for tanks
Conduit	Transformer

(2) Check material brought to the job site against approved shop drawings.

c. Anodes

(1) Be sure the anodes are not broken while being installed (Some anodes, such as duriron, are very brittle)

(2) Do not vary the spacing of the anodes more than 5% either way.

(3) The location of the anode bed should not be changed without consulting your supervisor.

(4) Be sure the anodes are installed in accordance with design and specifications.

d. Conductors

The insulation on the conductors must not be damaged during construction on impressed current systems. If it is damaged, the conductor may be soon be destroyed by electrolytic action.

e. Conductor Connections

Assure that joints are mechanically secure and that they are water tight.

f. Insulating Joints

Determine if insulating joints in pipe structures are required. Install in accordance with construction drawings. The insulating joints are used to accomplish the following: Isolate dissimilar metals; sectionalize pipe lines with dissimilar coatings; sectionalize one cathodic protection systems from another.

g. Bonding

(1) See that pipe joints are bonded (if called for in the contract) before the pipe line is backfilled.

(2) Be sure that bonds to other piping systems or structures are installed. If they are the resistor type, see that they are adjusted.

h. Test Points

Test points must be located exactly as shown on contract drawings.

i. Foreign Pipes and Structures

(1) Foreign pipes and structures may require cathodic protection.

(2) If you should discover, in the vicinity of the cathodic protection system, underground metal pipes or tanks that were unknown to the designer, bring them to your supervisor*s attention.

j. Backfill for Underground Metallic Structure

(1) Backfill of pipes and tanks must not contain rock or materials which would damage the coating on the structure or pipe.

(2) Check to see that only specified type of backfill is used. Cinder backfill should never he used.

k. Auxiliary Equipment

Check the installation of the rectifiers, transformers, conduit, and other electrical equipment using applicable parts of Chapter 16.

l. Electrical Measurements

(1) Impressed current system — Inform your supervision when the installation is complete.

(2) Sacrificial type anode system (using metallic anodes without external power supply) - Inform your supervisor when system is complete, prior to bonding the anodes to the structure.

m. Starting and Adjusting

Do not start the system to make adjustments. Request your supervisor or the CQC representative to obtain the services of one qualified in cathodic protection systems to perform these functions.

n. Record of Testing

Obtain a copy of the readings taken by the cathodic protection expert, including the potential measurements of the pipe before and after protection is applied, rectifier current and voltage readings for each set of potential measurements after the system is connected. These readings should be kept in the job records and turned over to the using agency when the work has been completed.

16B-05 ENERGY MONITORING AND CONTROL SYSTEMS (EMCS)

When inspecting Energy Monitoring and Control Systems use Huntsville Division*s publication, CEHND-SP-91-005-DE-ME, April 1991 or as updated, Quality Verification Guidelines for EMCS. In order to provide the best product for the customers, the District*s Construction Division EMCS Technical Coordinator must be actively involved during the construction phase. Any questions which the Area/Resident Engineer cannot answer, should go to the technical Coordinator. The District can then call a Special Evaluation Group meeting to resolve any unusual or

precedent setting questions. All Value Engineering proposals presented during any phase of the project must be reviewed by the Mandatory Center of Expertise (MCX) for EMCS at Huntsville Division.

16B-08 RF SHIELDED FACILITY

Direct all questions which arise during the construction phase of a C41 (RF Shielded) facility to the Protective Design Mandatory Center of Expertise (PD-MCX)

CHAPTER 16C

ELECTRICAL HEATING

INDEX

CHAPTER 16C

ELECTRICAL HEATING

16C-01 GENERAL

a. Definition

This chapter covers materials, equipment, and good workmanship practices for the installation of electrical heating system.

b. Approvals

Insure that all material, equipment, and shop drawings are approved prior to the Preparatory Inspection meeting and prior to installation of the electrical heating equipment. Obtain any helpful manufacturers installation information.

c. Storage and Handling

(1) Insure that all materials and equipment are handled carefully to prevent damage.

(2) Reject damaged material and equipment. Have it removed from the site.

(3) Check storage facility for adequate weather protection, possible damage, and safety hazard.

(4) When outside storage is necessary, store materials and equipment above ground.

d. Coordination of Work

Continually check for interferences between electrical, mechanical, architectural, and structural features.

e. Layout of Work

(1) The contractor must provide equipment and mechanical room layout drawings, which include location of hot water heater, for review and approval.

(2) Check location of water heater for accessability for mechanical and electrical, maintenance, and future replacement if necessary.

(3) The contractor must coordinate installation of electric heaters with work of other trades, to avoid obstruction to heating pattern and overheatings of adjacent surfaces. Coordinate changes in heater layout with supervisor.

16C-02 ELECTRIC WATER HEATERS (Project Specifications, Plumbing)

a. Check for the required number of heating elements (Federal Specification).

b. Check to determine that each heating element is controlled by a separate thermostat (Federal Specification).

c. Check for manual-reset type high-limit cutout. High-limit cutout to open all electrical connects to all heating elements (Federal Specification).

d. Voltage rating of heaters to be in accordance with specification requirements. 240 volt units, if operated on 208V, will only deliver approximately 75% of design heating capacity.

16C-03 ELECTRIC HEATERS

a. Check voltage rating of equipment furnished.

b. Check wattage rating of heater (Project Specification or Design)

c. Check to see whether a high-limit switch is required (Project Specification)

d. Check physical requirements of heater. Embedded elements are usually specified.

e. Heaters for hazardous areas are to bear a tag indicating Underwriters Laboratories approval.

f. A functional test is required on electric heaters.

g. Check thermostats for range of operation, differential, locking facilities, thermometer, and lock-shield requirements (Project Specifications).

16C-04 COORDINATION WITH MECHANICAL WORK FOR ELECTRIC WATER HEATERS

a. Pressure — Temperature Relief Valve

Check to see that relief valve is stamped for the specified pressure and temperature. Check to see that relief valve is correctly positioned and piped to safely discharge. Check to see if relief valve will reset after being manually activated. Relief valves may be separate or combination pressure and relief on equipment used for heating water or storing hot water.

b. Piping and Insulation

See Section 15A for piping and Section 15C for Insulation.

CHAPTER 16D

ALARM AND DETECTION SYSTEM

INDEX

CHAPTER 16D

ALARM AND DETECTION SYSTEMS

16D-01 GENERAL

a. Definition

This chapter covers materials, equipment, and good workmanship practices for the installation of fire alarm and detector system. The inspector must closely coordinate this chapter with Chapter 15A, 16A and 16B. It is important that the inspector have a thorough knowledge of the NEC and applicable NFPA codes, contract specifications, and the fire protection plan for the whole building. Any missing or non consistent application of the various fire protection parts should be called to the attention of your supervisor. See specification and 1984 NEC, Article 760, Fire Protective Signaling System. Paragraph 760-1 lists NFPA codes applicable to the several protective systems.

b. Approvals

Insure that all materials, equipment, and shop drawings are approved prior to preparatory inspection and installation. Obtain helpful manufacturer's installation information.

c. Storage and Handling

(1) Insure that all materials and equipment are new and handled carefully to prevent damage. Reject damaged materials or equipment and have it removed from the site.

(2) Check storage facility for adequate weather protection, possible damage, and safety hazard.

d. Layout of Work

(1) Check equipment requirements and locations on contract drawings and specifications.

(2) Check approved shop drawings for complete wiring and schematic diagram for equipment furnished, equipment layout, and other details required to demonstrate that the system has been coordinated and will function as a unit.

(3) Check contract specification for requirements for contractor to furnish spare parts and spare parts data, operating instruction manual, maintenance instructions manual, and performance test reports. Note requirement in specifications which items are to be turned over and which items are to be posted permanently in the building.

a. Coordination of Work

(1) Continually check for interferences between electrical, mechanical, architectural, and structural features. Insure that paint is not accidently applied to sensors, nameplates on equipment, or on posted operating instructions.

(2) Electrical work is to be installed under the guidance of Section, 16A Interior Electrical. Other coordination

requirements are with Section 15H; Fire Protection Systems; and 15A, Piping Systems. Mechanical installation will normally be in accordance with NFPA 13 unless otherwise specified in the contract specification.

16D-02 FIRE DETECTING DEVICES

Fire detecting device will be located as shown or otherwise indicated. Unless otherwise shown the devices will be surface mounted. Smoke detectors will not be located in direct supply air flow nor closer than 3 feet from an air supply diffuser.

a. Smoke Detectors, Ionization Types

Check for dual chamber design. Check for sensitive adjustment. Check for correct operating voltage and type of current (AC or DC). Check for indicator lamp. Check duct-mounted detector to see if the air sampling tube length is equal to width of duct. Smoke detectors located in the underfloor spaces will only be mounted in upper portion of the space with the detector facing downwards, or mounted sideways.

b. Smoke Detectors, Photo-eletric Type

Check for factor calibration and not field adjustment. Check for light source lamp or LEO of specified voltage.

c. Heat Detectors

1. Check heat detector requirements for fixed temperature or combination fixed temperature and rate-of-rise ratings. Check for replaceable fixable elements. Check for specified locations of detectors.

2. Heat detectors located in spaces where the ambient temperature can be over 100 degrees F will be rated higher than ordinary temperature; e.g. Detectors located in attic spaces should have an intermediate temperature rating.

16D-03 FIRE ALARM STATIONS

Check for type of station specified. Check for coded or non-coded requirement. Check for test key requirement. Check locks for being keyed alike with fire alarm control panel. Check mounting requirements.

16D-04 SIGNALING DEVICES

Check for locations as indicated on contract documents. Bells are normally mounted on removable adapter plates over electrical outlet boxes. Exterior bells: check for weather proof type bells with metal housing and protection grills. Visual fire alarm indicators are mounted same as bells. Trouble Indicators are normally mounted in flush mounted panels.

16D-05 CONTROL UNITS

Check control unit for complying with approved shop drawings. Check for proper operating voltage. Check to see that upon failure of power supply, that system shall operate from back-up power supply. Check panel for metal construction, with factory applied red enamel finish, accessable from the front, and surface mounted unless otherwise indicated. Check for proper labeling of control panels such as descriptive labeling of zones.

a. Smoke Detector Panel

Check for proper voltage power supply. Check for back up power system. Panel fabrication; paint color, and mounting same as control units.

b. Annunciator Panel

Check annunciation panel for complying with approved unit. Check for tamper proof.

16D-06 POWER SUPPLY

Check specifications for power feed, overload protection, conductor hook-up equipment. Check specifications for back up power requirements, i.e. primary, batteries, and charges.

16D-07 TESTING

Check specifications for 30 day contractor*s notification to contracting office before conducting performance end acceptance tests. Test to be conducted in presence of CO or his authorized representative. Check specification for description of tests to be conducted. Check to see that all quality control records, teat reports, and records of corrective actions are furnished to the Government.

CHAPTER 16E

ALUMINUM CONDUCTORS

INDEX

CHAPTER 16E

ALUMINUM CONDUCTORS

16E-01 GENERAL

The information included is important because of recurring and serious problems in public and private construction where aluminum conductors are used in the wiring system. We permit a limited use of aluminum conductors. Special skills and tools are required when making connections and terminations with aluminum conductors.

16E-02 MATERIAL

a. Conductors

(1) The electrical systems shown on drawings indicate copper wire size given in gauge number, American Wire Gauge (AWG).

(2) Aluminum is permitted only for copper wire sizes No. 6 AWG and larger.

(3) Aluminum wire size substitutions for copper wire must have ampacity of not less than the copper wire size shown. The tables in Article 310 of the National Electric Code (NEC) show the allowable ampacities of insulated copper and insulated aluminum conductors. The correct size aluminum wire can be determined by using the ampacity value for copper wire in a given size in the aluminum conductor table. The equivalent temperature rating of the conductor must match-up with the conductor being installed.

b. Bolts, Nuts and Washers

(1) Check these materials for proper alloy and finish. An anodized finish may be required.

(2) Plain, standard series flat washers are required; Narrow series washers cannot be used.

(3) Antioxidant Joint Compound

Use approved oxide-inhibiting joint compound when making-up aluminum conductor/pressure fitting connections and at bus bar connections.

(4) Connectors

(a) Pressure connectors must be tinned aluminum bodies.

(b) Must be rated for use with aluminum conductors.

(c) Must be required size, material, and tightened to specified torque.

16E-23 INSTALLATION

a. Conductor Size

(1) Aluminum wire used must be number 4, AWG or larger.

(2) Check for the equivalent aluminum gauge size as the size shown on the drawings is for copper.

b. Removing Insulation

(1) Check removal or stripping method; wire should not be damaged. Recommended methods are:

Whittling - Using a knife as in sharpening a pencil.

Peeling - Using a knife from the end of the conductor to peel back, and cut off the insulation, cutting away from the wire.

Stripping - Using the proper size stripping tool. A tool that will nick or ring the wire shall not be used. (Ringing is to cut the wire over its circumference)

(2) Wire conductors which are nicked or ringed should have damaged portion removed and the conductor properly prepared.

(3) A nick or ring reduces conductor ampacity and introduces a weak point.

c. Surface Preparation

(1) Check for clean surface.

(2) Wire may require wire brushing to assure aluminum oxide is removed.

(3) Cleaning may require a coating of antioxident joint compound and a second wire brushing.

(4) Check for the required costing of antioxident joint compound on wire immediately before the connection is made.

(5) On aluminum bus bars check for silver plating at connection point surfaces.

(6) Also check for a light coating of antioxidant joint compound at bus bar connections.

d. Connections

(1) Are bolted connections tightened with an approved calibrated torque wrench?

(2) Check that compression connectors are applied with the proper tool and force.

(3) Are screw connections properly torqued?

(4) Are terminal lugs and connectors made from approved materials? Must be of aluminum and tin and so labeled. Also cap be nickel plated copper.

(5) Are compression terminals and connectors tightened with the special tool?

(6) Screws of bolt type terminals and connectors must be tightened with an approved, calibrated torque wrench.

(7) Check torque wrenches for calibration by an approved testing firm. These wrenches are designed to slip when the present torque is exceeded.

e. Connection to Vibrating or Cycling (Intermittent Duty) Equipment

Aluminum conductors are not recommended for this equipment. Use standard or solid copper conductors as specified.

(1) Check for use of aluminum conductors to vibrating equipment. Extreme movement and vibration induces stresses in aluminum wire. Aluminum wire has poor workability.

(2) Check for use of aluminum conductors in cycling equipment. The aluminum conductor receives high current and stress each time equipment is energized. This causes connections to loosen from creep.

16E-04 ENVIRONMENTAL CONDITIONS

Conditions which can effect Aluminum Conductors

(a) Salt water, air pollution and high relative humidity conditions or corrosive soil will accelerate corrosion of unprotected aluminum wire.

(b) Extreme changes in the ambient temperature will adversely affect workability and the extent of creep and oxidation.

(c) When any of these conditions are present check for use of aluminum conductors. When used, check for a protection tape wrap for the exposed bare aluminum wire. Apply oxide— inhibiting joint compound to the surface of exposed connectors and terminals.

16E-05 INSPECTION AND ANALYSIS

a. Wrong wire size? Aluminum wire gauge must be No. 4 AWC or larger. See Article 310, NEC, for aluminum equivalent size for copper size shown.

b. Is the conductor ringed or nicked? Disapprove and require a new section of undamaged conductor be prepared using proper methods.

c. Terminal material must be bi-metalic when copper and aluminum are used on the same terminal or bus. Check for stamped letters “AL-CU” for an approved bi-metalic terminal. Check for both proper size and type of terminals and connectors.

d. Is aluminum bus, silver plated at the connection point surfaces? If not, disapprove, as it must be factory plated.

e. Is aluminum wire cleaned and coated with oxide-inhibiting joint compound immediately before making connections?

f. Is an approved, calibrated torque wrench used to tighten bolted and screwed connections? Check calibration date for being recent.

g. Check for proper crimping tool use in compression connections.

h. Is connection loose or otherwise poorly made? After electrical system is activated check for:

(1) Voltage drop across the connection (there is no voltage drop across a good connection)

(2) Discoloration of the aluminum wire and/or insulation at the connection : gray-white color coating on the wire indicates aluminum oxide corrosion. A brown-black color on the insulation, or if the insulation is brittle, indicates a failure.

i. A “Hot Spot Check” with an infra-red scan will indicate thermal build-up at points of failure.