Attachment B

FAA-GL-918C

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
GREAT LAKES REGION
CHICAGO, ILLINOIS

FAA-GL-918C
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SPECIFICATION FOR CONSTRUCTION OF TERMINAL NAVIGATIONAL AID FACILITIES

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DIVISION 1 - GENERAL REQUIREMENTS
SECTION 1A
SPECIAL CONDITIONS

1A.1 SCOPE.

a. This specification covers general requirements for construction of an Instrument Landing System (ILS) and Visual Guidance Lighting Systems. The complete ILS consists of several component facilities. The term Visual Guidance Lighting Systems covers lighting facilities. Refer to the solicitation package for types of facilities to be constructed. This specification includes requirements common to all facilities and requirements specific to individual facility types. In general, all parts of this specification covering construction required on project drawings and in other contract documents, are applicable to this contract.

b. The contractor shall furnish all plant, labor, materials (except Goverment Furnished Property), equipment, energy, transportation, and other services necessary to construct all elements of the systems required in the specifications, drawings, and other contract documents. Construction shall include all miscellaneous and incidental work necessary for a complete and operational system, whether or not such work is specifically shown or specified.

1A.2 GOVERMENT FURNISHED PROPERTY. Government Furnished Property (GFP) is also known as Government Furnished Material (GFM). Goverment Furnished Property for this contract is shown on the Goverment Furnished Property List. The Goverment Furnished Property List is the sole contract document which validly identifies Goverment Furnished Property under this contract. The contract drawings give little or no indication of which items are Government Furnished Material. To determine whether an item of equipment or other material is Government Furnished, see the Goverment Furnished Property List. For Goverment Furnished Property, the contractor shall provide for and pay for loading of this property at the storage location (location indicated on the Goverment Furnished Property List) and transportation to, and unloading at, the job site.

1A.3 CONTRACTOR FURNISHED MATERIAL. The contractor shall furnish all material under this contract per Paragraph 1A.1b, except the Goverment Furnished Property identified on the Goverment Furnished Property List. The instruction install on the drawings means furnish and install unless the item(s) to which the instruction applies is Goverment Furnished Property included in the Goverment Furnished Property List. The contractor shall be aware that certain materials to be furnished by the contractor, may be long-lead-time items. Therefore, the successful bidder should determine the availability of all material immediately after contract award, and initiate procurement action on long-lead-time items at the earliest possible date. To facilitate the use of this specification in procuring material and equipment, see the Material and Equipment Specification Index at the end of this section. Where the specifications mention material or equipment by brand, it is regarded as a known acceptable source, as it meets specifications.

1A.4 SUBMITTALS AND BRAND NAME USAGE.

a. Introduction. Each product required for use in the contract drawings and specifications must meet the actual minimum needs of the Government as demonstrated in the salient (prominent, important) characteristics for that product. If a brand name product is used in the drawings or specifications, it should be regarded as a "known acceptable source" (i.e., a product that meets the actual minimum needs, and demonstrates the appropriate salient characteristics). The product used can be identical or equal to the brand name product or known acceptable source in meeting the salient characteristics, but it need not exceed the actual minimum requirements. Any brand name product or known acceptable source mentioned will, however, not be required for use in order to comply with the specification or drawing unless those documents make it clear that the brand name product is required, and substitution is prohibited. The following submittal procedure shall be followed in order to:

(1) Insure adherence to functional and quality standards in substitute contractor furnished material.

(2) Inform the FAA of the contractor's plans to use certain material and equipment, e.g., splicing materials and tools, even if they are a known acceptable source.

b. Definition. A submittal is a collection of information required by specifications, or by the Contracting Officer, presenting detailed information on:

(1) Material or equipment items the contractor proposes to use.

(2) Methods or plans of action which the contractor intends to employ in specific situations.

c. Requirements. Submittal requirements are formally defined in a paragraph of the contract Special Specifications. Submittal guidance of varying extent is presented in this specification (FAA-GL-918C), as indicated in the Material and Equipment Specification Index at the end of this section. Each product that a contractor wishes to use that is not a known acceptable source, must be approved before use, by the Contracting Officer or the Contracting Officer's designee. To gain approval, the contractor must submit documents and/or samples that will demonstrate that that product clearly will meet the Government's minimum needs, and demonstrates appropriate salient characteristics. All submittals must be in writing. The Contracting Officer shall have the right to require submittals from the contractor where the contractor makes an unsolicited change proposal. The information presented in a submittal shall be sufficient to demonstrate that all specification requirements for the subject material, equipment, methods, or plans, are met by the contractor's proposal. The informational materials may include documents such as shop drawings, sketches, calculations, data sheets, written plans of action, manufacturers' catalog cuts, brochures, and/or specification sheets. If the specifications or Contracting Officer requires actual samples of material or

equipment, the contractor shall provide them. For any documentary submittal, the contractor shall submit four identical sets of documents.

d. Submittal Review. When submitting before the Notice to Proceed date, the contractor shall send the submittal package(s) directly to the Contracting Officer. When submitting after contract work has begun, the contractor shall give submittal packages to the Resident Engineer, who will forward them promptly to the Contracting Officer. The Contracting Officer may personally evaluate the submittal, or request FAA engineers to evaluate it. In either case, the submittal will return directly from the Contracting Officer to the contractor, with the Contracting Officer's approval, approval with comments, or disapproval.

e. Submittal Time Frame. To provide adequate time for document transmission and submittal review, the FAA reserves the right to take two weeks to complete a review, transmission date to transmission date. Terminal navigational aid contracts are brief contracts. The review process can therefore span a substantial portion of the contract period. For this reason:

(1) The contractor is urged to initiate submittals as soon as feasible after contract award, and to expedite document transmission.

(2) The Contracting Officer and other reviewers (if any) will expedite reviews and document transmission insofar as feasible.

Maximum use of fast document transmission modes (e.g., fax, couriers, and overnight freight forwarders) is encouraged.

f. Procurement Before Approval. The contractor is advised not to procure any item for which submittal approval is required but not yet granted. If approval is denied, the contractor will be prevented from installing the disapproved item(s). The contractor must transmit a new submittal package for the new items replacing the disapproved items, and must procure only approved items. The contractor shall take responsibility for the delivery and installation of any items installed before submittal approval is granted. The FAA reserves the right to discontinue field work on any item furnished without submittal approval. Procuring and/or installing material which is later disapproved could result in substantial losses of money and time for the contractor.

1A.5 PRE-CONSTRUCTION CONFERENCE. The contractor shall attend a pre-construction conference when required by the contracting officer or airport management. The contractor shall abide by all agreements reached at the conference regarding safety practices, ingress and egress routes to the site, maintenance of airport security (locking gates, etc.), deference to air traffic, and other operational procedures.

1A.6 COORDINATION. All coordination between the contractor and the airport management and local FAA personnel, shall be accomplished through the Resident Engineer.

1A.7 PROJECT DRAWINGS.

a. Conflict Between Site Drawings and Standard Drawings. If any conflict should exist between site drawings (location-specific drawings) and standard drawings (drawings not referring to a particular location), the site drawings shall govern.

b. Drawings Referenced But Not Provided. Unless otherwise specified, drawings which are referenced on contract drawings, but which are not listed in the list of specifications and drawings, do not apply to the contract.

1A.8 TEMPORARY ELECTRICAL POWER. Unless otherwise specified, the contractor shall make all arrangements and pay all costs for temporary electrical power needed for construction of the facility.

1A.9 COMPLIANCE WITH LOCAL AND OTHER CODES. The contractor shall comply with standards (e.g., National Electrical Code) adopted by the contract documents, and with local and other codes. Where the requirements of the specifications and drawings exceed those of the adopted and local codes, the contractor shall comply with the requirements of the specifications and drawings.

1A.10 SANITARY FACILITIES. Sanitary facilities are not available at the work sites. The contractor shall provide temporary toilet facilities as required for his employees. The locations of the toilet facilities shall be where directed by the Resident Engineer.

MATERIAL AND EQUIPMENT SPECIFICATION INDEX

Material or Equipment Specified	Relevant Paragraph(s)	Does the paragraph include: Product(s) listed?	Submittal guidance?
air conditioner	16A.17e	N	N
anti-seize compound	13A.2d(1)	Y	N
	13C.2b	Y	N
cable			
600V power cable, DEB	Section 16B	N	N
600V armored power cable, DEB	Section 16C	N	Y
5,000V power cable, DEB	Section 16D	N	Y
clamp	13A.2d(2)	Y	N
control cable	Section 16E	N	Y
connector protection	16A.24	Y	N
end caps	16A.8	Y	N
splicing connectors			
power	13A.6c	Y	Y
power and control	16F.6	Y	Y
splicing kits			
MALS power	13A.6b	Y	Y
power and control	16F.6	Y	Y
circuit breakers	16A.14b&e	Y	N
conduit	16A.1	N	N
	16A.3	N	N
door hardware for shelters	13E.4	Y	N
electrical coating	16A.25	Y	N

MATERIAL AND EQUIPMENT SPECIFICATION INDEX (CONTINUED)

Material or Equipment Specified	Relevant Paragraph(s)	Does the paragraph include: Product(s) listed?	Submittal guidance?
electrical enclosures and wireways	16A.15	N	N
electrical tape	16A.21	Y	N
environmental equipment for shelters	16A.17	Y	N
exothermic welding kits	16A.4f	Y	Y
expansion couplings	16A.27	Y	N
fiber forms for concrete piers	3B.7b	Y	N
fire and arc proofing	16A.23	Y	N
framing, commercial metal	16A.26	Y	N
frangible couplings	16A.20	Y	N
fuses for switches	16A.13f	Y	N
geotextile	2B.3a	Y	Y
grounding electrode material	16A.4c	N	N
crimped connectors for	16A.4g	Y	Y
grounding conductor	16A.4d	N	N
heater	16A.17c	Y	N
heater timer unit (components)	16A.17d	Y	N
landscape fabric	2B.3b	Y	Y
lamp, MALS 120-watt	13A.5	Y	Y
lighting equipment for shelters	16A.17f	Y	N
	16A.17g	Y	N
lightning protection equipment	16A.18	Y	N

MATERIAL AND EQUIPMENT SPECIFICATION INDEX (CONTINUED)

Material or Equipment Specified	Relevant Paragraph(s)	Does the paragraph include: Product(s) listed?	Submittal guidance?
paint	9A	N	N
	13E.7	Y	N
panelboard	16A.14	Y	N
pre-stretched rubber tubing	16A.22	Y	N
safety disconnect switches	16A.13	Y	N
screw anchor foundations	Section 13D	Y	Y
shelter steel siding	13E.8	Y	N
splicing connectors and kits	see under cable		
surge arrester	13F.7	Y	N
	16A.16	Y	Y
switches, safety	16A.13	Y	N
fuses for	16A.13	Y	N
tape	see electrical tape		
terminal strips for control cable	16A.19	Y	N
vent fan	16A.17a	Y	N
thermostat for	16A.17b	Y	N

DIVISION 1 - GENERAL REQUIREMENTS
SECTION 1B
SAFETY ON AIRPORTS

1B.1 DEFINITIONS.

a. Classified Area. A classified area is a graded and compacted safety area consisting of all land within 200 feet of runway centerline, for the full length of the runway and to 1,000 feet outbound of each end of the runway, or within 125 feet of taxiway centerline, or within 75 feet of edges of ramps.

b. Unclassified Area. An unclassified area is an area not located within a classified area.

1B.2 GENERAL PRECAUTIONS. The contractor shall abide by all requirements as specified herein, in the contract clauses, on the construction safety plan, and as established by airport authorities in the pre-construction conference. The contractor shall be responsible for thoroughly explaining all safety and security precautions required on the airport to all workmen, both under his direct employment and under his subcontractors.

1B.3 CONSTRUCTION WITHIN CLASSIFIED AREAS.

a. Restrictions.

(1) Construction within or access through classified areas will not be permitted whenever runways or taxiways defining the classified areas are being used for aircraft operations.

(2) If runways and taxiways within classified areas are required to remain open, construction within the classified areas will be interrupted as necessary to permit normal aircraft operations.

(3) The portions of VASI, REIL, and PAPI construction in classified areas, involving the use of hand tools only, will generally not require runway or taxiway closure, unless otherwise specified or directed. Such work may include the assembly, installation, wiring and adjust-ments of equipment units, but will preclude the use or parking of construction equipment, or vehicles, in the applicable classified area.

b. Time Frame. All construction within classified areas shall be completed within the shortest possible time. Construction shall be performed continuously during normal working hours, excepting as otherwise specified, until all work within the classified areas is completed.

1B.4 CONSTRUCTION WITHIN UNCLASSIFIED AREAS. Construction will be permitted within unclassified areas while aircraft are using adjacent runways and taxiways, excepting as specified elsewhere or established during the pre-construction conference.

1B.5 MAINTENANCE OF AIRCRAFT OPERATING SURFACES. Soil, debris, or loose materials dropped or tracked onto airport roads, runways, taxiways, and ramps shall be immediately swept up and removed. Likewise, all loose material at the job site or dropped enroute to the job site which can be blown onto the above aircraft surfaces, shall be immediately placed in closed containers to prevent damage to aircraft.

1B.6 EQUIPMENT PARKING. All equipment not in use at the close of each day shall be parked as directed by the Resident Engineer or removed to a pre-designated area.

1B.7 RADIO COMMUNICATIONS. At airports served by airport traffic control towers or airport owner/operator radio communications facilities, (if so directed by the airport management), the contractor shall furnish and operate two-way radio communications with these facilities when personnel, vehicles, and equipment are required to enter the aircraft operations area, to obtain proper clearance for construction hazards to aircraft, and at all other times established during the pre-construction conference.

1B.8 TEMPORARY AIRCRAFT PAVEMENT TEMPORARY MARKING AND LIGHTING.

a. Installation. If runway and/or taxiway closure or runway threshold relocation or displacement is required, the contractor shall install temporary marking or temporary marking and lighting, as shown on the construction safety plan drawing(s), if any. All temporary marking shall be constructed of plywood, durable fabric, or other approved material, placed and secured so as to pose no threat of damage to aircraft, and which can be easily removed after construction completion.

b. Maintenance. It will be the contractor's responsibility to maintain the temporary marking and lighting in a condition acceptable to the Resident Engineer. If marking or lighting is damaged or becomes inoperative, the contractor shall immediately repair the affected items.

c. Removal. Upon acceptable completion of the work that necessitated runway threshold displacement or runway and/or taxiway closure, the contractor shall remove all temporary marking and lighting, and shall return the runway and taxiway and lighting configuration to the original condition.

DIVISION 2 - SITE WORK
SECTION 2A
EARTHWORK AND SITE IMPROVEMENTS

2A.1 DESCRIPTION OF WORK. The extent of earthwork is indicated on the drawings and by the provisions of this section. Requirements for access road and site surfacing and paving are covered in Sections 2B and 2C.

2A.2 QUALITY ASSURANCE.

a. Codes and Standards. Perform all earthwork in compliance with applicable requirements of governing authorities having jurisdiction.

b. Testing and Inspection.

(1) Soil materials and degree of compaction shall conform to ASTM specifications referenced herein. Professional soil testing methods associated with this specification will generally not be required, but the FAA reserves the right to engage a state licensed soil testing service to resolve disputes regarding adequacy of all earthwork performed.

(2) Visual inspection and qualitative testing shall be performed by the contractor in the presence of, and wherever directed by, the Resident Engineer.

2A.3 SAFETY REQUIREMENTS.

a. Refer to Division 1 for construction within classified and unclassified areas.

b. To protect life, property, and work, all earthwork operations shall be performed in compliance with local and OSHA (Occupational Safety and Health Administration) requirements. The contractor shall provide all sheeting, shoring, and other bracing as necessary.

c. All trenches in classified areas, excavated in one day, shall be backfilled during the same day. An effort shall be made to backfill other excavations in classified areas, during the same day.

2A.4 JOB CONDITIONS.

a. Existing Utilities.

(1) Locate all underground cables, utility lines, and other underground construction before beginning excavation work. Any damage to such lines or construction belonging to the FAA, utility companies, or others, shall be promptly repaired, at contractor's expense, to the complete satisfaction of the owner.

(2) Project drawings generally indicate locations of cables maintained by the Federal Aviation Administration only. The FAA will field establish approximate locations of its own cables.

b. Weather Conditions.

(1) Excavating and backfilling for foundations, trenches, and jacking or boring pits, shall not proceed when excessively wet or freezing weather conditions could adversely affect the load-bearing characteristics of the soil, or prevent proper compaction.

(2) When freezing weather is expected, excavations shall not be made to full depth unless concrete or conduits can be placed immediately. If an excavation is already at full depth, the excavation shall be protected from frost.

c. Drainage.

(1) All excavations shall be continually drained by natural means or pumping to prevent any decrease in soil bearing capacity or damage to poured foundations or to trenches.

(2) Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

(3) Establish and maintain temporary drainage ditches and other diversions outside excavations limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

2A.5 MATERIALS.

a. Structure and Foundation Materials. In-place undisturbed inorganic soils will be adequate to support all project structures, unless otherwise indicated. Highly organic soils (topsoil, peat, and swamp location soils) shall be removed entirely from areas to be occupied by structures.

b. Backfill and Fill. Material shall be inorganic soil excavated from site, or borrow comprised of inorganic soil approved by the Resident Engineer. All such soils

shall be free of rock, gravel, and cohesive lumps greater than two inches in any direction, and debris, waste, vegetation, frozen material, and other deleterious materials.

c. Base Course for Concrete Slabs. Material shall be a graded mixture of washed crushed stone or crushed or uncrushed gravel with 100% passing a 1 1/2 inch sieve, and not more than 5% passing a number 4 sieve.

2A.6 SITE PREPARATION.

a. Clearing and Grubbing. The contractor shall scalp areas where excavation or embankment will be made. Scalping shall include the removal of materials such as trees, brush, roots, sod, grass, residue of agriculture crops, sawdust, and decayed vegetable matter, from the surface of the ground. These materials shall be removed from the site and disposed of off airport property.

b. Topsoil Removal.

(1) Topsoil shall be considered soil containing visible vegetable matter and black loam that will not compact with the usual compacting methods.

(2) Unless otherwise specified, topsoil shall be removed from all areas to receive fill, granular surfacing, pavement, and structures, and from all areas where subsoil excavating is required, such as for roadway cuts and ditches. Dispose of excess topsoil on or off airport property, as directed by the Resident Engineer, at no additional cost to the Government.

2A.7 EXCAVATION.

a. Excavation Classification. Excavation is unclassified and includes excavation to subgrade elevation indicated, regardless of character of materials and obstructions encountered excepting as qualified herein.

b. Rock Excavation. If rock is encountered above the design footing elevations of any facility structure, such foundation shall bear entirely on clean solid rock or on soil, but not on both. If the soil-and-rock bearing condition is encountered, the Resident Engineer will determine which material shall support the structure. If rock surface is used, it shall be reasonably level or shall be stepped to make level segments.

c. Unauthorized Excavation. Removal of materials beyond design subgrade elevations or dimensions without specific direction from the Resident Engineer constitutes unauthorized excavation. Remedial work for such excess excavation shall be as directed by the Resident Engineer at the contractor's expense.

d. Additional Excavation. When any excavation has reached required subgrade elevation, notify the Resident Engineer, who will inspect soil conditions. If the

Resident Engineer determines that the soil possesses inadequate bearing capacity, carry such excavation deeper as directed by the Resident Engineer.

e. Excavation for Structures.

(1) Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services and other construction, and for inspection.

(2) In excavating for footings and foundations, take care not to disturb the bottom of the excavation. Excavate by hand to final grade just before concrete reinforce-ment is placed. Trim bottoms to required lines and grades to leave a solid base.

f. Excavation for Cable and Conduit Trenches.

(1) Excavate in compliance with lines and depths shown on drawings. Minimum trench depth shall be 24 inches and 30 inches, on and off airport lands, respectively, unless otherwise specified. Slope trenches to same elevations as conduits where cables will be routed to a building interior. Minimum trench width shall be that required to accept power-operated mechanical tampers.

(2) Grade bottom surfaces of trenches to provide uniform bearing and continuous support for cable and conduit.

(3) Material excavated in excess by error, or due to unsuitable bearing, shall be replaced with mechanically compacted inorganic soil.

(4) If solid rock is encountered, the Resident Engineer will decide if such rock need be removed or if an alternate trench route or lesser depth conduit installation will be acceptable.

(5) If a trench must cross a concrete or asphalt paved surface, all cuts shall be saw cuts, unless otherwise specified.

2A.8 COMPACTION.

a. General.

(1) All compaction shall be accomplished by using power-operated mechanical equipment except for limited use of manual tampers in constricted areas. Operate all power equipment as herein specified to achieve the minimum degree of compaction subject to acceptance by testing.

(2) Cohesive soils are defined herein as those containing less than 60 percent sand, gravel, or stone. Percentages greater than 60 percent are herein termed non-cohesive soils.

b. Cohesive Soil Compaction.

(1) Use sheepsfoot roller of such minimum weight that at least 200 psi will be transmitted to surface area of studs or feet. Operate at speeds not exceeding 4 mph on each layer of fill until roller walks itself to top of grade.

(2) Use motor-operated soil tamper (stomper) in confined areas, including trenches, on each layer of fill until no further visible consolidation is evident.

(3) Use a heavy blunt tamping rod on each layer of fill in the most constricted locations where power equipment cannot be used.

c. Non-Cohesive Soil Compaction.

(1) Use pneumatic tire roller fully loaded and weighing not less than 275 pounds per inch of tire tread width. Operate at speeds not exceeding 4 mph. A minimum of ten passes of the roller is required on each layer of fill.

(2) Use motor-operated vibratory tamper in confined areas, including trenches, on each layer of fill until no further visible consolidation is evident.

(3) Use heavy blunt tamping rods on each fill layer in constricted locations where power equipment cannot be used.

d. Moisture Control.

(1) Where soil material must be moisture-conditioned before compaction, uniformly apply water to a layer of soil material in such quantity that free water will not appear on the surface during or subsequent to compaction operations.

(2) Scarify and air-dry soil material that is too wet to permit compaction to specified density.

e. Percentage of Maximum Density Requirements.

(1) General Requirements. The required densities for cohesive and non-cohesive soils are determined by quantitative testing procedures defined by ASTM Standards D 1557 and D 4253/4254, respectively. To assure compliance, the contractor may arrange for such professional soil testing services, at no additional cost to the Government. The FAA, at its expense, may also make such arrangements if qualitative testing procedures appear inadequate.

(2) Structures, Slabs, and Access Roads/Parking Areas. Compact top surfaces of subgrade and each layer of backfill or fill material to 90% of maximum density for cohesive soils, or to 95% relative density for non-cohesive material.

(3) Turf and Non-Vehicular Surfaced Areas. Compact top surfaces of subgrade and each layer of backfill or fill material to 90 percent of maximum density for cohesive soils, or to 90 percent relative density for non-cohesive material.

f. Qualitative Testing and Inspection Procedures.

(1) General. The contractor shall perform qualitative soil compaction testing and inspection procedures for each type of backfill or fill material used wherever directed by, and in the presence of, the Resident Engineer. Special attention shall be given to the backfilling of structures and trenches.

(2) Qualitative Testing.

(a) Qualitative soil testing will consist of comparing the resistance to penetration of undisturbed soil to that of compacted backfill of the same composition. For borrow material the penetration comparison shall be made between maximum test sample density and in-place fill density.

(b) A soil penetration device (penetrometer) indicating depth and force exerted shall be utilized. Compaction will be adequate if backfill or fill possesses at least 95% of the resistance to penetration of undisturbed soil or test sample, respectively.

(c) Borrow test sample shall be a four inch deep (compacted measurement) layer of soil, aerated or moistened as directed by the Resident engineer, and compacted by power equipment until no further consolidation occurs, as approved by the Resident Engineer.

(3) Concrete Slab Base Course. Compact with vibratory tamper until no further visible consolidation is evident.

2A.9 BACKFILL AND FILL.

a. Structure Foundations. Backfill or fill as promptly as work permits, but not until completion of the following:

(1) Acceptance of construction below grade.

(2) Recording locations of underground conduit.

(3) Removal of concrete formwork, bracing, trash, and debris.

b. Ground Surface Preparation. Remove vegetation, debris, topsoil, and unsatisfactory subsoil from ground surface, and compact the subgrade, prior to placement of fill layers.

c. Placement and Compaction.

(1) Place acceptable backfill and fill materials in layers not more than eight inches in loose depth for material to be compacted by heavy equipment, and not more than four inches in loose depth for material to be compacted by hand-operated tampers.

(2) Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Do not place backfill or fill on water, ice, snow, frozen soil, or excessively wet soil.

d. Cable Trench Backfill.

(1) Before laying cables, inspect the bottom of the cable trench. If it is not smooth, or if any rock or stone that would be retained on a 1/4-inch sieve is present, place a two-inch layer of bedding material, according to Paragraph (2) below, in the trench. Do not compact this layer. Lay cables on top of this layer.

(2) The first layer of backfill material over cables shall be three inches deep, loose measurement, and shall be sand or other homogeneous inorganic soil containing no mineral aggregate particles that would be retained on a 1/4-inch sieve. This layer shall not be mechanically compacted.

(3) The second layer, in turf and crushed rock surface areas, shall be four inches deep, loose measurement, and shall contain no mineral aggregate particles that would be retained on a one-inch sieve. Subsequent layers shall be clean soil containing no rock particles larger than two inches in their largest dimension.

(4) Except for surfacing material, all layers of trench backfill, for areas to be paved or surfaced with crushed rock, shall be sand, placed and compacted as required for access roads.

(a) If a trench crosses an area surfaced with crushed rock, the top 12 inches of trench backfill shall be crushed rock, placed and compacted as required for access roads. The finished grade elevation of the crushed rock backfill shall equal the grade elevation of existing adjacent crushed rock.

(b) If a trench crosses an area surfaced with concrete or asphalt pavement, the pavement shall be replaced with materials of the same composition, thickness, and degree of compaction as the adjacent pavement structure, except that the crushed rock base shall be a minimum of 12 inches deep. Replacement concrete shall have a 28-day compressive strength of 3,000 psi. Finished grade of the pavement patch shall be flush with the adjacent pavement surfaces.

e. Backfill and Fill Surface Elevations. Finished grade, shown on the drawings, is the top surface of turf and crushed rock or crushed stone surfaced areas. Therefore, make allowances for six inches of topsoil and depths as detailed or specified for surfaced areas when establishing top surface of fill or backfill.

2A.10 GRADING.

a. General. Uniformly grade areas within limits of grading, including adjacent transition area. Smooth the finished surfaces within specified tolerances, and compact with uniform slopes between points where elevations are indicated, or between such points and existing grades.

b. Grading Outside Building Lines. Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish areas to receive topsoil and surfacing within 0.10 feet above or below required subgrade elevations.

c. Grading Surface of Fill Under Building Slabs. Grade smooth and level and to proper elevation to within a tolerance of 1/2 inch when tested with a 10-foot straightedge.

2A.11 MAINTENANCE.

a. Protection of Graded Areas. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

b. Reconditioning. Where compacted areas are disturbed by construction operations, adverse weather, or where any settlement has occurred, scarify surface, add acceptable fill, reshape, grade, and compact as necessary.

2A.12 DISPOSAL OF EXCESS AND WASTE MATERIALS. Remove and dispose of all excess soil and waste material from the project site and adjacent lands. All costs associated with disposal shall be at contractor's expense.

DIVISION 2 - SITEWORK
SECTION 2B
CRUSHED AGGREGATE ROAD AND SITE SURFACING

2B.1 DESCRIPTION OF WORK. The extent of work is indicated on the drawings and by the provisions of this section.

2B.2 STATE SPECIFICATIONS. State highway construction specifications, latest edition, form a part of this specification and are applicable for all work unless otherwise specified. This referenced specification will be hereinafter referred to as "State Specifications." Disregard all references in the State Specifications to layout of work by others, and to measurements and payments. All layout work will be accomplished by the contractor, and payment for all work under this section will be a part of the lump-sum contract.

2B.3 MATERIALS.

a. Geotextile.

(1) Application. The most common application of geotextiles in FAA navaids construction is as a separator. In this application, the geotextile is placed over prepared roadway subgrade soil, and crushed aggregate is placed and compacted on top of the geotextile. The geotextile permits water to permeate into the subgrade, while preventing the aggregate from mixing with the subgrade soil. The geotextile specified below is for application as a separator.

(2) Separator Geotextile Selection Criteria. The geotextile fibers, and the threads used in joining the geotextile by sewing, shall consist of long chain polymeric fibers composed of polypropylene, polyester, polyolefins, or polyamide. Both the geotextile and threads shall be resistant to chemical attack, mildew, and rot. The geotextile shall conform to the physical property requirements listed in the following table. All values shall represent certifiable minimum values in the weakest principle direction of the fabric.

Property	Test Method	Requirement
Thickness	ASTM D-1777	75 mils, min
Grab tensile strength	ASTM D-4632	160 lbs, min
Grab elongation	ASTM D-4632	60%, min
Puncture resistance	ASTM D-4833	80 lbs, min
Mullen burst strength	ASTM D-3786	275 psi, min
Water flow rate	ASTM D-4491	130 gpm/ft^2, min
Permittivity	ASTM D-4491	1.74 sec^{-1}, min
Permeability	ASTM D-4491	33 cm/sec, min
Apparent opening size	ASTM D-4751	U.S. Sieve #70, max

Trevira Spunbond 1120 fabric manufactured by Hoechst Celanese Corporation is one of the products which meets these specifications. For any substitution, provide the Contracting Officer with complete product literature, including values of the properties tabulated above, and a sample of fabric. Do not procure any substitute before receiving the Contracting Officer's approval. (See Paragraph 1A.4 above.)

(3) Geotextile Fabric Width. Fabric width shall be at least 12.5 feet for the normal 13-foot-wide access road. Fabric in other vehicular areas shall be cut to fit, and overlapped per Paragraph 2B.4c(2)(b), below, to fully cover such areas.

b. Landscape Fabric.

(1) Application. Landscape fabric shall be applied under all non-roadway crushed rock surfacing, such as walkways around navaid shelters, at RVR sites, and between light bars of a MALSR. In these applications, landscape fabric is placed over prepared walkway subgrade soil, and crushed aggregate is placed and compacted on top of the landscape fabric. The landscape fabric acts as a separator, as does geotextile, and blocks weed growth. The contractor shall have the option of substituting geotextile per Paragraph 2B.3a, for landscape fabric.

(2) Landscape Fabric Selection Criteria. The landscape fabric fibers shall consist of long chain polymeric fibers composed of polypropylene, polyester, polyolefins, or polyamide. The fabric shall be resistant to chemical attack, mildew, and rot. The fabric shall conform to the physical property requirements listed in the following table. All values shall represent certifiable minimum values in the weakest principle direction of the fabric.

Property	Test Method	Requirement
Grab tensile strength	ASTM D-4632	100 lbs, min
Grab elongation	ASTM D-4632	60%, min
Trapezoidal tear	ASTM D-4533	30 lbs
Puncture resistance	ASTM D-751	25 lbs, min
Water flow rate modified)	ASTM D-4491	30 gpm/ft^2, min
Permittivity	ASTM D-4491	.25 sec^{-1}, min
Apparent opening size	ASTM D-4751	U.S. Sieve #50, max

Typar 3301 landscape fabric manufactured by Reemay is one of the products which meets these specifications. For any substitution, provide the Contracting Officer with complete product literature, including values of the properties tabulated above, and a sample of fabric. Do not procure any substitute before receiving the Contracting Officer's approval. See Paragraph 1A.4 above.

(3) Landscape Fabric Width. Fabric width shall be 3 feet wide for a 3-foot-wide crushed rock walkway. Fabric in other walkway areas shall be cut to fit, and overlapped per Paragraph 2B.4c(2)(a), below, to fully cover such areas.

c. Crushed Aggregate Surfacing.

(1) Crushed rock or crushed stone aggregate shall comply with State Specification quality requirements for crushed rock or crushed stone used for road surface course, and shall be of the State gradation most closely conforming with the following gradation:

Sieve Size	Total Passing, Percent
1-inch	100
3/4-inch	80-100
3/8"-inch	30-60
No. 4	48-65
No. 8	35-50
No. 30	19-30
No. 50	13-23
No. 100	7-15
No. 200	0-8

(2) A certified sieve analysis, referenced to State Specification gradation, shall be submitted to the Resident Engineer for approval.

2B.4 CONSTRUCTION.

a. General Requirements. All earthwork requirements in Section 2A for areas to receive surfacing are applicable, excepting as qualified herein. Where the additional work or more stringent requirements in this section conflict with Section 2A, requirements herein shall prevail.

b. Foundation Preparation.

(1) Foundation Material. All topsoil shall be removed from areas to receive paving and surfacing or fill under such surfaces. Only inorganic soil shall exist under surfaced or paved areas.

(2) Compaction. Compact as required in Section 2A.

(3) Grading. Shape with motor grader to achieve such surface trueness that when tested with a 10-foot straightedge, no deviation greater than 1/2-inch shall exist.

(4) Corrective Work. Any ruts or soft-yielding spots that may appear in the subgrade, any areas having inadequate compaction, and deviations of the surface from the requirements specified shall be corrected by loosening, removing, and adding approved material and reshaping and recompacting the affected areas to line and grade, and to the specified density.

c. Geotextile or Landscape Fabric.

(1) General. Geotextile or landscape fabric, if required on the drawings, shall be installed on prepared subgrade for all areas that will experience vehicular traffic or pedestrian traffic, respectively.

(2) Construction Requirements.

(a) Prepared subgrade and foundations shall be compacted smooth and level as specified elsewhere and as shown on the drawings.

(b) The fabric shall be rolled out directly upon the prepared surface, and shall not be dragged over any surface. Fabric in place shall have a smooth surface and shall be free of folds, wrinkles, cuts, or other imperfections. Individual panels of fabric shall be overlapped at least 24 inches, with the preceding layer overlapping the following layer in the direction that surfacing material will be spread. No vehicular traffic will be permitted directly upon the fabric.

d. Crushed Aggregate Surfaced Areas and Crushed Aggregate Base Course for Bituminous Pavement.

(1) Spreading. Crushed aggregate surfaced areas and base course shall be constructed in one or more layers of maximum 6-inch compacted thickness each. Crushed aggregate shall be deposited directly and uniformly on the prepared subgrade, if no geotextile or landscape fabric is used. If geotextile fabric is required, the aggregate shall be back-dumped on the fabric, and machine spread in the direction of overlap. Dumping in windrows, which requires excessive rehandling, will not be permitted. When deposited, the aggregate shall be free from segregation, and shall require minimum blading or manipulation.

(2) Compaction and Grading.

(a) Each layer of aggregate shall be compacted using equipment required in the State Specifications. For compacting aggregate on a geotextile or landscape fabric, use a smooth-drum roller. Compaction shall closely follow the spreading operation to prevent loss of contained moisture or displacement of materials.

(b) When the surface stability of the crushed aggregate cannot be obtained due to lack of fines, additional fines shall be added to the upper portion of the course in an amount sufficient to secure stability, at no additional cost to the Government. In no case, however, shall the quantity of fines added increase the percent passing the Number 200 sieve by more than 15 percent in the upper portion.

(c) Any irregularities or depressions that develop in the layers under rolling operations shall be corrected by loosening the material and removing or adding aggregate and rerolling. The rolling shall be continued until the surface is shown to be smooth and uniform, and to such trueness that when tested with a 10-foot straightedge it shall not show any deviation in excess of 1/4-inch. At all places not accessible to the roller, the aggregate of each layer shall be tamped separately and compacted to grade and line with mechanical tampers.

(d) If any subgrade material is worked into the aggregate material during the compacting or finishing operations, all granular material within the affected areas shall be removed and replaced with new aggregate. The Resident Engineer may restrict hauling or traffic over the completed or partially completed base after inclement weather or at any time when the subgrade is soft, and there is a tendency for the subgrade material to work into the base material.

(e) If considered necessary by the Resident Engineer, water shall be applied to each layer to aid in compaction and prevent segregation of the material. Disc or harrow surfacing material during moistening operations to secure uniform moisture distribution. Add water in a manner that will not soften the subgrade. All work associated with the additional water shall be accomplished at no additional cost to the Government.

(f) The aggregate shall be compacted to 95 percent maximum density as determined by AASHO-T99. Compaction shall continue until no further discernible compaction is evidenced under action of the compaction equipment. If in the opinion of the Resident Engineer, the required degree of compaction has not been achieved, testing in accordance with the standard will be conducted and paid for by the Government. If testing confirms unacceptable compaction, reconstruction or other remedial work may be required by the contractor at no additional cost to the Government.

DIVISION 2 - SITEWORK
SECTION 2C
ASPHALT CONCRETE PAVEMENT

2C.1 DESCRIPTION OF WORK. The extent of asphalt concrete pavement construction is indicated on the drawings and by the provisions of this section. Pavement construction will include placing prime and tack coats and asphalt concrete base and surface courses on prepared subgrade and aggregate base course.

2C.2 CERTIFICATION. Provide certification signed by material producer and contractor that all materials and mix compositions comply with the specified requirements.

2C.3 APPLICABLE SPECIFICATIONS.

a. American Association of State Highway and Transportation Officials (AASHTO) material referenced herein.

b. State Highway Construction Specifications.

(1) State highway construction specifications, latest edition, form a part of this specification and are applicable for all work, unless otherwise specified. This referenced specification will hereinafter be referred to as "State Specifications."

(2) Disregard all references in the State Specifications to layout of work by others, and to measurements and payments. All layout work will be accomplished by the contractor, and payment for all work under this section will be a part of the lump-sum contract.

(3) Prime and tack coats, as specified herein, are a requirement under this contract even if such coats are not required under the State Specifications.

2C.4 WEATHER LIMITATIONS.

a. Surface Conditions. Apply all coats and asphalt layers to dry surfaces only. Do not commence work when wet weather threatens.

b. Temperatures.

(1) Apply prime and tack coats when air temperature is above $50^{o}F$ and when temperature has not been below $35^{o}F$ for 12 hours immediately prior to application.

(2) Construct asphalt concrete base and surface courses when air temperatures are above $30^{o}F$ and rising, and above $40^{o}F$, respectively.

2C.5 MATERIALS.

a. General Requirements. Provide locally available materials that comply with the State Specifications for asphalt concrete pavements and all requirements herein.

b. Base (Binder) and Surface Course Aggregates. Provide sound angular crushed rock or crushed stone, sand, and stone screenings.

c. Asphalt Cement. AASHTO M 226 (ASTM D 3381) for viscosity-graded material and AASHTO M 20 (ASTM D 946) for penetration-graded material.

d. Prime Coat. Cut-back asphalt type; AASHTO M 82 (ASTM D 2027) MC-30, MC-70, or MC-250.

e. Tack Coat. Emulsified asphalt; AASHTO M 140 (ASTM D 977) or MC-208 (D 2397); SS-1, SS-1h, CSS-1 or CSS-1h, diluted with one part water to one part emulsified asphalt.

2C.6 ASPHALT-AGGREGATE MIXTURE. Provide plant-mixed, hot-laid asphalt-aggregate mixture complying with ASTM D 3515 and the State Specifications.

2C.7 CONSTRUCTION.

a. Surface Preparation.

(1) Prepare subgrade and provide road stabilization/ reinforcement fabric and aggregate base course as required in Sections 2A and 2B herein.

(2) Inspect aggregate base for unstable areas and areas requiring additional compaction before proceeding with pavement work and correct all unsatisfactory conditions.

b. Prime Coat. Apply at a rate of 0.20 to 0.50 gallons per square yard, over compacted aggregate base course. Apply material to penetrate and seal, but not flood, surface. Cure and dry as long as necessary to attain penetration and evaporation of volatile.

c. Tack Coat. Apply to surface of asphalt concrete base (binder) course and abutting surfaces of existing pavement, at the rate of 0.05 to 0.15 gallons per square yard of surface. Allow to dry before placing surface coat.

d. Placement of Mix.

(1) General. Place asphalt concrete mixture on prepared surface, spread, and strike off. Spread mixture at a minimum temperature of 225^{o}F (107^{o}C). Place inaccessible and small areas by hand. Place each course to required grade, cross-section, and compacted thickness.

(2) Course Thickness. Unless indicated otherwise on the drawings, asphalt concrete base and surface courses shall be 3 inches and 1 1/2 inches thick, respectively.

(3) Paver Placing. Place in strips not less than 10 feet wide, unless otherwise acceptable to the Resident Engineer. After the first strip has been placed and rolled, place succeeding strips, and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.

(4) Joints. Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have the same texture, density, and smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.

e. Rolling.

(1) General.

(a) Begin rolling when mixture will bear roller weight without excessive displacement.

(b) Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

(2) Breakdown Rolling. Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.

(3) Second Rolling. Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

(4) Finish Rolling. Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

f. Patching. Remove and replace paving areas mixed with foreign materials, and defective areas. Cut out such areas, and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

g. Protection. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

2C.8 FIELD QUALITY CONTROL.

a. General. Test in-place asphalt concrete courses, at intervals as directed by the Resident Engineer, for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by the Resident Engineer.

b. Thickness. In-place compacted thickness will not be acceptable if they exceed the following allowable variation from required thickness:

(1) Base Course. 1/2-inch

(2) Surface Course. 1/4-inch

c. Surface Smoothness. Test finished surface of each asphalt concrete course for smoothness, using 10-foot straightedge applied parallel with, and at right angles to, centerline of paved area. Surfaces will not be acceptable if they exceed the following tolerances for smoothness.

(1) Base Course Surface. 1/4-inch

(2) Wearing Course Surface. 3/16-inch

(3) Crowned Surfaces. Test with crowned template centered and at right angle to crown. Maximum allowable variance from template: 1/4-inch.

DIVISION - SITEWORK
SECTION 2D
TOPSOIL AND GRASS COVER

2D.1 DESCRIPTION OF WORK. The extent of topsoil placement and establishment of grass cover is indicated on the drawings and the provisions of this section.

2D.2 GENERAL REQUIREMENTS. All areas of the project site, access road right-of-way, and cable trench routes, which will not be occupied by pavement, crushed rock/stone surfacing, or other construction, shall receive preparation and grass seed planting and maintenance. Included in this work will be off-site turf reconditioning and replacement for those areas damaged by construction operations.

2D.3 MATERIALS.

a. Topsoil. Material shall be that removed from project site location preparatory to trenching and site construction. Reuse only that part of stockpiled topsoil reasonably free of subsoil, trash, roots, stumps, weeds, debris, litter, and stones larger than 2 inches.

b. Fertilizer. Provide complete fertilizer of 5-10-5 composition (percentages of nitrogen, phosphorous, and potash, respectively).

c. Grass Seed. Provide fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official Seed Analysts of North America. Provide the following seed mixture composed of grass species and proportions:

Proportion by Weight	Common Name
45%	Kentucky Bluegrass
5%	Perennial Ryegrass
35%	Redtop
15%	White Clover

d. Anti-Erosion Mulch. Provide clear, seed-free salt hay or threshed straw of wheat, rye, oats, or barley. Anchor the mulch sufficiently to prevent it from being blown away.

2D.4 PREPARATION FOR PLANTING.

a. Subsurface Preparation. After completion of all construction operations that could disturb topsoil areas, subgrades shall be cleared free of waste and stones larger than 2 inches, then tilled to a depth of 3 inches, and graded to remove surface irregularities.

b. Topsoil and Surface Preparation. Spread topsoil uniformly to provide a 6-inch layer, after compaction, on all fill and backfilled areas to receive grass seed. Compact with a roller weighing 85 to 100 pounds per foot of width. Subgrade and topsoil shall be damp when work is performed, but not wet, dusty, or frozen.

c. Preparation of Unchanged Grades. Where seed will be planted in areas that have not been altered by grading, prepare soil for planting as follows: till to a depth of 6 inches, apply fertilizer, remove high areas and fill depressions, till soil to a homogenous mixture of fine texture, free of lumps, stones, roots, and trash, and compact as above.

d. Fertilizer. Apply fertilizer at the rate of 30 pounds per 1000 square feet of area. Mix fertilizer into top 2 inches of topsoil.

e. Surface Preparation. Fine grade to a smooth, even surface and to a loose, uniformly fine texture. Roll, rake, and drag seeded areas, remove ridges, and fill depressions as necessary to meet finish grades. Limit work to areas that can be planted immediately. Moisten prepared areas before planting if soil is dry. Allow surface mixture to dry and proceed with seeding.

2D.5 SEEDING.

a. Seed Condition. Do not use old, wet, or moldy seed. The seed shall be dated with the year in which it is being applied.

b. Sowing. Use spreader or sowing machine. Do not seed when wind velocity exceeds 5 mph. Distribute seed evenly over entire area by sowing equal quantities in two directions at right angles to each other. Seed at rate of 5 pounds of seed per 1000 square feet of area. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with a fine spray.

c. Protection. Spread mulch uniformly to form a continuous loose blanket after completion of seeding operations. Anchor the mulch sufficiently to prevent it from being blown away.

2D.6 MAINTENANCE. Maintain for a period of 60 days after seeding. If maintenance for a 60 day period is not feasible, the contractor shall use a commercially available mix of seed, fertilizer, and long-lasting mulch, or a preseeded anchored mat that can be maintained less frequently with the same results. Water, fertilize, regrade, and replant as required to establish smooth, acceptable turf.

DIVISION 2 - SITE WORK
SECTION 2E
MISCELLANEOUS SITE IMPROVEMENTS

2E.1 DESCRIPTION OF WORK. The extent of miscellaneous site work is indicated on the drawings and by the provisions of this section.

2E.2 CONDUIT INSTALLATION BY JACKING OR BORING.

a. Materials. Conduit shall be 4-inch diameter, rigid, galvanized steel unless otherwise specified on the drawings. The leading end of the conduit to be jacked shall be equipped with an approved cap or point designed specifically for pipe jacking.

b. Excavation and Backfill of Jacking or Boring Pits. Excavation and backfill of all pits used for the installation of conduit shall conform to Section 2A.

c. Jacking Equipment. Pipe jacking equipment shall be an approved design for the purpose of jacking pipe and shall be capable of developing sufficient force to overcome frictional and/or other resisting forces built up over the distance involved.

d. Location. Conduit shall be located where shown on the drawings and/or as staked out by the Resident Engineer. Conduit shall be started into place at a minimum of 36 inches below finished grade, if not otherwise specified in the proposal or on drawings. The transverse alignment shall be considered satisfactory only when the terminating or leading end of the conduit exits within 5 feet of its intended location for a conduit length of less than 50 feet. For lengths greater than 50 feet, the transverse location must not be outside of 15 feet of the intended location. The vertical limits of the point of exit of the leading end of the conduit shall be between 24 inches and 50 inches below finished grade for conduits up to 50 feet in length and between 24 inches and 84 inches for conduits of greater length.

e. Conduit Length. Unless otherwise specified, conduit, no matter how installed, shall extend a minimum of 5 feet beyond each side of the pavement or structure.

f. Conduit Sealant. After completion of conduit and cable installation, both ends of the conduit shall be sealed with Permagum or other approved compound to prevent entrance of moisture.

2E.3 REMOVAL OF EXISTING FOUNDATIONS. All foundations of removed buildings, trailers, antenna supports, or other structures shall be removed to a minimum depth of two feet below final grade and backfilled with compacted earth in accordance with Section 2A, unless noted otherwise on the site drawings. The site areas shall be graded smooth and topsoil added to match the original terrain, unless otherwise specified.

2E.4 FACILITY RELOCATION.

a. General. Where relocation of a building, trailer, or other structure is required, the structure shall be moved intact to its new location. Interior circuits and equipment shall remain undisturbed and unchanged. Existing cables and conduits from the building to exterior shall be disconnected at convenient junction boxes, panels, or couplings. After a building is relocated, the new incoming cables and conduits shall be installed to the points where disconnections were made, unless otherwise specified.

b. Deviation From Standard. When standard drawings are provided for the installation and relocation of existing structures, relocate existing equipment in accordance with these drawings as much as possible. Deviations from the standards are permitted where provided for on the site drawings, or to accommodate nonstandard features of existing structures. The contractor shall check the dimensions of the existing structures and foundations against the standard drawings, note any discrepancies, and report them to the Resident Engineer. He shall construct the new foundation to accommodate these discrepancies.

c. Reference Drawings. The standard drawings often refer to other drawings not included in the list of specifications and drawings. Drawings referred to but not included pertain to original construction, and are unnecessary for relocation.

2E.5 FENCES.

a. Materials and Installation. All materials and installations shall be in accordance with project drawing requirements.

b. Fence Grounding. Grounding materials and procedures shall be in accordance with project drawing requirements. Fence grounding conductors may be attached to the grounding electrodes of a shelter perimeter grounding system if such electrodes are located 20 feet or less from the fences to be grounded.

2E.6 CULVERTS.

a. Material. When shown on the drawings, corrugated galvanized sheet metal pipe shall conform to the requirements of AASHTO standard specification M-36.

b. Installation. Excavation for culverts shall provide a firm uniform foundation. Backfill around culverts shall be the same materials used in the road embankment and shall be well compacted in layers of not more than eight inches. Unless otherwise specified, there shall be a minimum of one foot of cover over all culverts. Bed the bottom quadrant of culverts in undisturbed soil.

2E.7 REPLACEMENT OF SURFACING AGGREGATE AND PAVEMENT. For replacement of surfacing aggregate and pavement removed for trenching operations, see Paragraph 2A.9d(4) above.

2E.8 SPECIAL SURFACING.

a. General. If required on the drawings, surfacing for VASI, PAPI, and REIL light units, and all other small surfacing areas within 300 feet of runway and taxiway edges, shall be the material placed as required below. Special surfacing requirements will preclude displacement onto aircraft operating surfaces.

b. Material and Installation. Crushed rock or crushed stone surfacing at light unit locations shall be 4 inches deep and centered on the units. Material shall be 1 1/2 to 2 inches nominal size washed crushed rock. No substitutions will be accepted. Rock shall be tamped as tightly as material permits. Finished surface shall be flush with existing surrounding grade.

DIVISION 3 - CONCRETE
SECTION 3A
CONCRETE FORMWORK AND REINFORCEMENT

3A.1 DESCRIPTION OF WORK. Extent of work is indicated on the drawings and by the requirements of this section.

3A.2 CONCRETE FORMWORK.

a. Design of Forms. Forms shall conform to shapes, lines, and dimensions of the members shown on the plans, and shall be sufficiently tight to prevent leakage of mortar. They shall be properly tied together so as to maintain position and shape.

b. Form Removal. Forms shall not be loosened or removed until the concrete members have acquired strength sufficient to support their own weight. No additional loads shall be placed on the concrete for at least 48 hours after placing.

c. Form Ties. Form ties for concrete shall be of a type that will break back 1 1/2 inches from the concrete surface. Ties shall be removed to a minimum depth of 1 1/2 inches, and the surface patched.

3A.3 CONCRETE REINFORCEMENT.

a. Materials. Reinforcement bars shall conform to "Specifications for Billet - Steel Bars for Concrete Reinforcement", ASTM A-615. All bars shall be intermediate grade deformed bars.

b. Cleaning and Bending Reinforcement. At the time concrete is placed, metal reinforcement shall be free from rust scale or other coatings that will destroy or reduce the bond. All bent bars shall be bent cold. No bars partially embedded in concrete shall be field bent except as shown on plans.

c. Placing Reinforcement. Metal reinforcement shall be accurately placed according to the plans, and adequately secured in position by concrete, metal, or other approved chairs, spacers, or ties.

d. Splices in Reinforcement. No splices or reinforcement shall be made except as shown on the plans or as authorized by the Resident Engineer. All welding shall conform to the American Welding Society's recommended practices for welding reinforcing steel, metal inserts and connections in reinforced concrete construction (AWSD12.1).

e. Concrete Protection for Reinforcement. The reinforcement shall be protected by the thickness of concrete shown on the drawings. Where not shown, the thickness of concrete over the reinforcement shall be as follows:

(1) Where concrete is deposited against the ground without the use of forms, not less than 3 inches.

(2) Where concrete is exposed to the weather or to the ground but placed in forms, not less than 2 inches for bars larger than number 5, and 1 1/2 inches for number 5 bars or smaller.

DIVISION 3 - CONCRETE
SECTION 3B
CAST-IN-PLACE CONCRETE

3B.1 DESCRIPTION OF WORK. The extent of work is indicated on the drawings and by the provisions of this section.

3B.2 MATERIALS. Cement shall conform to Specification for Portland Cement ASTM C-150, Type I, or Specification for Air-Entraining Portland Cement ASTM C-175, Type 1A, unless otherwise specified. The concrete shall have a minimum 28-day compressive strength of 3,000 PSI, a maximum slump of 4 inches, and a maximum aggregate size of 1-inch. The concrete mix shall contain an air-entraining admixture. Air content shall be 5 to 7 percent. The contractor shall give the Resident Engineer a certificate from the concrete supplier, bearing the intended job mix and certifying that the concrete delivered will meet the above requirements. The contractor shall obtain approval of the job mix from the Resident Engineer prior to placing concrete.

3B.3 PREPARATION OF EQUIPMENT AND PLACE OF DEPOSIT.

a. Before placement, all equipment for mixing and transporting the concrete shall be cleaned. All debris and ice shall be removed from the places to be occupied by the concrete. Forms shall be thoroughly wetted (except in freezing weather) and oiled prior to placing reinforcing steel. The reinforcement shall be thoroughly cleaned of ice, dirt, rust scale, or other coatings.

b. Water shall be removed from place of deposit before concrete is placed. All laitance and other unsound material shall be removed from hardened concrete before additional concrete is added.

3B.4 CONVEYANCE. Concrete shall be conveyed from the mixer to the place of final deposit by methods that will prevent segregation or loss of materials. Equipment for chuting concrete shall be of such size and design so as to ensure a continuous flow of concrete at the delivery end without segregation of materials.

3B.5 PLACEMENT.

a. Concrete shall be placed within 1 1/2 hours after mixing begins. Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. The placing of concrete shall be carried on at such rate that concrete is at all times plastic, and flows readily into the spaces between the bars. No concrete that has been contaminated by foreign material shall be used, nor shall retempered concrete be used.

b. When placing is started, it shall be carried on as a continuous operation until placement is completed.

c. Concrete shall be placed in layers not exceeding 18 inches deep, and vibrated in place. During and immediately after depositing, the concrete shall be consolidated by vibrators. The concrete shall be thoroughly worked around reinforcement, around embedded fixtures, and into corners. Accumulations of water on the surface of the concrete due to water gain, segregation, or other causes, shall be prevented as much as possible by employing proper placement, consolidation, and finishing practices. Provisions shall be made to remove such water as may accumulate, so that under no conditions will concrete be placed in such accumulations.

d. Vibrators shall be the internal immersion type, operating at speeds of not less than 7,000 RPM. Vibrators shall be kept constantly moving in the concrete and shall be applied at points uniformly spaced not further apart than the radius over which the vibrator is visibly effective. The entire depth of a new layer of concrete shall be vibrated. The vibrators shall penetrate several inches into the layer below to insure thorough union of the layers. The vibrator shall not be held in one location long enough to draw a pool of grout from the surrounding concrete. Vibration shall be such that the concrete becomes uniformly plastic.

3B.6 FOOTINGS. All footings and foundations without footings shall bear on firm, undisturbed soil.

3B.7 CYLINDRICAL CONCRETE PIERS.

a. All cylindrical concrete piers if required, shall be formed to full depth in fiber forms. Tops of piers shall be finished flat within the confines of the fiber forms. No spillage (mushrooming) over the tops of forms will be permitted. Where conduit emerges from vertical surfaces of concrete piers, no appreciable amount of concrete shall be permitted to spill through forms adjacent to such conduit.

b. Fiber forms for cylindrical concrete piers shall be spirally constructed of laminated plies of fiber. The total wall thickness shall be as published by the manufacturer. The width of each ply shall not be less than 6 inches. Plies shall be laminated with an adhesive of a non-water-sensitive type, with a proven record of satisfactory service in concrete forms. The exterior surface shall be uniformly wax impregnated for weather and moisture protection. The interior surface shall be coated with pure polyethylene uncontaminated by paraffin or other additives. A-Coated Sonotube forms by Sonoco Products Company of Hartsville, South Carolina, are among the products that meet these specifications.

c. Remove all loose soil from bore holes so that concrete will bear on undisturbed soil. Support forms rigidly and in proper horizontal and vertical alignment. After pouring, remove only that part of each form that will be exposed above grade. Backfill excess space between bore holes and forms with thoroughly compacted inorganic soil. Do not use sand backfill unless adjacent undisturbed soil is sand.

3B.8 ANCHOR BOLT INSERTS. No drilling for or placing of anchor bolt inserts or anchors will be permitted in concrete for a period of three days after placement, unless noted otherwise on the drawings.

3B.9 CURING.

a. Provision shall be made for maintaining concrete in a moist condition for a period of at least 5 days after placement.

b. In lieu of wet curing, one coat of a concrete coring sealer which forms a film over the concrete surface, may be used for curing the concrete. The sealer shall meet the ASTM C-309 and AASHTO M-14 specification for moisture retention as tested per ASTM C-156 and AASHTO M-155. The compound shall not be a type that permanently discolors the concrete. Symons Cure and Seal is one of the products which meet this specification. On exposed surfaces, application shall be made immediately after the concrete has been finished. If there is any delay, the concrete shall be kept moist until the application is made. After the forms are removed, the concrete shall be sprayed lightly with water, and then the coat of curing compound applied. If the forms (wood only) cannot be removed within 48 hours, they shall be wetted down and kept wet until their removal, and then the compound applied as above.

3B.10 COLD-WEATHER REQUIREMENTS.

a. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather. No frozen materials or materials containing snow or ice shall be used. Concrete shall not be placed on frozen soil.

b. All reinforcement, forms, fillers, and ground which will make contact with concrete shall be free from snow and ice. Whenever the temperature of the surrounding air is below 40^{o}F, all concrete placed in forms shall have a temperature of 45oF or higher, after placement. Adequate means shall be provided for maintaining this temperature for 4 days. Any additional time necessary to ensure proper curing of the concrete shall be provided as directed by the Resident Engineer. The housing, covering, or other protection used in connection with curing, shall remain in place and intact at least 24 hours after the artificial heating is disconnected. Do not use salt or other chemicals to prevent freezing.

3B.11 HOT-WEATHER REQUIREMENTS.

a. In hot weather, suitable precautions shall be taken to avoid drying of the concrete prior to finishing operations. Use of windbreaks, sunshades, fog sprays, or other devices shall be provided as directed by the Resident Engineer.

b. Concrete deposited in hot weather shall not have a placing temperature that will cause difficulty from loss of slump, flash set, or cold joints. Concrete temperature shall be less than 90^{o}F.

3B.12 SLUMP. Concrete shall be tested for consistency at the mixer or at the place of deposit if delivered ready-mixed. The sample shall be taken immediately from the batch and tested by the contractor in the presence of the Resident Engineer in accordance with ASTM standard C143. Concrete with slump in excess of four inches shall be rejected.

3B.13 DELIVERY TICKETS. At the time of concrete delivery, the contractor shall give the Resident Engineer a copy of the delivery ticket bearing the quantity, strength, and air entrainment of the concrete delivered.

3B.14 CONCRETE TESTS. If the Resident Engineer determines that concrete strength and air entrainment tests are needed, the Federal Aviation Administration will make arrangements for and bear costs of such tests.

DIVISION 5 - METALS
SECTION 5A
MISCELLANEOUS METALS

5A.1 DESCRIPTION OF WORK. Extent of metal work is indicated on the drawings and by the provisions of this section.

5A.2 MATERIALS.

a. Structural Steel Shapes and Plates. ASTM A 36 steel.

b. Steel Pipe. ASTM A53, Type E or S, Grade B steel or ASTM 501. Weight schedules shall be as specified in the special specifications or on the drawings.

c. Anchor Bolts. ASTM A 307 without heads.

d. Unfinished Threaded Fasteners. Where not otherwise indicated, ASTM A 307, Grade A, regular low-carbon steel bolts and nuts of hexagonal design, hot-dipped galvanized.

e. Finished Threaded Fasteners. Stainless steel cap screws and heavy semi-finished nuts of hexagonal design for exterior connections, unless otherwise indicated.

5A.3 FABRICATION.

a. General.

(1) After performing all fabrication and welding operations, remove all sharp edges and burrs that could cause injury. Properly finish surfaces of exposed items so as to be free of visible defects.

(2) Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes.

b. Welding. Comply with AWS Code for procedures, appearance, and quality of welds. Weld all work to produce assemblies free of warpage.

c. Galvanizing.

(1) All steel members, plates, and assemblies shall be hot-dipped galvanized in accordance with ASTM A 123 and A 385, unless otherwise specified.

(2) Prepare all structural steel items for galvanizing by solvent cleaning, hand and power tool cleaning, and/or sandblasting as required for permanent adhesion of galvanizing.

5A.4 INSTALLATION.

a. Install all work plumb, level, and square in accordance with the drawings.

b. Apply high zinc-dust-content paint for repair of galvanized surfaces damaged by welding. Paint shall conform to M.I. Specification MIL-P-21035.

DIVISION 6 - CARPENTRY
SECTION 6A
ROUGH CARPENTRY

6A.1 DESCRIPTION OF WORK. The extent of exterior carpentry work is indicated on the drawings and by the provisions of this section. Refer to Section 13E for MALSR and ILS shelter carpentry.

6A.2 MATERIALS.

a. Service Pole.

(1) Electrical service pole, if required, shall be Western Red Cedar, Douglas Fir, or Southern Pine complying with American Standard Specifications and Dimensions for Wood Poles, ASA 05.1, American Standards Association.

(2) Poles shall be ASA 05.1 class 6 or better as dictated by height requirements.

(3) Poles shall be pressure preservative treated with pentachlorophenol or creosote in accordance with American Wood Preservers Association (AWPA) Standard C4.

b. Lumber. Lumber shall be stress-rated and marked #2 structural grade, any species. Sizes indicated are nominal. All lumber shall be dressed S4S. All lumber shall be seasoned and have 19 percent moisture content. Hand select all lumber pieces for straightness and freedom from defects.

c. Plywood. Plywood shall be all-veneer construction of sizes indicated on the drawings, and complying with American Plywood Association (APA) grade designation: APA BC, Exterior, or better.

d. Lumber and Plywood Preservative Treatment.

(1) All exterior lumber and plywood shall be preservative treated and shall comply with applicable requirements of the American Wood Preservers Association (AWPA) Standards C2 (lumber), and C9 (plywood), and with American Wood Preservers Bureau (AWPB) Standards below. Mark each treated item with the AWPB quality mark requirements.

(2) Pressure treat above-grade and below-grade items with water-borne preservatives complying with AWPB LP-2 and AWPB LP-22, respectively.

(3) Treat all cut surfaces with heavy brush coat of same chemicals used for treatment and complying with AWPA M4.

e. Fasteners. Provide type, size, and finish of fasteners indicated on the drawings. All exterior fasteners shall be galvanized or stainless steel. If not otherwise specified, exterior lumber joints shall be secured with carriage bolts, flat washers and nuts, minimum two each per joint.

6A.3 CONSTRUCTION.

a. Discard units of material with defects that could impair quality of work. Set carpentry work to required lines and levels with members plumb, level, and square. Accurately cut and fit all work.

b. Secure all carpentry work by anchoring or fastening as required by recognized standards. Make tight connections between members. Install all fasteners without splitting wood. Pre-drill as required.

c. Coat all exterior exposed cut edges and ends of lumber and plywood pieces with wood preservatives as required above.

DIVISION 9 - FINISHES
SECTION 9A
PAINTING

9A.1 DESCRIPTION OF WORK. Extent of work is indicated on the drawings, in the special specifications and by the provisions of this section. Refer to Section 13E for MALSR and ILS shelter painting.

9A.2 GENERAL REQUIREMENTS.

a. Unless otherwise specified all surfaces to be painted shall receive one coat of primer and two finish coats of paint. Primer shall be compatible with the surface being painted as recommended by the paint manufacturer.

b. At completion of painting or work of other trades, painted surfaces shall be touched-up and restored where damaged or defaced, to the satisfaction of the Resident Engineer.

c. A completely finished job is required, regardless of whether every individual item is specified or not. Work requiring paint, which is not specifically mentioned, shall be finished in the same manner specified for other similar work.

d. Work shall be accomplished by skilled tradesmen, and resulting work shall be uniform in appearance.

9A.3 APPLICABLE FEDERAL SPECIFICATIONS.

TT-E-489	"Enamel, Alkyd, Gloss (for Exterior and Interior Surfaces)"
TT-P-641	"Primer, Paint; Zinc Dust - Zinc Oxide (for Galvanized Surfaces)"
TT-P-645	"Primer, Paint; Zinc-Chromate, Alkyd Type"

9A.4 MATERIALS.

a. All painting materials shall be the first quality products of a name brand paint company, which meet or exceed the requirements of the applicable federal specifications.

b. Deliver all painting and finishing materials in original containers with seals unbroken and labels intact. No materials other than those specified or approved shall be stored on site.

c. Basic painting materials such as linseed oil, shellac, turpentine, thinner, driers, etc., shall be of the highest quality and have identifying labels on containers.

9A.5 PREPARATION OF METAL SURFACES.

a. Unpainted or shop painted ferrous metal shall first be washed free of grease, dirt, and oil with mineral spirits, and primed or spot primed if the metal is exposed. Prime with rust prohibitive primer after removing any existing rust.

b. Previously painted existing ferrous metal shall be cleansed of grease, dirt, oil, and all other foreign substances. Existing paint which shows signs of deterioration, loosening, or chalking shall be removed. Further surface preparation shall be made as recommended by the paint manufacturer for the particular surface and type of paint being used.

c. Exposed galvanized surfaces shall be solvent cleaned as necessary to remove all oil, grease, and other foreign substances. Nonferrous metal surfaces to be painted shall be treated with vinyl type wash coat. The vinyl type wash coat shall have a dry film thickness of 3 to 5 mils. The wash coat shall be permitted to dry for at least 30 minutes or as recommended by the manufacturer.

9A.6 APPLICATION.

a. Do not apply exterior paint in damp, rainy weather, or until the surface has dried thoroughly from the effects of such weather.

b. The temperature of the surface to be painted and the surrounding air temperature shall be maintained between 45oF and 95o during the application and drying period.

c. The surface to be painted shall be clean, dry, smooth, and adequately protected from dampness. Each coat of paint shall be applied smoothly, worked out evenly, and allowed to dry completely before the subsequent coat is applied.

d. Finished work shall be uniform and of the approved color. It shall be completely covered and shall be smooth and free from runs and sags. Make edges of paint adjoining other materials or colors sharp and clean without overlapping. Where high gloss enamel is used, lightly sand undercoat to obtain a smooth finish coat.

e. All painting shall be completed according to the manufacturer's printed instructions.

9A.7 PAINT SYSTEM SCHEDULE.

a. Ferrous Metals (Unpainted).

(1) Primer - Federal Specification TT-P-645

(2) Intermediate and Finish Coats - Exterior Oil Paint

b. Galvanized Metal.

(1) Primer - Federal Specification TT-P-641

(2) Intermediate and Finish Coats - Exterior Oil Paint

c. Aluminum.

(1) Pretreatment - Vinyl Wash Coat

(2) Primer - Federal Specification TT-P-645

(3) Intermediate and Finish Coats - Federal Specifications TT-E-489.

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13A
APPROACH LIGHT SYSTEMS

13A.1 DESCRIPTION OF WORK. This section is applicable for construction required for a Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) and other approach lighting systems utilizing similar construction.

13A.2 INSTALLATION OF MALSR LIGHTS.

a. Screw Anchor Foundations. Comply with Section 13D and project drawings if screw anchor foundations are required on the drawings.

b. Installation Tolerances. Installation tolerances for the various types of light bars and flasher units shall be as follows:

(1) Longitudinal (along the runway centerline) + 6 inches deviation from design station.

(2) Lateral (perpendicular to the runway centerline). ± 3 inches

(3) Horizontal distance between individual frangible lights. ± 1 inch

(4) Mounting height.

(a) Up to 6 feet. ± 1 inch

(b) 6 to 40 feet. ± 2 inches

(c) Over 40 feet. ± 3 inches

(5) All lights in a frangible bar shall be installed within ± 1 inch of a line perpendicular to the runway centerline.

c. Assembly of PAR-56 Lights. If installation of PAR-56 lights is included in the contract, the contractor shall assemble the PAR-56 lampholders, lamps, and, if included, filter-holding clips, colored glass filters, and (for ALSF-2 facilties) shorting devices, into complete units, from unassembled condition. Use the spring-loaded lamp-retaining hardware supplied with the lampholders.

d. Frangible EMT Mountings.

(1) Frangible Coupling Installation. Each frangible coupling has a hexagonal throat with a break-off groove in the middle, designed to break at low impact, thereby minimizing damage to colliding aircraft. When installing the frangible coupling, take care to use a wrench which will grip only the lower portion of the hexagonal throat of the coupling, i.e., that portion immediately below the break-off groove. If the wrench grips the upper portion of the hexagonal throat, the coupling may break when torque is applied. See Paragraph 16A.20 for thread remediation. Whether thread remediation is performed or not, the contractor shall apply anti-seize compound to the threads of the frangible coupling, and to the internal threads of the receiving coupling or hole, to facilitate removal. The compound shall be an anti-seize assembly lubricant formulated to provide protection for stainless steel and dissimilar metal threaded fasteners against galling, seizure, and heat-freeze. Do not use plumber's pipe-joint compound. The frangible coupling shall be screwed down tightly into the conduit coupling or light base cover plate threaded hole, to prevent the EMT mounting from turning.

(2) Cable Connectors. Where cable connectors are required within the frangible couplings, the connectors shall have the capability of separating easily upon breakage of the frangible couplings. Therefore, apply silicone grease of high dielectric strength to the mating surfaces of the plug and receptacle connectors. Do not allow the silicone grease to make contact with the plug and receptacle terminals, and do not place electrical tape over the connector joints. A cable clamp or cable connector clamp shall firmly grip the receptacle connector of the lower cable assembly (never the plug connector of the upper cable assembly). The connectors shall be vertically positioned such that the joint between the two connectors is as close as feasible to the breakoff groove. If the receptacle cable connector is the 1"-diameter style (e.g., 90R-B6), the connector shall be gripped by an aluminum split-ring cable clamp. The Multi Electric Part No. 961-X cable clamp is among the clamps which meet this specification. If the receptacle cable connector of the style having a 1.75-inch-diameter donut for use in a light base (such as on the secondary lead of isolation transformers), the connector shall be gripped by the cable connector clamp which comes with the base plate.

(3) Upper Cable Assembly. Sufficient slack shall be left in the upper cable assembly at the point of entering the lampholder to permit:

(a) Removal of the lampholder.

(b) Disconnection of the cable connectors in the frangible coupling without disturbing connections to the lampholder.

e. Plumbness Tolerance for EMT Frangible Light Masts. EMT frangible light masts shall be installed to a plumbness tolerance of 1/16-inch per foot of mast height. This requirement is in addition to all other placement tolerances. If the mast foundation is concrete, the plumbness tolerance shall be met by proper placement of the concrete-embedded section of conduit, not by bending the mast. To insure plumbness, temporary rigid conduit masts shall be threaded into the conduit couplings, and clamped in place in a rigid brace during concrete placement, finishing, and setting. If the masts are to rise from a steel channel attached to a screw anchor foundation, the plumbness tolerance shall be met by proper attachment of the conduit couplings to the channel, not by bending the masts. In this case, temporary rigid conduit masts shall be threaded into the conduit couplings, and clamped in place in a rigid brace during the welding of the couplings to the channel.

f. Fiberglass LIR Approach Lighting Towers. LIR means Low Impact Resistance. An LIR tower is a tower designed to disintegrate when struck by an aircraft, offering low impact resistance to the aircraft, thus minimizing aircraft damage. The fiberglass LIR towers, if required by the drawings, shall be assembled from knocked-down (unassembled) condition according to the manufacturer's assembly instructions. Install the towers on foundations constructed in accordance with the drawings. On drawings, for brevity, fiberglass LIR towers are sometimes also called masts and poles.

g. Aiming and Alignment of Lights. Each light shall be adjusted so that its optical axis is parallel to the runway centerline, directed outward from the runway threshold, and aimed upward to the required vertical angle. An aiming device is furnished for vertical aiming of the PAR-56 and the PAR-38 lampholders and flashing light units.

13A.3 MALSR BRIGHTNESS. The contractor shall adjust the MALSR to operate as follows:

Step	% Relative Intensity MALS	RAIL
High Intensity	100	100
Medium Intensity	20	8
Low Intensity	4	1

13A.4 OPERATIONAL TESTS. The contractor shall demonstrate, by operational tests, that the entire system will operate satisfactorily. If the contract requires the establishment of remote control, satisfactory system operation shall be demonstrated on remote and local control. If the contract does not require the establishment of remote control, satisfactory system operation shall be demonstrated on local control only. The test shall demonstrate that the system meets all requirements of this specification and of the manufacturer's instruction manual.

13A.5 MALS LAMPS. If MALS lamps are not shown on the Government Furnished Property List, the contractor shall furnish ninety (90) PAR-38, 120-watt spot lamps. The photometric performance of these lamps shall equal or exceed the vertical and horizontal brightness beam spread candela values shown on Figure L at the end of this section. The Figure L beam spread curves were approximately reproduced from the July 1983 FAA Technical Center data report on photometric tests of MALS PAR-38 spotlights. The lamps must also be physically shaped to fit the PAR-38 lamp aiming device supplied as part of the MALSR equipment from the MALSR manufacturer. The General Electric PAR-38 120V, 120W, Wattmiser spot lamp (GE Designation 150 PAR/SP/120/WM) is one of the products which meet these specifications. If the contractor intends to furnish a substitute lamp, the contractor shall submit to the Contracting Officer, complete manufacturer's information, including vertical and horizontal brightness beam spread candela values, and a sample lamp, to demonstrate that the lamp will fit the MALSR manufacturer's PAR-38 lamp aiming device. See Paragraph 1A.4 above. The contractor shall install the required number of these lamps on the MALS structures. The remaining lamps shall be delivered to the Resident Engineer as spares.

13A.6 MALSR CABLE SPLICES.

a. Restrictions. The only underground MALSR cable splices which will be permitted under this contract will be the splices shown on the drawings. The contractor shall inventory the reels of Government furnished cable and contractor furnished cable, to verify that sufficient continuous lengths are available to preclude any other splices. If the contractor discovers that insufficient continuous lengths are furnished, he shall report this condition to the Resident Engineer immediately.

b. Mold and Compound. Every 600-volt power cable splice shall be made with a flexible film plastic mold with a built-in spacer web to provide cable and connector centering, and proper coverage by the insulating and sealing compound. The applied mold shall be filled with a flexible polyurethane electrical insulating and sealing compound capable of continuous operation at 90°C, with an emergency overload temperature rating of 130°C. The splices shall be rated for direct burial applications. The splicing kits shall be sized properly to the application. Splicing kits of the 3M Scotchcast 85 series are among products which meet these specifications. If kits of this series are selected, splices at the threshold bar, at EMT light bars, and at 5-tower bars, shall be made with 85-16 kits, unless specified otherwise. Splices at the MALS T-bar towers shall be made with kits no smaller than 85-12, unless specified otherwise. Substitute splicing kits require submittals per Paragraph 1A.4 above.

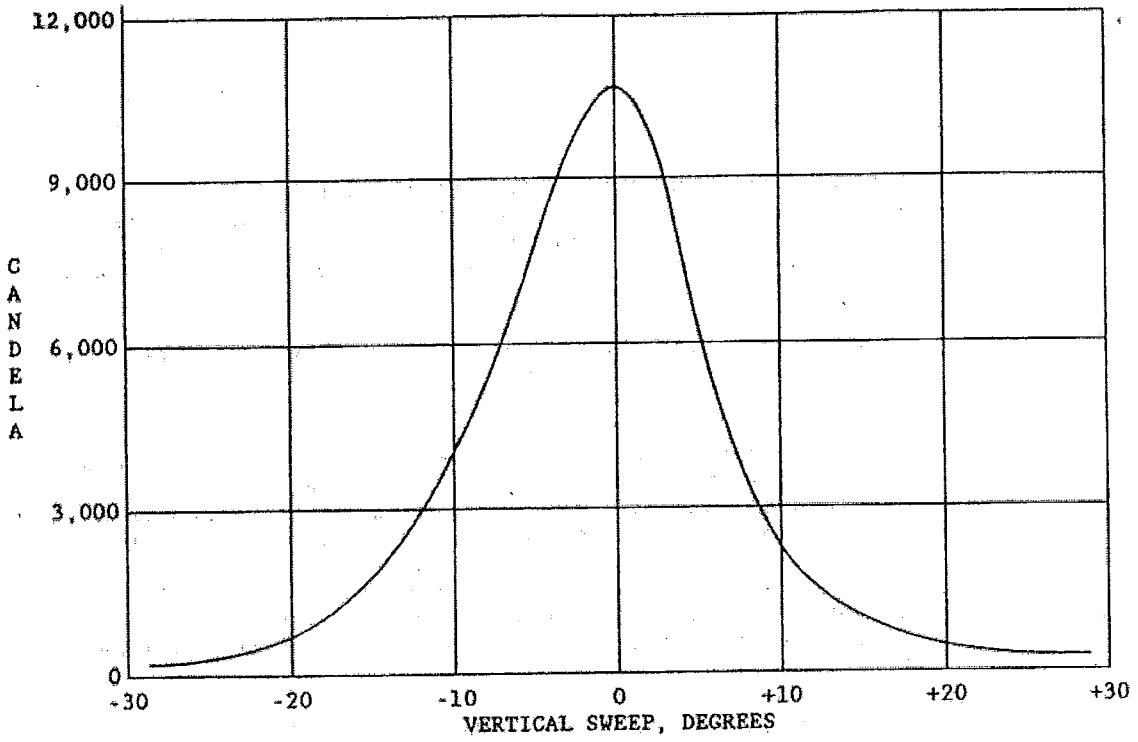
c. Connectors. Connectors used in the splices shall be compact compression tap connectors properly sized to the application. The connectors shall be copper, except aluminum connectors are permitted if they are designed for use with copper conductors. The contractor shall furnish and use the proper crimping tools and dies for the connectors, and shall execute the number of crimps required by the manufacturer. Mechanical (bolted) tap connectors shall not be used in splices below grade. The following connectors, primarily for underground splices at MALS bars, are approved, as they are among the products which meet these specifications (substitutes require submittals per Paragraph 1A.4 above):

(1) The following Burndy Crimpit Type YC-C compression connectors:

Cat. No.	Run	Tap
YC10C10	#10 AWG	#10 AWG
YC8C8	#8 AWG	#10 AWG
YC26C2	#2/0 AWG	#2 AWG
YPC26R8U	#2/0 AWG	#10 AWG

(2) For #2, #4, or #6 run cable to #10 tap cable, Burndy street lighting tap, Catalog Number YPC2A8U.

13A.7 MALS POWER DISTRIBUTION PANEL CIRCUIT DIRECTORY. The contractor shall mark the MALS power distribution panel circuit directory, identifying each branch circuit breaker by the MALS bar station(s), each breaker serves. Spare breakers shall be so identified.



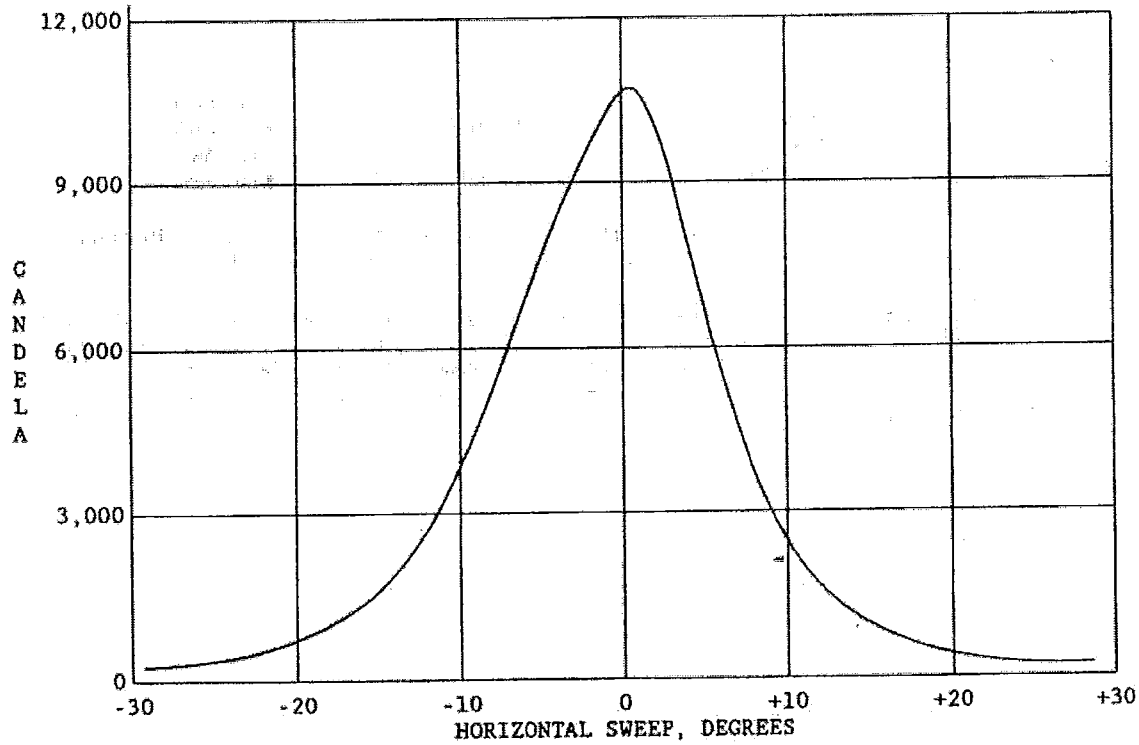


FIGURE L

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13B
INSTRUMENT LANDING SYSTEM

13B.1 DESCRIPTION OF WORK. This section applies to special construction required for an Instrument Landing System (ILS).

13B.2 SCREW ANCHOR FOUNDATIONS. Comply with Section 13D and project drawings if screw anchor foundations are required on the drawings.

13B.3 CABLE SPLICES. No splices will be permitted in radio frequency cables (cables with an RG designation, e.g. RG333/U).

13B.4 OBSTRUCTION LIGHTS. The obstruction lights on the glide slope antenna mast shall be installed and lighted continuously when the tower is 20 feet high or higher.

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13C
VASI, REIL, PAPI, AND RVR SYSTEMS

13C.1 DESCRIPTION OF WORK. This section applies to special construction required for a Visual Approach Slope Indicator (VASI), Runway End Identifier Lights (REIL), Precision Approach Path Indicator (PAPI), and New Generation Runway Visual Range (RVR).

13C.2 FRANGIBLE SUPPORTS FOR VASI, REIL, PAPI, AND RVR EQUIPMENT.

a. Description. Frangible couplings will be used to support VASI, REIL, PAPI, and RVR equipment installed near runways. Each frangible coupling has a hexagonal throat with a break-off groove in the middle, designed to break at low impact, thereby minimizing damage to colliding aircraft.

b. Coupling Installation. When installing the frangible coupling, take care to use a wrench which will grip only the lower portion of the hexagonal throat of the coupling, i.e., that portion immediately below the break-off groove. If the wrench grips the upper portion of the hexagonal throat, the coupling may break when torque is applied. See Paragraph 16A.20 for thread remediation. Whether thread remediation is performed or not, apply anti-seize compound to the threads of the frangible coupling, to facilitate removal. The compound shall be an anti-seize assembly lubricant formulated to provide protection for stainless steel and dissimilar metal threaded fasteners against galling, seizure, and heat-freeze. Do not use plumber's pipe-joint compound. The frangible coupling shall be screwed down tightly into the conduit coupling.

c. Cable Connectors. Where cable connectors are required within the frangible couplings, the connectors shall have the capability of separating easily upon breakage of the frangible couplings. Therefore, apply silicone grease of high dielectric strength to the mating surfaces of the connector plug and receptacle housings in the frangible couplings. Do not allow the silicone grease to make contact with the plug and receptacle terminals, and do not place electrical tape over the connector joints. A cable clamp shall firmly grip the receptacle connector of the lower cable assembly (never the plug connector of the upper cable assembly). The connectors shall be vertically positioned such that the joint between the two connectors is as close as feasible to the breakoff groove.

13C.3 EQUIPMENT ELEVATIONS.

a. Elevations of Record. After the contractor has installed the VASI, REIL, PAPI, or RVR lighting unit foundations (concrete or screw anchor), he shall survey and record all such independent foundation top elevations to the nearest 0.01 foot and deliver this information to the Resident Engineer for as-built drawing record. Elevations should be clearly referenced to locations where measured, such as a specific corner of a screw anchor or anchor plate. It is emphasized that all foundations of every lighting unit shall be measured such as the four legs of an individual VASI box.

b. Elevation Verification. Runway elevations indicated on the drawings were established on the date indicated. Prior to using these elevations for construction survey proposes, the contractor shall verify, through the Resident Engineer, that such runways have not been resurfaced after the date of the engineering survey. If resurfacing has occurred, new benchmarks will be established by the Resident Engineer. The VASI unit light slot elevations shall not be altered from those indicated on the drawings.

13C.4 ALIGNMENT AND AIMING ANGLE TOLERANCES.

a. Aiming Angles. Refer to site drawings for locations and aiming angles for individual VASI, REIL, PAPI, or RVR lighting units.

b. VASI and PAPI Lamp Housing Assembly (LHA) Unit Tolerances.

(1) Longitudinal Alignment Tolerances. Front face of each LHA unit shall be located within ± 6 inches of single line perpendicular to the runway centerline.

(2) Azimuthal Alignment Tolerance. Longitudinal axis of each LHA unit shall be parallel to the runway centerline within ± 1/2 degree.

(3) Mounting Height Tolerance. Light beam centerline of each LHA unit (within a bar for VASI) shall be located on a single horizontal plane within ± one inch.

(4) Aiming Angle Tolerance. Aiming angle of each LHA unit shall be within ± 2 minutes of angle specified.

13C.5 SYSTEM CONTROL. Unless otherwise indicated, VASI, REIL, or PAPI system construction shall include a method of on/off control shown on the drawings or specified herein. REIL control will also include provision for varying the lighting intensity.

13C.6 OPERATIONAL TESTS. The contractor shall demonstrate that the VASI, REIL, or PAPI system will operate satisfactorily by a series of operational test cycles and a continuous test run of 24 hours minimum. The tests shall clearly indicate that the system meets all the requirements of the drawings, specifications, and the manufacturer's instruction manuals.

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13D
SCREW ANCHOR FOUNDATIONS

13D.1 DESCRIPTION OF WORK. This section is applicable if screw anchor foundations are required on the drawings.

13D.2 SCREW ANCHOR FOUNDATION DESIGN AND USAGE. On drawings, screw anchor foundations are also called screw-in foundations and screw-in-anchor foundations. The two most frequently used screw anchor foundations, and the PAPI plate, are shown on Figures 1, 2, and 3 at the end of this section. The Figure 1 foundation is commonly used for ILS, RVR, MALSR, and PAPI facilities. The Figure 2 foundation is commonly used for VASI and REIL facilities. A. B. Chance foundations, Cat. Nos. T112-0262 and T112-0676, and PAPI plate T112-0337, are among the products that meet the requirements of Figures 1, 2, and 3, respectively, and the specifications below. These items are also known by Cat. Nos. CT112-0262, CT112-0676, and CT112-0337. The Chance Figure 1 foundation is known as an "Instant" foundation (formerly known as a streetlight foundation).

13D.3 PLATES. The following specifications apply to the square top plate (base plate) which is an integral part of the Figure 1 screw anchor foundation, and to the Figure 3 PAPI plate. The flat, smooth, plate top surface shall not have any curvature or other deformity induced by the manufacturing process. The plate shall be flame cut, deburred, and machined smooth both on the external edges and on the inner holes and slots. During fabrication of the Figure 1 foundation, the base plate edge shall be permanently and plainly marked in a highly visible manner, indicating the shaft cableway slot location, manufacturer, and Julian date. All tapped holes are to be center tapped within 1 degree of perpendicular to the plate. The threads shall be fully cleaned after hot dip galvanizing, such that a bolt may be hand run in the threads.

13D.4 SHAFT. Foundation shafts shall be machine flame cut to the length specified on the figure. The shaft shall be 90° square-cut on the top end, and to the true helical shape on the bottom end. The cableway slot (Figure 1 only) shall be machine smoothcut on one side of the shaft. The sides of the cableway openings shall be within 1/2 degree of parallel, as measured along their full length. The round shaft material shall be new, unused, and mill traceable.

13D.5 ASSEMBLY. Weld the component parts as Figures 1 and 2 specify. The completed assemblies (Figures 1, 2, and 3) must be hot dip galvanized after fabrication. Each Figure 1 foundation shall be supplied with four sets of carriage bolts, hex nuts, and lock washers. When bolts, nuts, and lock washers are shipped assembled, the nuts shall be tightened securely to prevent loss in shipment. Otherwise, the hardware shall be supplied in a burlap bag securely taped to the foundation.

13D.6 QUALITY ASSURANCE. No screw anchor foundations will be accepted from a manufacturer, unless the manufacturer has in place and in operation, a quality assurance department as a separate and distinct element of the manufacturer's organization. The quality assurance department must:

a. Employ quality assurance engineers who execute quality assurance by industry-accepted methods such as Statistical Process Control (SPC).

b. Maintain, and operate under, a quality assurance manual defining quality control functions and operations such as:

(1) Controlling the quality of incoming raw materials.

(2) In-process inspection, assembly inspection, and final inspection and tests, including specific actions to be taken when defects are found.

(3) Integration of quality assurance practices into the manufacturing process at the level of individual production operators.

(4) Welder certification. The qualification of personnel must be accomplished in accordance with the American Welding Society, Structural Welding Code (D1.1-83).

(5) Tool and gauge control, including calibration test schedules.

(6) Record keeping for all of the above quality assurance actions.

13D.7 INSTALLATION EQUIPMENT. If screw anchor foundations are shown on the drawings, the contractor shall furnish the installation equipment. The digger derrick or other driving equipment shall have sufficient clearance between the driving head and the ground to accommodate the screw anchor foundations specified. Pre-drilling (see Paragraph 13D.8c, below) or any other excavation at the anchor installation site for the purpose of gaining clearance under the driving head to accommodate the length of the anchor foundations, is expressly prohibited.

a. Figure 1 Foundation. The Figure 1 foundation requires the following items of installation equipment:

(1) Kelly bar adapter selected to fit directly to the kelly bar (rotating shaft) of the driving equipment.

(2) A tool to transmit the driving torque from the kelly bar adapter to the Figure 1 foundation. This driving tool must fit the kelly bar adapter and the Figure 1 foundation. Universal Driving Tools A. B. Chance Catalog No. C303-0139 and C303-0684, are two of the products that meet this requirement.These tools are used to drive Figure 1 foundations. The moderate-strength (C303-0139) tool connects to the kelly bar adapter with six 1/2"-dia bolts. The high-strength (C303-0684) connects to the kelly bar adapter with up to twelve 5/8"-dia bolts. Both tools have various bolt holes for attachment to the anchor foundation. A range of moderate-strength kelly bar adapters for various kelly bar dimensions is presented in Figure 4, with an illustration of Universal Driving Tool C303-0139. A range of high-strength kelly bar adapters for various kelly bar dimensions is presented in Figure 5, with an illustration of Universal Driving Tool C303-0684. The A. B. Chance items listed and illustrated are among the products which meet requirements. The contractor may substitute other drive tooling without submittals if the substitute tooling is dimensionally and dynamically compatible with the kelly bar and foundation.

b. Figure 2 Foundation. The Figure 2 foundation requires the following items of installation equipment:

(1) Kelly bar adapter selected to fit directly to the shaft of the driving equipment.

(2) A tool to transmit the driving torque from the kelly bar adapter to the Figure 2 foundation. This driving tool must fit the kelly bar adapter and the Figure 2 foundation. The Wrench Driving Tool, Chance Cat. No. 639000, is one of the products which meet this requirement. This tool is used to drive Figure 2 foundations. It has a square 2-inch socket and two set screws which serve to connect the tool to the screw anchor foundation.

A range of kelly bar adapters for various kelly bar dimensions is presented on Figure 6, with an illustration of the Wrench Driving Tool. The A. B. Chance items listed and illustrated are among the products which meet requirements. The contractor may substitute other drive tooling without submittals if the substitute tooling is dimensionally and dynamically compatible with the kelly bar and foundation.

13D.8 SCREW ANCHOR FOUNDATION INSTALLATION REQUIREMENTS.

a. Plumbness. The foundations shall be installed plumb, within a tolerance of 1/8" horizontal per foot vertical.

b. Foundation Top Elevation and Cableway Orientation. The foundation shall not be backed out to meet a specific foundation top elevation. Therefore, the top elevation must be checked as the foundation is driven. Foundations shall be turned down an additional fraction of a revolution in order to properly align the bolt holes. If a specific orientation of the cableway slot in the shaft is required (e.g., facing the RVR power and control stand), the contractor shall so orient the shaft.

c. Pre-drilling.

(1) Pre-drilling is defined as augering a hole centered on the design location of a foundation. Pre-drilling is sometimes necessary in very stiff soils, to permit driving the foundation to design depth without exceeding a torque which would damage the foundation.

(2) Pre-drilling, if authorized by the Resident Engineer, shall be accomplished using an auger not larger in diameter than the foundation shaft diameter (not helix diameter).

(3) The need for, and depth of, pre-drilling shall be determined solely by the Resident Engineer, with information from the contractor. The contractor shall do no pre-drilling until the Resident Engineer authorizes him to do so. The contractor shall not pre-drill to a depth greater than the depth authorized by the Resident Engineer.

13D.9 Procurement. Unless specified otherwise, screw anchor foundations shall be furnished by the contractor. If the contractor intends to furnish foundations other than the A. B. Chance foundations accepted in Paragraph 13D.2, the contractor shall submit complete manufacturer's information, including the quality assurance manual, and shop drawings, to the Contracting Officer. The contractor shall not procure the substitute screw anchor foundations before receiving the Contracting Officer's approval. See Paragraph 1A.4 above.

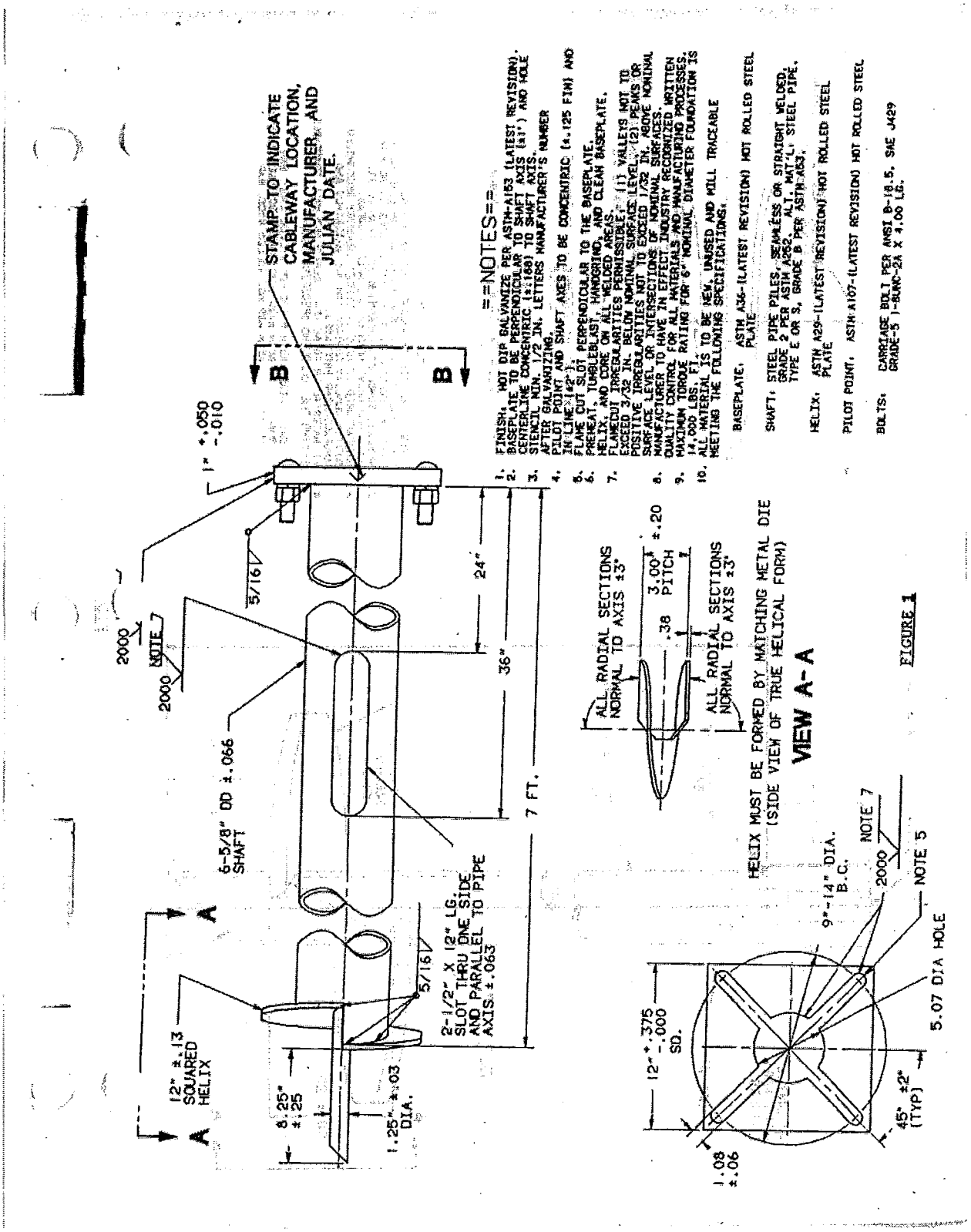


FIGURE 1

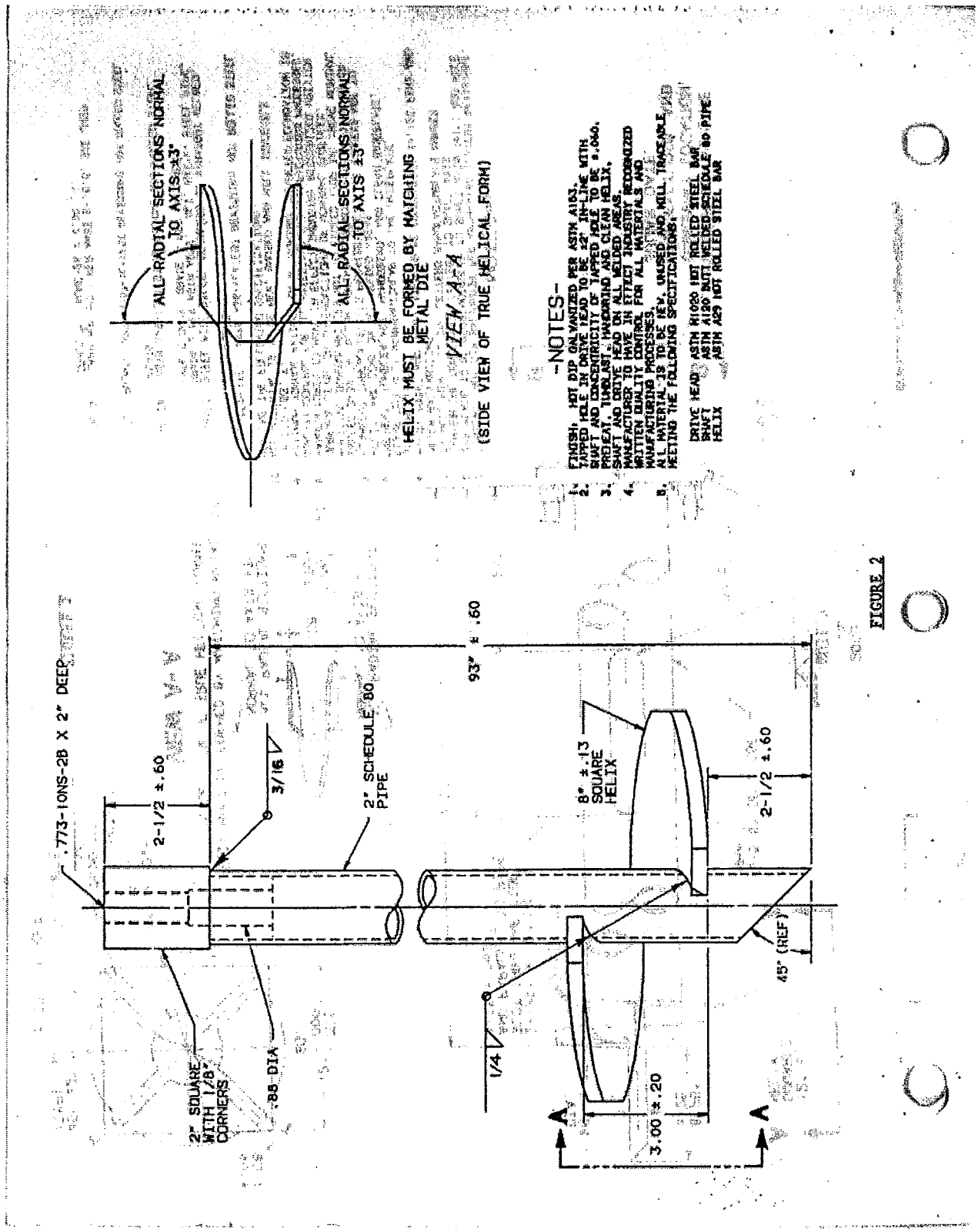


FIGURE 2

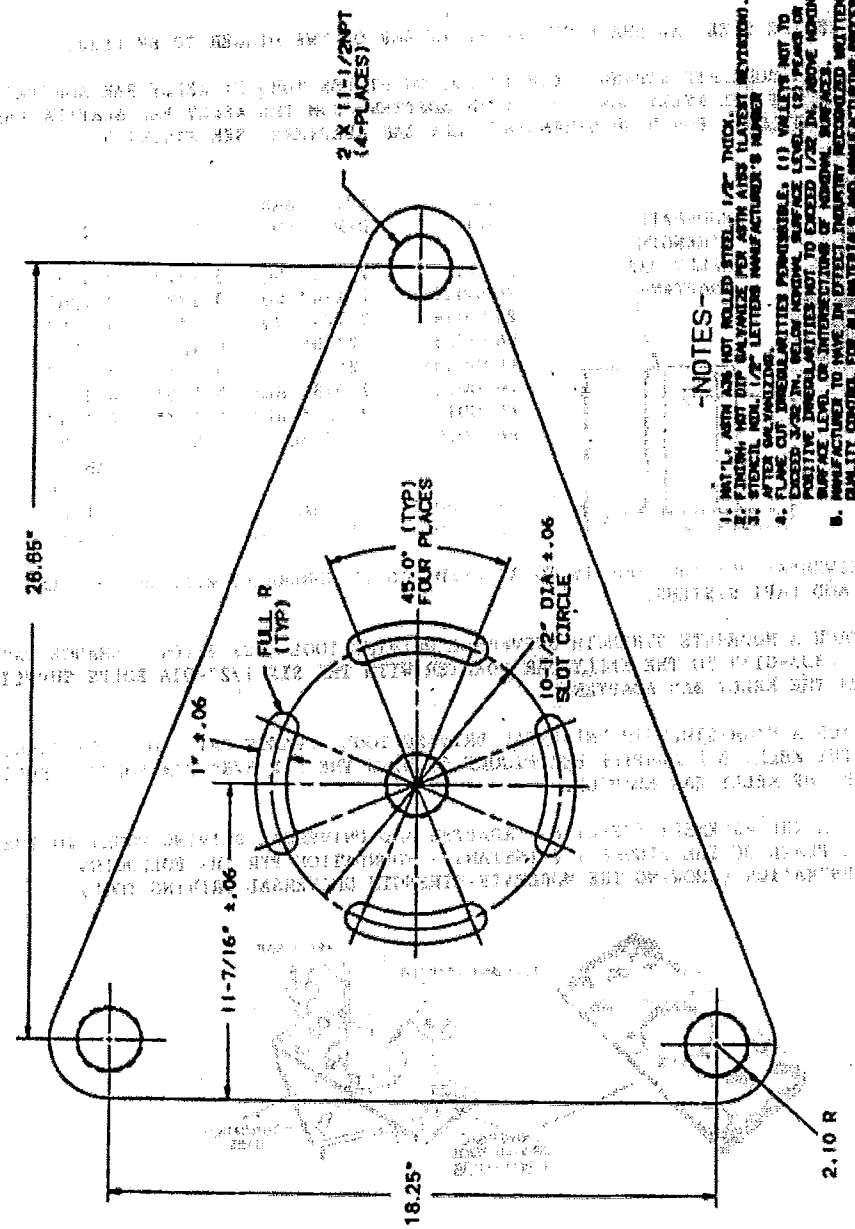


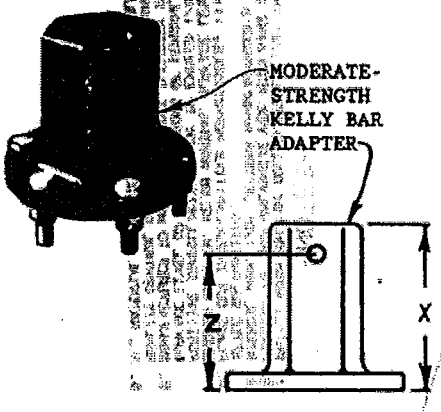
FIGURE 3

FIGURE 4

TOOLING FOR DRIVING SCREW ANCHOR FOUNDATIONS
FOR ILS, MALSR, AND PAPI SYSTEMS

1. DETERMINE THE SIZE AND SHAPE OF THE KELLY BAR OF THE DIGGER TO BE USED.

2. TO SELECT A MODERATE-STRENGTH (UP TO 10,000 FT-LBS TORQUE) KELLY BAR ADAPTER THAT WILL FIT THE KELLY BAR, SELECT AN ADAPTER FROM THE KELLY BAR ADAPTER PART NO. TABLE BELOW. FOR HIGH-STRENGTH KELLY BAR ADAPTERS, SEE FIGURE 5.



PART NO.	KELLY BAR DIMENSION	X	Z
P630017	2 1/2" SQ	3 1/2"	2 1/4"
P630016	2 1/4" SQ	3 1/2"	2 1/4"
P630014	2 1/4" SQ	7"	5 7/8"
P630013	2" HEX	6 1/8"	5"
P630013A	2" HEX	6 1/2"	3 1/4"
P630012	2 5/8" HEX	5 1/8"	4 1/4"
P630011	2 1/2" HEX	5 1/8"	4 1/4"
P630010	3" SQ	5"	3 1/2" AND 2 1/16"
C303-0017	3" HEX	5"	3 1/2"
C303-0016	3 1/2" SQ	5"	3 3/8"

3. IF A UNIVERSAL DRIVING TOOL IS TO BE USED, AS IT GENERALLY WILL BE FOR ILS, MALSR, AND PAPI SYSTEMS:

   A. ATTACH A MODERATE-STRENGTH UNIVERSAL DRIVING TOOL (SEE BELOW), CHANCE CAT. NO. C303-0139 TO THE KELLY BAR ADAPTER WITH THE SIX 1/2"-DIA BOLTS SUPPLIED WITH THE KELLY BAR ADAPTER.

   B. ATTACH A HIGH-STRENGTH UNIVERSAL DRIVING TOOL, CHANCE CAT. NO. C303-0684, TO THE KELLY BAR ADAPTER PER FIGURE 5, WITH THE SIX 5/8"-DIA BOLTS SUPPLIED WITH THE KELLY BAR ADAPTER.

   C. ATTACH THE ASSEMBLY (KELLY BAR ADAPTER AND UNIVERSAL DRIVING TOOL) TO THE BASE PLATE OF THE FIGURE 1 ("INSTANT") FOUNDATION PER THE FOLLOWING ILLUSTRATION (SHOWING THE MODERATE-STRENGTH UNIVERSAL DRIVING TOOL).

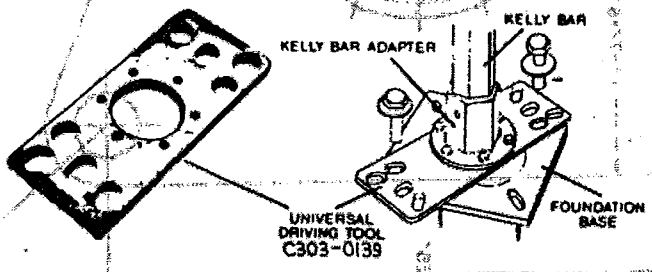
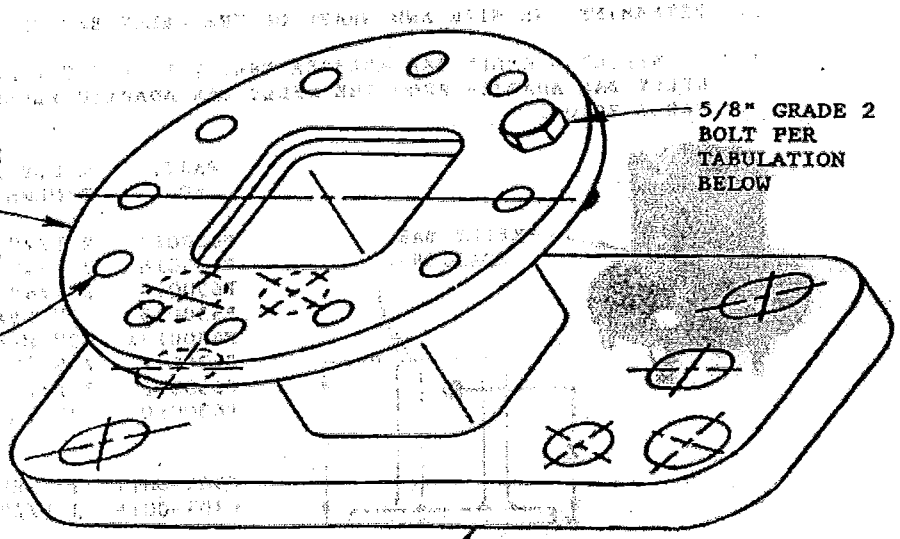


FIGURE 5

HIGH-STRENGTH UNIVERSAL DRIVING TOOL AND KELLY BAR ADAPTERS

NOTE: HIGH-STRENGTH TOOLING IS REQUIRED FOR DRIVING FIGURE 1 ("INSTANT") FOUNDATIONS WHEN INSTALLATION TORQUE MUST EXCEED 10,000 FT-LBS.



KELLY BAR ADAPTER WITH RETAINING PIN — (7.625" Bolt Circle)

Part No.	A	B	5/8" Gr. 2 Bolts Incl.	Retaining Pin Incl.	Kelly Bar Dimension
C303-0936	3 7/8"	8.12"	6	C303-0799	2 1/2" Hex
C303-0937	3 7/8"	8.12"	6	C303-0799	2 5/8" Hex
C303-0940	4 1/2"	8"	12	C303-0801	3" Hex
C303-0955	4 3/4"	7"	6	C303-0791	2 1/2" Square
C303-0958	3 1/2" & 4 15/16"	7"	12	C303-0791	3" Square

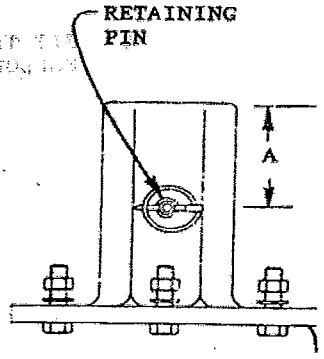
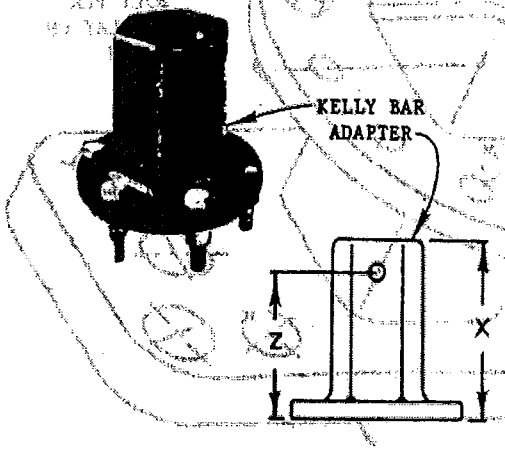


FIGURE 6

TOOLING FOR DRIVING SCREW ANCHOR FOUNDATIONS FOR VASI AND REIL SYSTEMS

1. DETERMINE THE SIZE AND SHAPE OF THE KELLY BAR OF THE DIGGER TO BE USED.

2. TO SELECT A KELLY BAR ADAPTER THAT WILL FIT THE KELLY BAR, SELECT A KELLY BAR ADAPTER FROM THE KELLY BAR ADAPTER ILLUSTRATION AND PART NO. TABLE BELOW.

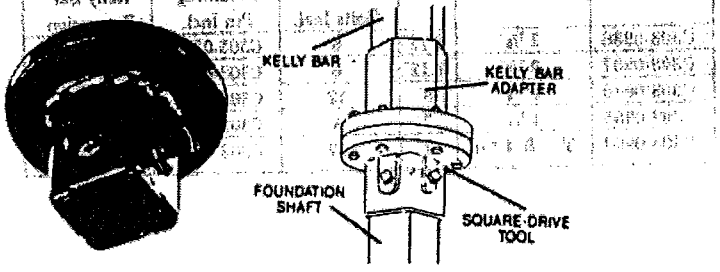


PART NO.	KELLY BAR DIMENSION	X	Z
P630017	2 1/2" SQ	3 1/2"	2 1/4"
P630016	2 1/4" SQ	3 1/2"	2 1/4"
P630014	2 1/4" SQ	7"	5 7/8"
P630013	2" HEX	6 1/8"	5"
P630013A	2" HEX	6 1/2"	3 1/4
P630012	2 5/8" HEX	5 1/8"	4 1/4"
P630011	2 1/2" HEX	5 1/8"	4 1/4"
P630010	3" SQ	5"	3 1/2" & 2 1/16"
C303-0017	3" HEX	5"	3 1/2"
C303-0016	3 1/2" SQ	5"	3 3/8"

3. IF A SQUARE DRIVE TOOL IS TO BE USED, AS IT GENERALLY WILL BE FOR VASI AND REIL SYSTEMS:

   A. ATTACH THE SQUARE DRIVE TOOL (CHANCE PART NO. 639000) TO THE KELLY BAR WITH SIX 1/2"-DIA BOLTS.

   B. FIT THE 2"-SQUARE SOCKET TO THE END OF THE FOUNDATION ANCHOR PER THE FOLLOWING ILLUSTRATION.



DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13E
MALSR AND ILS EQUIPMENT SHELTERS

13E.1 DESCRIPTION OF WORK. This section is applicable if equipment shelter construction is required for a MALSR or ILS. Extent of work is indicated on the drawings. All wood-frame shelters shall be constructed on their foundations, unless specified otherwise.

13E.2 SHELTER CARPENTRY.

a. Lumber and Plywood Materials.

(1) General Requirements.

(a) Factory mark each piece of lumber and plywood identifying grading agency, grade, and species.

(b) All lumber sizes are nominal, dressed S4S and seasoned to 19 percent moisture content.

(2) Dimension Lumber.

(a) Studs. "Stud" grade, any species.

(b) Joists, Rafters and Plates. "Structural Joists and Planks" Number 2 grade or better, any species. Plates in contact with concrete shall be pressure treated.

(3) Plywood Sheathing. All veneer plywood complying with following:

(a) Exterior sheathing. APA Structural 1 Rated Sheathing, Exterior, Exposure 1, or APA CC Plugged Exterior of sizes indicated.

(b) Interior Sheathing. APA AC Exterior.

b. Installation.

(1) Securely attach carpentry work by anchoring and fastening as shown or as required by recognized standards. Set work to required lines and levels with members plumb and accurately cut and fitted.

(2) Use common nails except as indicated. Select fastener sizes that will not conflict with other work.

13E.3 SHELTER DOOR AND FRAME.

a. Quality Assurance. Provide doors and frames complying with Steel Door Institute "Recommended Specifications: Standard Steel Doors and Frames" (SDI-100) and as herein specified.

b. Fabrication.

(1) General. Fabricate steel door and frame units to be rigid, neat in appearance, and free from defects, warpage, and buckle. Wherever possible, fit and assemble units in the manufacturer's plant.

(2) Door Type/Grade. Doors shall be SDI-100, Grade III, extra heavy duty, Model 1, full flush, minimum 16 gage faces, 1 3/4 inch thick.

(3) Construction.

(a) Fabricate exposed faces of door and panels from cold-rolled steel only. Fabricate concealed stiffeners, reinforcement, and edge channels from either cold or hot rolled steel at fabricator's option. All door and frame materials shall be galvanized.

(b) Close top and bottom edges of exterior doors flush as an integral part of construction or by the addition of 16-gage channels.

(4) Thermal Insulation. Door and frame shall be thermal-rated (insulated) assemblies tested in accordance with ASTM C 236. Provide thermal insulation with maximum U factor of 0.1 BTU/(hr ft^2 ^oF).

(5) Finish Hardware Preparation.

(a) Prepare doors and frames to receive mortised and concealed finish hardware in accordance with Subsection 13E.4, and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 series specifications for door and frame preparation for hardware.

(b) Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at project site.

(c) Locate finish hardware in accordance with "Recommended Locations for Builder's Hardware", published by the Door and Hardware Institute.

(6) Door Frames. Fabricate door frames of style shown on the drawings. Conceal fastenings and fabricate frames from minimum 16-gage galvanized cold rolled furniture-quality steel. Fabricate frames with mitered and welded corners.

(7) Shop Painting. Apply shop coat of primer paint to provide a uniformly finished surface ready to receive finish coats.

c. Installation.

(1) Placing Frame.

(a) Comply with provisions of SDI-105 "Recommended Erection Instructions for Steel Frames".

(b) Install at least 3 wall anchors per jamb at hinge and strike levels. Anchor to wood stud framing using fasteners and devices for rigid attachment.

(2) Doors. Fit hollow metal doors accurately in frames, within clearances specified in SDI-100.

(3) Adjust and Clean.

(a) Immediately after erection, sand smooth any corroded or damaged areas of prime coat and touch-up paint with compatible primer.

(b) Apply finish paint coats per Division 9.

(c) Check and readjust operating finish hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.

13E.4 DOOR HARDWARE.

a. General Requirements.

(1) Templates. Furnish hardware templates to fabricator of doors and frames to be factory-prepared for installation of hardware.

(2) Finish. BHMA #612 (Federal Specification US 10) satin bronze plated for hinges and lock set.

(3) Fasteners. Provide Phillips flat-head machine screws, matching finish and of proper design size for hardware item furnished.

b. Materials.

(1) Hinges. Provide 1 1/2 pair 4 1/2 x 4 1/2 hinges, full mortise type, heavyweight, ball bearing, five knuckle, square corner, swaged, steel with steel pin, non-removable and non-rising pin, flat button and matching plug tips. Stanley #FBB-168 is one of the products meeting these specifications.

(2) Lockset. Provide mortise lockset, Best Lock Corporation Catalog Number 35H-7-F-3-J-626-RHRB having a 7-pin cylinder and furnished without core. The FAA Resident Engineer will supply the construction core which the Resident Engineer receives from FAA sector personnel. The contractor shall install the construction core. No substitution for the above lockset will be permitted.

(3) Doorholder. Provide a door holder, overhead surface type, exterior door use, with safety release, combination door stop, shock-absorbing cushion, and holder complying with FS 1161 and BHMA C012511. Glynn-Johnson #GJ90M is one of the products meeting these specifications.

(4) Threshold. Provide an aluminum threshold not less than 3 1/2 inches wide, and of such height that weather-stripping insert will contact inner face of door. Threshold shall include rabbeted design with replaceable neoprene insert in step. Zero #563 Rabbeted Saddle is one of the products that meets these specifications.

(5) Weatherstripping at Door Jambs and Head. Provide continuous weatherstripping at all edges of doors. Provide only those units where resilient seal strips are easily replaceable and readily available from the manufacturer. Construction shall include flexible neoprene bulb insert in extruded aluminum channel with snap-on cover, hidden fasteners, surface-mounted design. Zero #475 is one of the products that meet these specifications.

c. Installation.

(1) Hardware Mounting Heights. Mount units of hardware at heights indicated in "Recommended Locations for Building Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.

(2) Procedures.

(a) Install each item per manufacturer's instructions.

(b) Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

(c) Drill and countersink units which are not factory prepared for anchor fasteners. Space fasteners in accordance with industry standards.

(d) Set thresholds in full bed of butyl-rubber or polyisobutylene mastic sealant.

13E.5 INSULATION.

a. Material. Wall and ceiling installation shall be fiberglass batt insulation faced with coated Kraft paper. Insulation batts shall have staple flanges. The batts shall be nominally 6 inches thick, with R-19 insulation value. Batt width shall be compatible with stud spacing.

b. Installation. Install insulation batts between all studs and joists such that batts will retain full thickness. Stuff loose fiberglass insulation into cracks impossible to fill with batts. Compress loose insulation no tighter than 50 percent of normal volume when needed to hold it in place.

13E.6 RESILIENT FLOORING.

a. General.

(1) Manufacturer. Provide resilient flooring and accessories as produced by a single manufacturer including recommended primers, adhesives, and leveling compounds.

(2) Temperatures. Maintain 65^{o} minimum temperature in space to receive flooring for at least 48 hours before installation, during installation, and for at least 48 hours thereafter. Store flooring materials in space where they will be installed for 48 hours prior to installation.

(3) Order of Work. Install resilient flooring and accessories after completion of painting and other finishing work. Do not install over concrete slab until the concrete is cured to the satisfaction of the Resident Engineer.

b. Materials.

(1) Floor Tile. Material shall be vinyl composition tile complying with FS SS-T-312, Type IV, 12" x 12", 1/8-inch gage, composition 1 (asbestos free). The following products are among products that meet the specification.

Armstrong: Standard Excelon, Imperial Texture - #51890 Desert Tan.

Azrock: Custom Cortina - V846 Thyme.

Kentile: Architectural Criterion - #1458 Wheat.

(2) Vinyl Wall (Cove) Base. Material shall be vinyl base complying with FS SS-W-40, Type II, with matching end stops and preformed or molded corner units. Height shall be 4 inches, thickness 0.080 inch. Style shall be standard top-set cove with toe. The following products are among products that meet these specifications:

Armstrong:	#124 Pecan.
Azrock:	#YCB-5 Beige.
Kentile:	#KC-22 Taupe.

(3) Adhesive (Cements). Waterproof, stabilized type as recommended by flooring manufacturer for material and substrate conditions.

(4) Concrete Slab Primer. Non-staining type as recommended by flooring manufacture.

(5) Leveling and Patching Compounds. Latex types as recommended by flooring manufacturer.

(6) Floor Wax. Product recommended by floor tile manufacturer.

c. Installation.

(1) Preparation.

(a) Use leveling and patching compounds as recommended by flooring manufacturer for filling small cracks, holes, and depressions in slabs.

(b) Remove coatings from slab surfaces that would prevent adhesive bond, including curing compounds if incompatible with flooring adhesive.

(c) Broom clean or vacuum surfaces.

(d) Apply concrete slab primer, if recommended by flooring manufacturer.

(2) Floor Tile.

(a) Install in strict compliance with manufacturer's printed instructions. Extend floor tile into door reveals and similar openings.

(b) Scribe, cut, and fit floor tile to permanent fixtures, columns, walls, conduit and similar construction.

(c) Tightly cement floor tile to slab without open cracks, voids, raising, and puckering at joints, telegraphing of adhesive spread marks or

other imperfections. Hand roll at perimeter of each covered area to assure adhesion.

(d) Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of room area are of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile at room perimeters.

(e) Cut tile neatly around all obstructions. Broken, cracked, chipped or deformed tiles are not acceptable.

(f) Lay tile in "checkerboard" fashion with grain reversed in adjacent tiles.

(g) Adhere tile flooring to slab using full spread of adhesive applied in compliance with flooring manufacturer's directions.

(3) Wall Base. Install base in lengths as long as practical with preformed corner units or fabricated from base material with mitered or coped inside corners. Tightly bond base to substrate throughout length of each piece, with continuous contact at horizontal and vertical surfaces.

d. Cleaning and Protection. Perform the following operations immediately upon completion of tile installation work. Sweep or vacuum floor thoroughly, but do not wash until tile adhesive has cured as recommended by manufacturer. Damp mop and remove any excess adhesive and other blemishes using cleaners recommended by manufacturer. Apply wax as recommended by manufacturer.

13E.7 PAINTING.

a. General Requirements. Comply with all requirements of Section 9A, excepting paint system schedule, and the requirements of this subsection.

b. Surfaces to be Painted.

(1) Interior.

(a) Plywood ceiling and wall surfaces.

(b) Wood trim and all other exposed finish carpentry work.

(c) Steel door and frame.

(d) All exposed conduit, outlet and switch boxes, but not pre-finished large electrical wall-mounted equipment enclosures.

(2) Exterior.

(a) Steel door and frame.

(b) Air intake hood.

(c) Air conditioner sleeve surfaces and supports.

(3) Ancillary Items. Major surfaces to be painted are those listed above. Paint minor items affixed or adjacent to such surfaces the same color as primary items.

(4) Exclusions. The following equipment shall not be painted:

(a) Pre-finished safety switch, power panelboard, electrical equipment enclosures and other large similar electrical items.

(b) Exhaust fan.

(c) Air conditioner.

(d) Ventilation dampers and motor operators.

c. Materials.

(1) Single Source Responsibility. Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

(2) Colors.

(a) Interior and exterior surfaces of door and frame shall be a medium gray color approved by the Resident Engineer.

(b) Interior wall and ceiling surfaces shall be white.

(3) Federal Specifications. Federal specification references establish minimum acceptable quality of paint materials. Provide written certification from manufacturer that materials provided meet or exceed the minimum if not so indicated on product labels.

d. Paint Schedule. In the paint schedule below, the following manufacturer codes in parentheses are used:

Benjamin Moore and Co. (Moore).

PPG Industries, Pittsburgh Paints (PPG).

Pratt and Lambert (P&L).

The Sherwin-Williams Company (S-W).

(1) Ferrous Metal. Provide two finish coats over primer. Omit primer for items delivered shop primed.

(a) Prime Coat. Red Lead Pigmented Primer (FS TT-P-86). The following products are among products which meet FS TT-P-86.

Moore: Ironclad Retardo Rust Inhibitive Paint.

PPG: UC 10424 Red Lead Primer.

P & L: P & L Red Lead Primer.

S-W: S-W Kromik Metal Primer.

(b) First and Second Finish Coats. High Gloss Alkyd Enamel (FS TT-E-489). The following products are among products that meet FS TT-E-489:

Moore: Impervo High Gloss Enamel Exterior/Interior.

PPG: 6-252 Speedhide Quick-Dry Alkyd Enamel.

P & L: Effecto Enamel.

S-W: S-W Metalistic II Enamel.

(2) Zinc-Coated Metal (New Unpainted Galvanized). Provide two finish coats over primer.

(a) Prime Coat. Zinc Dust - Zinc Oxide Primer (FS TT-P-641). The following products are among products that meet FS TT-P-641:

Moore: Ironclad Galvanized Metal Primer.

PPG: 6-215 Speedhide Galvanized Steel Primer.

S-W: S-W Galvanized Iron Primer.

(b) First and Second Finish Coats. High-Gloss Alkyd Enamel (FS TT-E-489), same as for ferrous metal.

(3) Interior Plywood.

(a) Lusterless (Flat) Emulsion Finish. Provide two coats.

(b) First Coat. Interior Latex Base Primer Coat (FS TT-P-650). The following products are among products that meet FS TT-P-650:

Moore: Moore's Latex Quick-Dry Prime Seal.

PPG: 6-2 PPG Quick-Drying Interior Latex Primer Sealer.

P & L: Pro-Hide Plus Latex Primer.

S-W: S-W Pro-Mar Latex Wall Primer.

(c) Second Coat. Interior Flat Latex Base Paint (FS TT-P-29). The following products are among products that meet FS TT-P-29.

Moore: Moore's Regal Wall Satin.

PPG: 6-70 Speedhide Latex Flat Wall Paint.

P & L: Pro-Hide Plus Latex Flat.

S-W: S-W Pro-Mar 400 Latex Flat Wall Paint

e. Application.

(1) Remove hardware, hardware accessories, plates, and similar in-place items not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Following completion of painting, reinstall removed items.

(2) Finish exterior door on top, bottom and side edges, the same as exterior face. Sand lightly between each succeeding enamel coat. Omit first coat (primer) on metal surfaces which have been shop-primed and touch-up painted.

f. Clean-Up and Protection.

(1) Upon completion of painting work, clean any paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

(2) Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing, or replacing, and repainting, as acceptable to the Resident Engineer.

13E.8 STEEL SIDING. Furnish and install steel siding panels and accessories in accordance with manufacturer's instructions and the following material specifications.

a. Steel Sheet and Forming. The steel sheet of the siding panels shall be .15 maximum carbon steel. The sheet shall have a G90 galvanized finish applied by the continuous hot-dipped galvanized method per ASTM Specifications A-525-81 and A-526-80. The nominal thickness of the sheet after galvanizing shall be 0.0165-inch. The siding shall be formed by a continuous roll forming process.

b. Painting. Factory painting shall be done such that:

The surface of the steel sheet is processed in line through a chromate pretreatment consisting of an alkaline chemical cleaning bath, followed by a chromate conversion coating. Primer is applied immediately after chemical treatment by roller coating, and baked under controlled oven temperature. The reverse side of the sheet is concurrently coated with R-21 epoxy enamel, and baked. A PVC plastisol coating is applied at a minimum dry film thickness of 3.5 mils, and baked in a controlled environment oven. Unless otherwise specified on the drawings, the outside finish color is white.

c. Siding Meeting Specifications. Super Steel Siding by Alside of Akron, Ohio is among products meeting these specifications. Substitutes require submittals per Paragraph 1A.4 above.

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13F
NEW GENERATION RVR SYSTEMS

13F.1 SCOPE. This section applies to special construction of New Generation Runway Visual Range (RVR) systems. The work includes all non-electronics facility construction, such as the installation of Visibility Sensor sites (VS), Runway Light Intensity Monitors (RLIM), and Ambient Light Sensors (ALS). RVR electronics installation will be performed by others.

13F.2 VISIBILITY SENSOR SITE (VS).

a. General. Fiberglass LIR tilt-down poles will support the electronic sensors used to measure runway visibility. The contractor shall fabricate and furnish the VS foundation adapter base plate. All of these parts shall be assembled and mounted on screw anchor foundations furnished by the contractor. For screw anchor foundations, see 13D above. Install all items per drawings and manufacturers' instructions. See the site plan for anchor location.

b. Fabricated Base Plates. In accordance with the drawings, the contractor shall fabricate base plates for both the visibility pole anchor and the tilt-down device anchor.

c. LIR Pole Cutting and Assembly. The contractor shall calculate the pole length required to put the RVR lamp centerline 14'-0" above the adjacent runway centerline elevation. The top of the fiberglass pole must be cut 1'-6" below the required RVR lamp centerline elevation. Do not cut the pole before the Resident Engineer verifies the required length. The contractor shall cut the fiberglass pole to proper length, according to the instructions shown on the project drawings. The pole shall be cut only in the presence of the Resident Engineer. See standard drawing GL-D-200-5A for pole cutting and assembly details.

d. Vertical Tolerance. After the assembled tube and preassembled mounting frame have been installed on the screw anchor foundation, adjust the leveling nuts on the base plate of the LIR structure such that the mast centerline is vertical within a tolerance of 1/2-inch between top and bottom of tube.

e. Test. The contractor shall demonstrate to the satisfaction of the Resident Engineer that the installed LIR structure will tilt down smoothly without evidence of binding or use of undue force. The pole must also rest squarely between the pole maintenance stand supports when in the down position. Adjust as necessary and repeat testing until accepted by the Resident Engineer.

f. Power and Control Stand.

(1) Structure. A frangible power and control stand shall be constructed not more than 4 feet away from the visibility sensor pole. The stand shall be located to prevent interference with tilting down the sensor pole, as indicated on the drawings. The base channel shall be shimmed, if necessary, to level it.

(2) Electrical Components. SIE boxes will be installed later by others. The power disconnects and control junction boxes shall be contractor-furnished and installed. See Division 16 for specific details about the junction boxes, wires, conduits, and power disconnect switches to be used. Power and control wiring that is above grade shall be run thru 3/4" UV resistant liquid-tight conduits to the SIE box location. If more than one SIE box is shown on the drawings, separate sets of power and control cables shall be run in 3/4" liquid-tight conduits to each SIE box location. Install 3/4" female end connectors on the ends of all conduits that will attach to the future SIE boxes.

13F.3 AMBIENT LIGHT SENSOR (ALS). One Ambient Light Sensor (ALS) will be required per airport to check lighting conditions on the field. This ALS shall be collocated with one of the visibility sensor sites where shown on the drawings. The 1 1/2" ALS mounting pipe position shall be such that the sensor unit will have an unobstructed view of the north horizon sky 6° above the horizon combined with a 6° field of view. To prevent false readings, the ALS sensor unit shall not be pointed parallel to the runway, towards brightly lighted areas, or toward the VS pole. Also ensure that the obstruction light is positioned to the side of or behind the ALS sensor. Take these criteria into account when positioning the 1 1/2" ALS mounting pipe on the power and control stand.

13F.4 OBSTRUCTION LIGHTS.

a. General. A double (L-810) steady-burning aviation red obstruction light fixture shall be installed 6'-6" above grade on the power and control stand as shown on the drawings. The lights shall be made to operate from the first night and thereafter following the installation of the LIR structure. The lights shall operate continuously, and be operational before the VS pole is raised. Do not install the obstruction light where the illumination will interfere with the operation of the Ambient Light Sensor.

b. Obstruction Light Fixtures. Fixtures shall be FAA Type L-810 (116W)double-lamp steady-burning units with cast aluminum fittings, aviation red fresnel lens globes, and a 1" inch threaded conduit bottom fitting. Hughey & Phillips, Inc., Model OB22, is among the products that meet this specification. These dual light fixtures shall be mounted on a 1" rigid galvanized conduit.

c. Photo Cell. All obstruction lights shall be controlled by a photo cell installed on the obstruction light rigid conduit. The photo cell shall be 120V,3000W rated, 1 pole, single throw double break type and shall be installed in a weatherproof housing. The cell shall be pointed north, and shall turn on when the northern sky illuminance reaching a vertical surface falls below a level of approximately 35 foot candles (376.7 LUX). The control device should turn off the lights when the northern sky illuminance rises to a level of not more than 60 foot candles (645.8 LUX).

13F.5 RLIM INSTALLATION. Runway Light Intensity Monitoring (RLIM) equipment shall be installed in the appropriate power vault(s) to sense the appropriate runway edge and/or centerline cable current. All conduits shall be routed around or over existing conduits, and shall avoid all "live" or exposed wires. Extreme care shall be exercised while working in the vaults, due to the numerous high voltage cables.

13F.6 GROUNDING CONDUCTORS.

a. Grounding Conductors with Tracer. A tracer is a factory-applied stripe spiraling around the insulation of a cable, of a color contrasting with that of the insulation. The equipment ground wire (cable) for the RVR control junction box shall be a #4 stranded green insulated wire with a red tracer. The VS and ALS sensor units shall each be grounded with a #6 stranded green insulated wire with an orange tracer. The RLIM current sensor location shall be grounded with a #12 stranded green insulated wire with an orange tracer wire.

b. SIE Box Grounding Conductor. Five feet of a #6 green SIE box ground wire connected to the ground rod shall be coiled above grade for connection to the future VS SIE box ground. Two such wires will be required if two SIE boxes are to be installed. The wire shall be routed into the ground through 3/4" PVC conduit to a depth of l8" below grade, then connected to one of the VS pole's ground rods. The top of all open conduits shall be sealed to make them waterproof.

c. For Power and Control Cables from Source. Ground wires (#6 bare) shall be run inside the entire length of both the RVR power and control cable conduits from their sources. Both ends shall be terminated at ground lugs. These wires are in addition to the buried guard wire required by Paragraph 16A.4e.

13F.7 AC SURGE ARRESTER. An AC surge arrester, 120V, single phase, with a weather-proof enclosure, shall be attached and wired to the line side of the safety disconnect switch. The Lightning Protection Corporation Model No. LPC 11755 AC surge arrester is one of the products that meet this specification.

13F.8 CONTROL JUNCTION BOX. The exterior control junction box mounted on the power and control stand shall be a padlockable 12" x 12" x 6", 16-gauge galvanized steel NEMA 3R hinged cover enclosure, meeting the requirements of Paragraph 16A.15 below. Hoffman Cat. No. A-12R126HCR hinged cover enclosure with a A-12N12P panel is one of the products that meets this specification.

13F.9 TERMINAL BLOCKS. The terminal blocks in the control junction box on the power and control stand, shall be fastened in a vertical array to the left side of the interior panel. This arrangement reserves space on the right side for later installation, by others, of lightning protection equipment. The terminal blocks shall be of the miniature style specified in Paragraph 16A.19.

13F.10 DRAWINGS. Standard New Generation RVR details are shown on drawings GL-D-200A thru GL-D-200-5A. See individual site plans for local details.

DIVISION 16 - ELECTRICAL
SECTION 16A
BASIC METHODS AND MATERIALS

16A.1 APPLICABLE DOCUMENTS.

a. Federal Documents. The following Federal Specifications in effect on the date of the invitation for bids or request for proposals, form a part of this specification.

(1)	WW-C-581	Conduit, Metal, Rigid; and Coupling, Elbow, and Nipple, Electrical Conduit: Zinc-Coated
(2)	WW-C-563	Conduit, Metal Rigid; Electrical, Thinwall Steel Type (Electrical Metallic Tubing); Straight Lengths, Elbows, and Bends
(3)	W-F-408	Fittings for Conduit, Metal, Rigid (Thickwall) and Thin-Wall (EMT)

b. Electrical Codes. The following publications and regulations, in effect on date of the invitation for bids or request for proposals, form a part of this specification and are applicable to the extent specified herein.

(1) NFPA Number 70 National Electrical Code.

(2) The rules and regulations of local utility companies providing service.

(3) Local governing body rules and regulations.

16A.2 REQUIREMENTS.

a. General. The contractor shall install all electrical work in accordance with the applicable drawings and specifications. All electrical work shall be installed to meet the provisions of the current issue of the National Electrical Code, NFPA-70, and all state and local regulations.

b. Contract Drawings.

(1) Where the electrical drawings indicate or (diagrammatically or otherwise) the work intended and the functions to be performed (even though some minor details are not shown), the contractor shall furnish all equipment, material (other than Government furnished items) and labor to complete the installation work, and accomplish all the indicated functions of the electrical installation.

(2) Minor departures from exact dimensions shown on the drawings may be permitted where required to avoid conflict or unnecessary difficulty in placement of the dimensioned item, provided all other contract requirements are met. The contractor shall promptly obtain approval from the FAA Resident Engineer for any such proposed departure.

c. Materials. Materials and equipment, to be acceptable, must comply with all contract requirements. Materials to be furnished by the contractor under this specification shall be new and, unless specified otherwise, the standard products of a manufacturer's latest designs. Wherever standards have been established by Underwriters' Laboratories, Inc., the materials shall bear the UL label.

16A.3 CONDUIT.

a. Where electrical metallic tubing is shown on the drawings, at exterior or interior locations, it shall be used without substitution.

b. Except where specified otherwise, conduit exposed to the weather, in concrete, or below grade shall be galvanized rigid steel with threaded joints. All conduit and conduit fittings in contact with earth shall be field coated with asphaltum or have a factory PVC coating.

c. Except where otherwise specified, conduit used entirely indoors shall be rigid or electrical metallic tubing. Compression type fittings shall be used with metallic tubing.

d. Minimum size of conduit shall be 3/4-inch unless otherwise noted on the drawings. Each conduit run shall be installed complete before cable is pulled through.

e. All outdoor connections of conduit to enclosures shall be made with weatherproof hub fittings unless otherwise specified. Indoor connections of rigid conduit to enclosures shall be made with double locknuts and bushings. Refer to grounding section for disconnect switch conduit terminations.

f. Ends of conduits installed but not used, shall be closed with bushings and pennies. All underground conduit shall be temporarily plugged during construction to prevent entrance of foreign material.

g. Wherever conduit from outdoors or underground enters an enclosure or junction box, either indoors or outdoors, seal space between conduit and cables with conduit seal.

h. Exposed conduit shall be installed parallel to or at right angles with equipment and building wall surfaces unless shown otherwise. Field bends shall be avoided where possible, and where necessary shall be made with a hickey or conduit-bending device. Radius of field bends shall not be less than ten times the inside diameter of the conduit. Conduit shall be fastened securely to adjacent members or surfaces with galvanized clamps, straps.

i. The contractor shall install one #6 copper pull wire in underground duct or conduit which is installed or utilized under this contract. This is in addition to all power or control cables installed under this contract. The pull wire shall be continuous through the duct or conduit, and shall extend five feet beyond each end of the duct or conduit.

j. Flexible conduit shall be installed where specified on the drawings.

16A.4 GROUNDING.

a. Equipment, Structures, and Raceways.

(1) All metallic non-current carrying parts of electrical equipment (including enclosures) and supporting structures installed under this contract, whether used either for power or control, shall be grounded with an equipment grounding conductor, whether or not shown on the drawings. The grounding conductor shall be sized in accordance with the National Electrical Code, but shall be of larger gauge if so shown on the drawings. In no case shall the grounding conductor be smaller than #12 AWG, unless shown otherwise on the drawings.

(2) A service entrance conduit or any other power feeder conduit emerging from below grade and supplying power to another facility or system component shall terminate with grounding bushings at both ends. These requirements apply unless shown otherwise on the drawings.

(3) The equipment grounding conductor shall be connected to the grounded conductor (neutral) only at the service entrance disconnecting means. The equipment grounding conductor shall be installed in the same conduit as its related branch and feeder conductors, and shall be connected to the ground bus in the branch or distribution panelboard. The equipment grounding conductor shall be connected to all grounding bushings on conduits through which the conductor passes. The equipment grounding conductor shall be connected to all other grounding conductors in enclosures and bodies through which the conductor passes.

(4) Where there are parallel feeders installed in more than one raceway, a properly sized equipment grounding conductor shall be installed in each raceway. The metallic conduit carrying the equipment grounding conductor shall be electrically continuous, forming a path parallel to the equipment grounding conductor. Under no circumstances shall the equipment grounding conductor be omitted from the electrical system. Nor shall any separate grounding system such as the signal ground, be used for an alternate grounding system or and alternate path to the grounding electrode, unless so shown on the drawings.

(5) All connections to the equipment to be grounded shall be made with a grounding connector specifically intended for that purpose. Connecting screws or mounting bolts and screws are not suitable for use as grounding connections. All ground lugs shall be of a non-corroding material suitable for use as a grounding connection, and must be compatible with the type of metal being grounded. **REMOVE PAINT AND OTHER NON-CONDUCTING MATERIALS FROM SURFACES OF GROUNDING CONNECTIONS.**

(6) Unless otherwise specified, control equipment enclosures, pull boxes, and raceways, shall be grounded as above for power wiring.

(7) Where surface-mounted square duct, other wireways, or cable tray systems are installed, a separate copper conductor shall be installed in the raceway, and shall be properly bonded to each section. Unless otherwise specified, the minimum size ground conductor shall be #6 green insulated copper.

b. Service Entrance Disconnect Switches and Breakers. All facility service entrance disconnect switches and breakers shall be grounded as follows:

(1) The neutral bar or lug shall be grounded with a green insulated copper grounding electrode conductor, running directly to the grounding electrode. The grounding electrode conductor size shall be in accordance with the NEC, but in no case shall the wire size be smaller than No. 4 AWG.

(2) The switch box or panelboard enclosure shall be grounded to the grounded neutral bar or lug with a green insulated conductor, or other service grounding means.

c. Grounding Electrode. Grounding electrodes (rods) shall be copper clad steel, 3/4-inch by 10 feet, except where otherwise specified. The top of the grounding electrode shall be a minimum of 12 inches below finished grade. Lightning down conductors shall be attached to electrodes with exothermic welds only. Shelter perimeter grounding conductors shall be attached to electrodes with exothermic welds only, except in grounding access wells. In a grounding access well, grounding conductors shall be attached with bolted mechanical connectors. Other grounding conductor(s) shall be attached to the electrode with an exothermic weld or by hydraulically crimped compression connectors, as specified below.

d. Grounding Conductor. All grounding conductors shall be copper. All grounding conductors which are totally above grade shall be green-insulated conductors. All grounding conductors which are either entirely or partially direct-earth buried, shall be #6 AWG bare conductors, unless noted otherwise on the drawings.

e. Buried Guard Wire. Underground cables which are not completely enclosed in ferrous metal conduit, shall be protected by a #6 AWG bare solid copper guard wire. The guard wire shall be embedded in the soil 10 inches directly above, and parallel to, the highest of the cables in the trench or duct system. The guard wire shall be bonded to the grounding electrode system at each end of the cable run, and to grounding electrodes along the cable run at intervals not exceeding 300 feet. The guard wire shall be connected to the electrodes with exothermic welds, or by hydraulic crimping, as specified below.

f. Exothermic Process for Connecting Grounding Conductors to Metal Objects. Where the drawings and/or specifications require connection of a grounding conductor to a metal object by exothermic process, the contractor shall supply the correct exothermic welding kit for the application. The mold and cartridge used shall be selected on the basis of size, number, and type of conductors to be connected, composition and surface shape of object, and position in which the weld will be made. Two sources of exothermic welding kits are Thermoweld (Continental Industries) and Cadweld (Erico Products, Inc.). Some of the kits are listed on the tabulation at the end of this section. Regardless of the source of the kits he selects, the contractor shall submit catalog cuts or other manufacturer information, demonstrating that the kits fit their intended applications on the above described basis. See Paragraph 1A.4 above. The contractor shall provide and use the

proper preparation tools in applying the exothermic process to insure an adequate weld. Torch welds and/or brazing will not be permitted. No single-use exothermic weld molds, such as Thermoweld "Single Shot" and Cadweld "One Shot", will be permitted.

g. Hydraulically Crimped Connections. Grounding conductors (except lightning down conductors, shelter perimeter grounding conductors, and conductors inside a grounding access well) may be connected to grounding electrodes with compression connectors crimped with a force of at least 24,000 pounds. All grounding conductors (except shelter lightning protection system conductors) may be connected to each other with compression connectors crimped with a force of at least 24,000 pounds. Connectors, tools, dies, and crimping procedures shall be compatible to the application and to each other, and shall conform to the manufacturer's catalog and instructions. Each connector shall be clearly marked with catalog number, conductor size, and installation die information. The tooling shall be of the type that embosses or engraves the die index number on the connector in the crimping process. All connectors shall be listed in conformance with Underwriters Laboratories Standard UL467 and the National Electrical Code. Burndy Hyground Compression System connectors, matching tools, and crimping procedures, are one system of products which meet these specifications. Regardless of the source of the connectors, tools, and dies selected, the contractor shall submit catalog cuts or other manufacturer information, demonstrating that these items fit their intended applications as described above. See Paragraph 1A.4 above.

h. Testing. Electrode grounds shall be tested for resistance intended applications as described above. (See Paragraph 1A.4 above.) Resistance to ground for each grounding location shall be 10 ohms or less. If this value is not achieved with the grounding electrodes, as shown on the drawings, additional grounding electrodes, spaced at least 6 feet apart, or electrode extensions of the same construction and diameter, shall be installed until the resistance value does not exceed the maximum of 10 ohms. A tabulated report of the final resistance value at each location shall be provided to the Resident Engineer.

16A.5 SPARE FUSES. Unless specified otherwise, for every fused switch the contractor installs, he shall furnish the Resident Engineer one full set of spare fuses in addition to the fuses installed in the switch. If the drawings require more than one full set, the contractor shall comply with the drawings.

16A.6 GROUND FAULT INTERRUPTING RECEPTACLE. All outdoor receptacles provided by the contractor shall be ground fault interrupting duplex receptacles in properly sized weatherproof boxes.

16A.7 CABLE ABANDONMENT. Ends of cables to be abandoned shall be buried two feet below grade unless otherwise specified.

16A.8 WATERPROOFING CABLE ENDS. All cable ends which will be exposed to weather, water, ground, or corrosive environment prior to termination, shall be sealed against these elements while awaiting termination. This also applies to all cable ends in manholes or handholes. The sealing material shall be properly sized, easily removable heat shrinkable end caps (3M ICEC are acceptable), or electrical tape (see Paragraph 16A.21 below), with an application of brushed-on protective electrical coating.

16A.9 CONDUIT AND CABLING FOR ENGINE GENERATOR. Where engine generator standby power will be extended to a facility, conduit shall run continuously, without intermediate manholes or handholes, from the engine generator to the facility. In the continuous conduit, power cables shall be installed without splices from the engine generator bypass switch to the facility service entrance switch.

16A.10 ELECTRICAL EQUIPMENT NAME PLATES.

a. Each of the following types of equipment shall be identified with a name plate showing the functional name of the unit, voltage utilized, one or three phase as applicable, and additional information if specified or requested by the Resident Engineer:

Switches (Except Local Lighting)
Panelboards
Main Circuit Breakers
Motor Controllers

b. Name plates shall be non-ferrous metal or rigid plastic, stamped, embossed, or engraved with 3/8-inch minimum height letters and numerals. Name plates shall be secured to the equipment with at least two screws, except main breaker plates may be epoxy glued.

16A.11 PANELBOARD CIRCUIT DIRECTORIES. The contractor shall clearly and neatly mark panelboard circuit directories, identifying each circuit he establishes, re-establishes, or changes, as to the circuit's function.

16A.12 COVERING HOLES IN ENCLOSURES. No electrical enclosure will be accepted which has an unused open hole, except weep holes or vent holes. Holes in enclosures where conduits, bolts, or other objects were removed and not reinstalled, shall be closed with panels of the same material, thickness, color, and shade as the enclosure.

16A.13 SAFETY DISCONNECT SWITCHES AND FUSES. Safety disconnect switches and fuses shall meet the following specifications.

a. General. Unless specified otherwise, all switches for circuit voltages of 600 VAC or less, shall be heavy duty (Type HD), UL listed, and shall bear the UL label. The switches shall be NEMA 1 or NEMA 3R, as required by the drawings or special specifications.

b. Switch Interiors. All switches shall have switch blades which are fully visible in the OFF position when the switch door is open. All current-carrying parts shall be of high-conductivity copper, designed to carry the rated load without excessive heating. Switches shall have removable arc suppressors where necessary to permit easy access to line side lugs. Lugs shall be front removable and UL listed for 60°C or 75°C, aluminum or copper wires.

c. Switch Mechanism. Switches shall quick-make, quick-break, such that during normal operation of the switch, the operation of the contacts will not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started. The operating handle shall be an integral part of the box, not of the cover. Switches shall have provisions for padlocking the switches in the OFF position with at least three locks. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door when the handle is in the ON position, and to prevent closing of the switch mechanism with the door open. The handle position shall indicate whether the switch is ON or OFF.

d. Enclosures. Covers on NEMA 1 enclosures shall be attached with pin type hinges. NEMA 3R enclosures shall be securable in the open position. NEMA 3R enclosures for switches through 200 amperes shall have provisions for interchangeable bolt-on hubs. Hubs shall accommodate the conduits of the diameters indicated on the drawings. NEMA 3R enclosures shall be manufactured from galvanized steel. All enclosures shall have a gray baked enamel finish, electrodeposited on cleaned, phosphatized steel.

e. Ratings. All fusible switches rated 100 through 600 amperes at 240 volts, and 30 through 600 amperes at 600 volts, shall have a UL-approved method of field conversion from standard Class H fuse spacing to Class J fuse spacing. The switch also must accept Class R fuses, and have provisions for field installation of a UL-listed rejection feature to reject all fuses except Class R. The UL-listed short circuit rating of the switches shall be 200,000 rms symmetrical amperes when Class R or Class J fuses are used with the appropriate rejection scheme. The UL-listed short circuit rating of the switch, when equipped with Class H fuses, shall be 10,000 rms symmetrical amperes.

f. Fuses. All fused switches meeting the above specifications shall be fused with dual element, time-delay, UL Class RK5 fuses, of the continuous current rating specified on the drawings. The fuses' interrupting rating shall be at least 10,000 rms symmetrical amperes. Bussmann Fusetron switch fuses are among the products that meet these specifications.

g. Switches Meeting Specifications. The following eight Square D 240V, single phase, 3-wire switches, are among switches meeting the above specifications:

(1) 30-amp-rated, for indoor use, Cat. No. H221A, with field-installable solid neutral assembly Cat. No. H60SNC.

(2) 30-amp-rated, for outdoor use, Cat. No. H221AWK, with field-installable solid neutral assembly Cat. No. H60SNC.

(3) 60-amp-rated, for indoor use, Cat. No. H222A, with field-installable solid neutral assembly Cat. No. H60SNC.

(4) 60-amp-rated, for outdoor use, Cat. No. H222AWK, with field-installable solid neutral assembly Cat. No. H60SNC.

(5) 100-amp-rated, for indoor use, Cat. No. H223A, with field-installable solid neutral assembly Cat. No. H100SNC.

(6) 100-amp-rated, for outdoor use, Cat. No. H223AWK, with field-installable solid neutral assembly Cat. No. H100SNC.

(7) 200-amp-rated, for indoor use, Cat. No. H224A, with field-installable solid neutral assembly Cat. No. H200SNC.

(8) 200-amp-rated, for outdoor use, Cat. No. H224AWK, with field-installable solid neutral assembly Cat. No. H200SNC.

16A.14 PANELBOARDS AND CIRCUIT BREAKERS. Panelboards and circuit breakers shall meet the following specifications.

a. General. Unless otherwise specified, all panelboards for circuits of 240 VAC or less, shall be surface mounted, and equipped with bolt-on circuit breakers with frame and trip ratings. Panelboards and circuit breakers shall be UL rated, and shall bear the UL label. When installed as service equipment, panelboards shall be suitable for use as service equipment.

b. Circuit Breakers. Circuit breakers shall be one-pole or two-pole thermal-magnetic molded-case circuit breakers. The two-pole breakers shall have an integral crossbar to assure simultaneous opening of both poles. Breakers shall have an overcenter, trip-free, toggle-type operating mechanism with quick-make, quick-break action and positive handle indication. Handles shall have ON, OFF, and TRIPPED positions. In addition, trip indication shall include a visible trip indicator appearing in the window of the breaker case. The circuit breakers shall be able to be installed in the panelboard without requiring additional mounting hardware. Circuit breakers shall be UL-listed in accordance with UL Standard 489 and shall be rated 240 VAC maximum with continuous current ratings as noted on the drawings. Circuit breakers up to but not including an ampere rating of 70 amperes, shall have an interrupting rating of 10,000 rms symmetrical amperes for a 120/240VAC circuit. Circuit Breakers with ampere ratings of 70 amperes or more, shall have an interrupting rating of 22,000 rms symmetrical amperes for a 120/240 VAC circuit. Single-pole 15 and 20-ampere circuit breakers for routine switching of fluorescent lighting loads, shall carry the SWD marking.

c. Bussing Assembly and Temperature Rise. Panelboard bus structure and main lugs or main circuit breaker shall have current ratings as shown on the drawings. Such ratings shall be established by heat rise tests, conducted in accordance with UL Standard 67. Bus structures shall be insulated. All current-carrying parts shall be of high-conductivity copper, designed to carry the rated load without excessive heating.

d. Cabinets and Fronts. The panelboard bus assembly shall be enclosed in a steel cabinet. The rigidity and gauge of the steel shall be as specified in UL Standard 50 for cabinets. Wiring gutter space shall be in accordance with UL Standard 67 for panelboards. The box shall be fabricated from galvanized steel or equivalent rust-resistant steel. Each front shall include a door, and shall have a flush, cylinder tumbler-type lock with catch and spring-loaded stainless steel door pull. All panelboard locks shall be keyed alike. Fronts shall have adjustable indicating trim clamps which shall be completely concealed when the doors are closed. Doors shall be mounted with completely concealed steel hinges. Fronts shall not be removable with the door in the locked position. A circuit directory frame and card with a clear plastic covering shall be provided on the inside of the door.

e. Panelboards Meeting Specifications. The following panelboards are among panelboards which meet the above specifications.

(1) 12-Space Panelboards. Panelboards assembled from the following Square D components, including 100-amp main lug or 100-amp main circuit breaker (CB) interiors with 12 single-pole branch breaker spaces:

	Indoor (NEMA 1)	Outdoor (NEMA 3R)
Interior	NQOD12L100CU (main lugs) NQOD12M100CU (main CB's)	NQOD12L100CU (main lugs) NQOD12M100CU (main CB's)
Enclosure	MH20 (main lugs) MH23 (main CB's)	MH20WP (main lugs) MH23WP (main CB's)
Interior Trim Kit	None	MH20TK (main lugs) MH23TK (main CB's)
Circuit Breakers	QOB style	QOB style

(2) 20-Space Panelboards. Panelboards assembled from the following Square D components, including 100-amp main lug or 100-amp main circuit breaker (CB) interiors with 20 single-pole breaker spaces):

	Indoor (NEMA 1)	Outdoor (NEMA 3R)
Interior	NQOD20L100CU (main lugs) NQOD20M100CU (main CB's)	NQOD20L100CU (main lugs) NQOD20M100CU (main CB's)
Enclosure	MH23 (main lugs) MH26 (main CB's)	MH23WP (main lugs) MH26WP (main CB's)
Interior Trim Kit	None	MH23TK (main lugs) MH26TK (main CB's)
Circuit Breakers	QOB style	QOB style

16A.15 ELECTRICAL ENCLOSURES AND WIREWAYS. Unless specified otherwise, electrical enclosures and wireways shall meet the following specifications.

a. Material. Electrical enclosures and wireways shall be constructed of code gauge sheet steel.

b. Corrosion-Resistant Coating. Enclosure and wireway sheet steel shall be coated by ASTM 525 G90 (galvanneal) galvanizing or corrosion-resistant phosphate primer, or both.

c. Finish. Finish shall be dark gray enamel inside and out, or ANSI 61 gray polyester coating inside and out, or ASA-49 gray epoxy paint inside and out.

d. Industry Standards.

(1) Enclosures. NEMA 1 enclosures shall meet NEMA Type 1 and UL 50 Type 1 standards. NEMA 3R enclosures shall meet NEMA Type 3R and UL 50 Type 3R standards.

(2) Wireway. NEMA 1 wireway (including troughs) shall meet NEMA 1 and UL 870 standards. NEMA 3R wireway (including troughs) shall meet NEMA 3R and UL 870 standards.

e. Hardware. All hardware shall be plated to prevent corrosion.

16A.16 FACILITY AC SURGE ARRESTER. The contractor shall furnish and install an AC surge arrester (power arrester) on the line side of the facility shelter service disconnecting means, as shown on the drawings. The arrester shall meet the following specifications.

a. Operating Lifetime. The arrester shall safely dissipate the number and amplitude of surges listed in Table 1, below. In this table, the 8x20us waveform defines a transient with a rise time of 8 microseconds (us) from inception to peak value that exponentially decays to 50 percent of peak value 20us after inception.

TABLE 1: LINE-TO-GROUND SURGE LEVELS FOR 120/208V, 120/240V, AND 277/480V AC SERVICES LINES
(Tabulated values are from Table I of FAA-STD-019b, dated August 28, 1990.)

Surge Current Amplitude 8x20 Microsecond Waveform	Number of Surges (Lifetime)	
	Normal Phase Current	
	100A or Less	Greater than 100A
10,000 amperes	1,000 surges	1,500 surges
20,000 amperes	500 surges	700 surges
30,000 amperes	250 surges	375 surges
40,000 amperes	25 surges	50 surges
50,000 amperes	1 surge	5 surges
60,000 amperes	0 surge	2 surges
70,000 amperes	0 surge	1 surge

Clamp (discharge) voltage shall not change more than ten percent over the operating life of the arrester.

b. Operational Characteristics. The arrester shall have the following operational characteristics.

(1) Reverse Standoff (Maximum Operating) Voltage. Reverse standoff voltage is the maximum voltage that can be applied across arrester terminals with the arrester remaining in an OFF (non-conducting) state. The reverse standoff voltage shall be 125 ± 5 percent of normal line voltage.

(2) Leakage Current. Leakage current shall not exceed 1 milliamp at reverse standoff voltage.

(3) Turnon Voltage. Turnon voltage is the minimum voltage across arrester terminals that will cause the arrester to turn on and conduct. Turnon voltage shall not exceed 150 percent of reverse standoff voltage.

(4) Clamp (Discharge) Voltage. Clamp voltage (discharge voltage) is the maximum sustained voltage that appears across an arrester output terminal while conducting surge currents. For 120/240V and 120/208V arresters, clamp voltage, each phase to ground, either polarity, shall not exceed those shown in the following tabulation:

Surge Clamp Current	Surge Voltage	Clamp Current	Voltage
5,000 amps	400 volts	40,000 amps	900 volts
10,000 amps	480 volts	60,000 amps	1,100 volts
20,000 amps	650 volts	80,000 amps	1,350 volts

(5) Overshoot Voltage. Overshoot voltage is the surge voltage that appears across the arrester terminals before the arrester turns on and clamps the surge to the clamp voltage. The overshoot voltage shall not exceed two times the arrester clamp voltage for more than 10 nanoseconds.

(6) Self-Restoring Capability. The surge arrester shall automatically return to the OFF state after surge dissipation when line voltage returns to normal.

(7) Fusing and Lamps.

(a) The input to each arrester phase component shall be internally fused to protect the AC power supply equipment against overload should an arrester device short. This fusing shall not increase the clamp voltage of the arrester. The fusing shall pass the surge current levels given in Table 1 without opening. The arrester internal fusing shall open on application of a steady state current at a level low enough to prevent damage to the AC power supply. The multiple arrester phase components shall be individually fused. A failed component shall blow its own fuse, and be automatically removed from the circuit, with the remaining components providing continued protection.

(b) Lamps. Each phase shall have two indicator lamps in parallel, to continuously monitor the arrester condition. The lamps shall be coordinated with the fuses such that the lamps dim or go out when the last arrester component remains. The arrester elements shall be connected line-to-neutral.

c. Composition and Construction. All components of the arrester shall be assembled and mounted in a single NEMA 4 waterproof enclosure. Heavy duty, screw-type studs shall be provided for all input and output connections. The arrester elements shall be connected line-to-neutral. The arrester shall have an internal means of easily disconnecting incoming power, so the arrester may be maintained without disconnecting facility power. The arrester elements shall be electrically isolated from the enclosure to a minimum of 10 megohms resistance. The enclosure door shall be hinged and electrically bonded to the enclosure when shut. The hinges shall not be used to provide electrical bonding. Indicator lamps shall be mounted on the front door. Fuses, lights, fuse wires, and arrester components shall be readily accessible for inspection and replacement.

d. Arrester Meeting Specifications. For 120/240V, single phase, 60Hz applications, the Lightning Protection Corporation (Goleta, California) Model No. LPC 20206-7 AC surge arrester is one of the products that meet the above specifications. If the contractor intends to furnish a substitute, or if a different power configuration must be accommodated, the contractor shall submit to the Contracting Officer, full manufacturer's literature on the substitute arrester, and shall not procure the substitute before receiving the Contracting Officer's approval. (See Paragraph 1A.4 above.)

e. Installation. The arrester shall be installed as close as practical to the facility service disconnecting means, but not more than 12 inches away from the disconnecting means. Wiring connections shall be on the line side of the service disconnecting means.

(1) Phase Cables. Surge arrester phase lugs shall be connected to corresponding phase terminals of the service disconnecting means with insulated #4 AWG (minimum gauge) stranded copper cable. These cables shall be as short and shall run as directly as feasible, without loops, sharp bends or kinks.

(2) Surge Grounding Cable. The surge grounding cable shall be routed as directly as feasible, without loops, sharp bends or kinks, from the surge grounding terminal:

(a) To the nearest grounding electrode, or

(b) To the neutral bus in the service disconnecting means, if so shown on the drawings.

The surge grounding cable shall be insulated #4 AWG (minimum gauge) stranded copper cable. This cable shall be color coded white when connected from the arrester to the service disconnecting means.

(3) Equipment Grounding Conductor. The surge arrester enclosure shall be connected to the ground bus in the service disconnecting means enclosure with a #6 AWG green insulated copper cable.

16A.17 SHELTER ENVIRONMENTAL AND LIGHTING EQUIPMENT. If required on the drawings, equipment for an equipment shelter (building) nominally sized 10'x12', shall meet the following specifications.

a. Vent Fan. For a MALSR shelter, the vent fan shall be at least 1/25 HP, and shall move at least 424 CFM at zero gauge pressure. Greenheck Model GW-75-D is one of the products that meet these specifications. For an ILS shelter, the vent fan installation shall be supplemented with a power damper and two-position damper motor. The Honeywell D640 power damper with two-position damper motor Honeywell M436A116, is one of the products that meet these specifications. The intake damper for the ILS shelter shall be a power damper with two-position damper motor identical to the vent fan power damper.

b. Vent Fan Thermostat. The vent fan thermostat shall be a 120VAC wall-mounted airswitch controller operating in a temperature range from at least 35° to 95°F. Honeywell Part No. T651A is one of the products that meet these specifications. This item applies to buildings without environmental control panels, e.g., MALSR and ILS marker shelters.

c. Heater. The heater shall be a 240V, 4,000-watt wall-mounted electric heater with surface mounting box. The QMark Cat. No. AWH-4404 heater is one of the products that meet these specifications.

d. Heater Timer Unit. The heater timer unit shall consist of a 1-hour 240-volt manual timer, and contactor with 208/240-volt coil and 30-amp rated contacts, mounted on and in a minimum 12"x12"x4" NEMA 1 hinged cover box with matching mounting panel. The following components are among components that meet these specifications: Timer, Dayton Stock No. 6X546; contactor, Honeywell Part No. R4243B1046; enclosure, Hoffman Cat. No. A-12N124, with A-12N12P mounting panel. The heater timer unit is applied to buildings without environmental control panels, e.g., MALSR and ILS marker shelters.

e. Air Conditioner. The air conditioner shall be nominally 240V (unless specified otherwise on the drawings), front air discharge model, with EER of at least 9.0, and shall have either a through-wall sleeve or a slide-out chassis. Air conditioners are applied to buildings with environmental control panels, e.g., ILS localizer and glide slope shelters.

f. Interior Light Fixture and Lamps. Each interior light fixture shall be surface mounted, 120-volt, having a white-painted steel chassis and a light-controlling plastic lens enclosure. The lens enclosure shall be of a wraparound style which illuminates the ceiling as well as the room. The fixture shall be nominally four feet long, and shall accommodate two 48"-long T-8 fluorescent lamp tubes. The ballast shall have a radio frequency suppressor. The ballast shall operate normally at temperatures above 20°F. The lamp tubes shall be 32-watt 48"-long T-8 fluorescent lamp tubes, each with an initial rating of 2,850 lumens. The Holophane Prismawrap Cat. No. M7100-4-1-A-6 light fixture is among fixtures which meet these specifications. The following 32-watt lamp tubes are among lamps which meet these specifications: General Electric Trimline, Philips TL70, and Sylvania Octron.

g. Exterior Light Fixture. The exterior light fixture shall be a 50-watt high pressure sodium unit, rated for 24,000-hour lamp life, having a cast aluminum housing, and a photocontrol installed inside the housing. Holophane Wallpackette luminaire, Cat. No. WP-2-A-050HP-12-GR-P, is among products which meet these specifications.

16A.18 SHELTER LIGHTNING PROTECTION EQUIPMENT. All shelters (buildings) shall have a lightning protection system installed per the requirements of the Lightning Protection Code, National Fire Protection Association (NFPA 78), and Underwriters Laboratories Master Labeled System (UL96A). Specific lightning protection equipment items shall meet the following specifications. Catalog numbers given in a through k below, are of Thompson Lightning Protection, Inc. of St. Paul, Minnesota.

a. Air Terminal Point. Air terminal points shall be nickel-tipped copper, 1/2" diameter x 36" long. Cat. No. 660 meets these specifications.

b. Point Bracket. For a roof ridge, the point bracket shall be made of pressed copper, shall bend to fit any roof slope, and shall hold the point and cable slightly above the center of the roof ridge. The bracket shall have a pressure cable clamp, and a stud to engage the point. Cat. No. 532 meets these specifications.

c. Air Terminal Brace. The air terminal brace shall be a 36"-long galvanized tripod assembly, with legs adjustable to accommodate any roof slope. Cat. No. 83 meets these specifications.

d. Roof and Down Conductors. Roof and down conductors shall each have 32 strands of #17 copper wire, 7/16" overall diameter, braided smooth twist, 65,500 circular mils, and a net weight of 215 pounds per 1000 feet. Cat. No. 32 meets these specifications.

e. Ridge Cable Support. Ridge cable supports shall be pressed copper cable supports at least 2" wide, to hold the roof cable above the top of the roof. The ridge cable supports shall be sized to accommodate the roof conductor. Cat. No. 533 meets these specifications.

f. Cable Holder. Cable holders shall be 1"-wide copper bent-strap type loops with 1/4" mounting holes. The cable holders shall be sized to accommodate the roof conductor. Cat. No. 166XX meets these specifications.

g. Parallel Clamp. Parallel clamps shall be bronze 2"-long clamps for connecting two conductors together, one conductor of maximum diameter 1/2", and the other conductor from 1/6" dia to 5/16" dia. Cat. No. 565 meets these specifications.

h. Flexible Bonding Strap. Flexible bonding straps, for connecting steel doors to steel door frames, shall be braids each composed of 480 #30 copper wires, with flat bronze or copper connectors crimped on at each end. The connectors shall have holes to take either 5/16" or 3/8" machine screws.

i. Pipe Clamp. Pipe clamps shall be adjustable tinned bronze clamps for bonding cables to pipes, and fitting pipes up to and including 1 1/4" O.D., and cables up to and including 1/2" diameter. Cat. No. 240 meets these specifications.

j. Bonding Equipment. Bond the steel siding, vent fan, hood, door frame, junction boxes, and any miscellaneous exterior metal objects to down conductors. If included, air conditioners, junction boxes, and flight check antenna masts shall be likewise bonded. Use the following equipment to perform the bonding:

(1) Bonding Plate. Bonding plates shall be 8-sq. inch tinned bronze plates with 2"-long pressure type cable connectors, designed to bond a continuous run of cable to metallic objects along their path. Each plate shall have two holes fitting sheet metal screws or 1/4" machine screws. Cat. No. 702 meets these specifications.

(2) Bonding Conductor. Bonding conductor shall be minimum #6 bare soft drawn copper, 1/6" dia, 26,250 circular mils, net weight 80 pounds per 1000 feet. Cat. No. 14X (#6 bare solid) and Cat. No. 509X (#4 bare solid) meet these specifications.

k. Ground Rod Clamps. In the grounding access well, the #6 grounding electrode conductor shall be connected to the 3/4"-diameter grounding electrode with a bronze 2-bolt ground rod clamp. Cat. No. 519 meets these specifications. In the grounding access well, the 4/0 counterpoise cable (perimeter ground) shall be connected to the 3/4"-diameter grounding electrode with a bronze clamp which will accept one vertical cable and one horizontal cable. Cat. No. 693 meets these specifications.

l. Grounding Access Well Frame and Lid. If shown on the drawings, the frame and lid of the grounding access well shall fit snugly into the opening of a 15"-diameter corrugated pipe. The frame and lid shall be ASTM A48 Class 35B gray cast iron. The lid shall be solid, not of an open construction. Neenah Foundry Co. (Neenah, Wisconsin) Cat. No. R-5900-B is one of the products that meet these specifications.

16A.19 CONTROL CABLE TERMINAL STRIPS. Unless specified otherwise, contractor-furnished control (telephone) cable terminal strips shall be units assembled from compatible components all from the same manufacturer. The individual blocks of the strips shall be miniature style (1/4" O.C.) nylon blocks with screw-activated tubular conductor clamps. The blocks shall be rated for a maximum voltage of at least 300 volts and a maximum current of at least 30 amperes. The conductor clamps shall accept wire sizes at least from #14 to #22. Stab-in wire connection blocks shall not be used. The blocks shall be mounted in a mounting channel. The assembled strip of blocks shall have a marking strip and holding plugs or end barriers. For terminating control cables on these strips, see Paragraph 16F.7 below. The following terminal strip components are among components which meet these specifications:

a. Buchanan: Blocks No. 125 mounted in channel No. 12 with clamps No. 11. Marking strip No. 15. Holding plug No. 16.

b. Square D: Blocks No. GM-3, with mounting channel and marking strip of the GH series, with end barrier No. GM3B.

16A.20 FRANGIBLE COUPLINGS.

a. Material Specification. Unless specified otherwise, contractor-furnished frangible couplings shall be 2" diameter cast aluminum couplings having a hexagonal clamping ring. The couplings shall accommodate 2"-diameter EMT conduit, and shall meet Military Specification MS-17814-1. Frangible coupling Cat. No. 961A by Multi Electric Mfg., Inc. of Chicago, Illinois, is one of the products that meet these specifications.

b. Thread Remediation. Often, the conduit threads of frangible couplings (both contractor furnished and Government furnished) are cast with mismatched halves. Often, this imperfection causes the threads to bind in the rigid coupling threads conduit threads of the required mating object), before the required engagement is reached, even when anti-seize compound is used. When this binding occurs, the contractor shall rework the frangible coupling threads to achieve the required thread engagement. This remediation may consist of rethreading with a straight conduit thread die, and/or of grinding off the threads on the two diametrically opposite sides of the thread helix where the cast thread discontinuity is found. This remediation must continue until the required thread engagement is achieved. All burrs and galls must be removed from the reworked threads.

c. Installation. For approach lighting systems, see Paragraph 13A.2c. For VASI, REIL, PAPI, and RVR, see Paragraph 13C.2b.

16A.21 ELECTRICAL TAPE. Unless specified otherwise, electrical tape shall meet the following specifications. The tape material shall be based on PVC polyvinyl and/or PVC copolymers. The tape shall have a rubber-based, pressure-sensitive adhesive. The tape shall be 8.5 mils thick, and be UL listed and marked per UL Standard 510 as "Flame Retardant, Cold and Weather Resistant." The tape must be applicable at temperatures ranging from 0°F through 100°F (-18°C through 38°C). The tape shall be classified for both indoor and outdoor use. The tape shall be compatible with synthetic cable insulations, jackets, and splicing compounds. Scotch Super 88 Vinyl Electrical Tape by 3M is one of the products that meet these specifications.

16A.22 PRE-STRETCHED RUBBER TUBING. Pre-stretched rubber tubing shall be open-ended tubular rubber sleeve, factory expanded and assembled onto a removable core. The tubing is supplied for field installation in this pre-stretched condition. The tube is positioned for installation over an inline connection, terminal lug, sleeve splice, or other cable insulation discontinuity requiring protection. Then the core is removed, allowing the tube to shrink to produce a waterproof seal.

The tubing shall be made of EPDM (ethylene propylene diene methylene) rubber containing no chlorides or sulfurs. The tubing must be capable of operation at emergency overload cable temperatures of 130°C. It must be usable without additional covering or adhesive, both indoors and outdoors, in overhead, direct buried or submerged applications, on cables rated up to 1,000 volts. The tubing must be applied without additional heat or flame and, when applied per the manufacturer's instructions, be immediately energizable. It must not be adversely affected by moisture, mild acids or alkalies, ozone or ultraviolet light. It must conform to the requirements of ANSI C119.1 1974, appropriate sections of Western Underground

Guide 2.14 and UL 486D. The tubing must have been accepted by the U.S. Department of Agriculture, Rural Electrification Administration (REA), for both submersible and aerial application. PST Cold Shrink Connector Insulators 8420 Series by 3M are among products which meet these specifications. All applications must be performed per the manufacturer's instructions.

16A.23 FIRE AND ARC PROOFING. Fire and arc proofing shall consist of a flexible conformable unsupported (having no adhesive) intumescent elastomer. The intumescent property causes the tape to expand in fire, thus providing an insulating firewall between the flame and cable. The tape shall be not less than .030 inches thick. The tape shall be capable of over 100% elongation. The tape shall be non-corrosive to metallic cable sheaths. It shall be compatible with synthetic cable jackets such as semi-conducting URD type, polyethylene, and PVC. The tape shall be self-extinguishing, i.e., shall not support combustion. The tape shall not deteriorate when subjected to water, salt water, gases, and sewage. The wrapped tape shall be secured by a band consisting of two layers (the second wrapped directly over the first) of glass cloth electrical tape at both ends of the fire and arc proofing wrap. The completed installation of a single half-lapped layer of fire and arc proofing shall be capable of withstanding a high 60 Hz current fault arc temperature of 13,000°K for 70 cycles. Scotch 77 Fire and Arc Proofing tape secured with Scotch 69 Glass Cloth Electrical Tape are among products that meet these specifications, when applied per the manufacturer's instructions. All applications must be performed per the manufacturer's instructions.

16A.24 CABLE CONNECTOR PROTECTION.

a. Primary Connections. Where single-conductor plug and receptacle cable connectors are joined in light bases or other underground enclosures, the joint shall be sealed with heat-shrinkable tubing specifically designed for this purpose. Each tubing unit shall consist of a polyolephin heat-shrinkable sleeve with sealant at each end. The tubing shall meet the performance specifications of ANSI C-119.1 and Western Underground Guide (2.5, 2.4), and shall be REA listed under "secondary" tap or splice cover, submersible.

   The sleeve is placed over the cable connectors, their joint, and a short length of cable at the ends of the connectors. The sleeve is shrunk with a torch or heat gun, with heat applied from the center of the sleeve toward the ends, to avoid trapping air. The sleeve shrinks under the heat, to conform to the shape of the connectors and the cables. The sealant at the ends of the sleeve forms a watertight seal around the cables. These sleeves shall be applied to cable connector joints between two isolation transformer primary leads, a primary lead and a cable, or two cables, wherever these joints are specified in a light base or other underground enclosure. The sleeves must be of a type designed for easy removal by applying a small amount of heat, slitting the sleeve with a knife, and peeling away the sleeve. Airport Lighting Connector Protection tubing, Series APL-823A, by Sigmaform Corporation of Vicksburg, Mississippi, is one of the products that meet these specifications. Substitutes require submittals per Paragraph 1A.4 above.

b. Secondary Connections. Where two-conductor plug and receptacle cable connectors are joined in light bases or other underground enclosures, the joint between the two connectors shall be sealed with at least two layers of electrical tape and an application of protective electrical coating. Where two-conductor plug and receptacle connectors are joined in a frangible coupling, apply no tape or any other protection.

16A.25 ELECTRICAL COATING. Cable connections, splices, or other joints wrapped with plastic electrical tape, shall be sealed with an electrical coating meeting Military Specification MIL-P-18623. Scotchkote electrical coating is among the products meeting this specification.

16A.26 COMMERCIAL METAL FRAMING. Where specified for mounting of electrical equipment or other purpose, the contractor shall furnish and install commercial metal framing. The channel framing members shall be formed from strip steel, with one side of the channel having a continuous slot with inturned lips. The principle of attachment is application of nuts which engage the inturned lips of the channel. For outdoor applications, framing members shall be hot-dip galvanized per ASTM Specification A-123 or A-153. For indoor applications, 16A.26 framing members shall be factory coated with enamel or epoxy coatings, or electro-galvanized per ASTM Specification B633, or pre-galvanized with a G90 zinc coating per ASTM Specification A-525. Uncoated framing members, or framing members coated only with oil, are not acceptable. Properly sized and matched channel framing members, fittings, and hardware from Unistrut Corporation of Wayne, Michigan, and from B-Line Systems, Inc. of Highland, Illinois are among products meeting the above specifications. Installation shall be in accordance with manufacturer's instructions.

16A.27 EXPANSION COUPLING. Where shown on the drawings, rigid metal conduits which emerge vertically from below grade to make a direct connection to an above-grade junction box or structure, shall be fitted with an expansion coupling. The purpose of the expansion coupling is to accommodate relative vertical movement, such as the movement due to frost heave. The coupling shall be rigid metal, and shall be threaded onto the rigid conduits at both ends of the coupling. The coupling must accommodate 8 inches of movement, unless space limitations prohibit installing such a coupling. If there are such space limitations, a coupling allowing only 4 inches of movement may be substituted. For expansion couplings accommodating 8 inches of movement, couplings of the Appleton XJ-8 series are among couplings meeting these specifications. For expansion couplings accommodating 4 inches of movement, couplings of the Appleton XJ-4 series are among couplings meeting these specifications. Electrical continuity across the expansion coupling must be maintained by installing a bonding jumper. Bonding jumpers of the Appleton XJB-4 series meet these specifications for 4"-movement expansion couplings. Bonding jumpers of the Appleton XJB-8 series meet these specifications for 8"-movement expansion couplings.

CADWELD EXOTHERMIC WELDING KITS

GROUNDING ELECTRODE	CABLE SIZE (RUN WIRE)	CABLE SIZE (TAP WIRE)	CONNECTION TYPE DESIGNATION AND MOLD NUMBER		WELD METAL	CONNECTION DESCRIPTION
Copperclad		#6 Solid	GR	GRT-181G	32	These are connections in which a horizontal copper cable terminates at the top of a vertical 3/4" grounding electrode.
		#6 Stranded	GR	GRT-181H	32	
		#2 Stranded[1]	GR	GRC-188D[2]	115	
Stainless Steel		#6 Solid	GR	GRT-331G	32	
		#6 Stranded	GR	GRT-331H	32	
		#2 Stranded[1]	GR	GRC-338D[2]	115	
Copperclad	#6 Solid		GT	GTP-181G	45	These are connections in which a through run cable connects to the top of a vertical 3/4" grounding electrode.
	#6 Stranded		GT	GTP-181H	45	
Stainless Steel	#6 Solid		GT	GTP-331G	45	
	#6 Stranded		GT	GTP-331H	45	
Copperclad	#4/0 Stranded		GY	GYE-182Q	150	These are connections in which a through run cable connects to the side of a vertical 3/4" grounding electrode.
Stainless Steel	#4/0 Stranded		GY	GYE-332Q	150	
	#6 Solid	#6 Solid	PC	PCC-1G1G	25	PC designates parallel connections of horizontal cables, with the tap on top.
	#6 Stranded	#6 Stranded	PC	PCC-1H1H	25	
	#2 Stranded	#6 Solid	PC	PCC-1V1G	32	
	#2 Stranded	#2 Stranded	PC	PCC-1V1V	65	
	4/0 Stranded	4/0 Stranded	TA	TAC-2Q2Q	150	TA designates tee connections of horizontal run and tap cables.
	4/0 Stranded	#32 Thompson	TA	TAC-2Q8C	115	
	4/0 Stranded	#506 Thompson	TA	TAC-2Q8F	150	

NOTE: 1. Lightning conductor, #2 copper stranded 17 AWG, 59500 CM, 187.5 lb/1000 ft., IPC #32S, approximately 15/32" diameter.

2. Use Cadweld E-Z Change Handle, Catalog Number L-160, when using this mold.

DIVISION 16 – ELECTRICAL
SECTION 16B
600-VOLT POWER CABLE FOR UNDERGROUND INSTALLATION

16B.1 SCOPE. This section covers the material requirements for all contractor furnished single-conductor 600-volt power cable required for direct earth burial installation. Installation of power cable is covered in Section 16F.

16B.2 GENERAL REQUIREMENTS. Cable construction shall include copper single conductor and XLP (thermosetting crosslinked polyethylene) insulation. Cable shall be UL listed as Type USE or RHW or RHH for use in circuits not exceeding 600 volts at conductor temperatures of 90°C for continuous normal operation, 130°C for emergency overload conditions, and 250°C for short circuit conditions. Cables shall be suitable for direct burial and above-grade installation in wet or dry locations.

16B.3 APPLICABLE SPECIFICATIONS.

a. Underwriters Laboratories Standard 854 for Service Entrance Cables.

b. Underwriters Laboratories Standard 44 for Rubber-Insulated Wires and Cables.

c. ICEA Publication Number S-66-524, NEMA Publication Number WC7 for Crosslinked Polyethylene-Insulated Wire and Cable.

d. Federal Specification J-C-30A.

16B.4 CABLE CONSTRUCTION. Cable characteristics shall include the following materials and construction:

a. Conductors. Conductors shall be solid or Class B stranded annealed uncoated copper, per UL Standards 854 and 44.

b. Separator. A suitable separator over the conductor may be used at the option of the manufacturer.

c. Insulation. Each conductor shall be insulated with XLP (crosslinked polyethylene) complying with the physical and electrical requirements of UL Standard 854 for Type USE and UL Standard 44 for Types RHW and RHH and Paragraph 3-6 of ICEA Publication Number S-66-524. The insulation shall be applied lightly to the conductor and shall be free-stripping.

16B.5 IDENTIFICATION. The cable shall be identified by surface marking indicating manufacturer's conductor size and metal, voltage rating, UL Symbol and type designation, and year of manufacture.

16B.6 TESTS. Cable shall be tested in accordance with requirements of UL Standard 854 for Type USE, UL Standard 44 for Types RHW and RHH, and ICEA Publication Number S-66-524, Paragraph 3.6.

16B.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.

16B.8 PACKAGING. All cable shall be provided on wooden or steel reels, and ends of all cable shall be sealed to prevent entry of moisture. All reels shall identify type, length, and year of manufacture of cable packaged on such reels. All such identification shall be clearly provided by the manufacturer.

DIVISION 16 - ELECTRICAL
SECTION 16C
600-VOLT ARMORED POWER CABLE

16C.1 DESCRIPTION. This section covers the material requirements for all contractor-furnished 600-volt 3-conductor armored power cable required for direct earth burial installation. Installation of power cable is covered in Section 16F.

16C.2 GENERAL REQUIREMENTS. Cable construction shall include three copper conductors with XLP (thermosetting crosslinked polyethylene) insulation, galvanized steel interlocking armor, and PVC jackets under and over armor. Cable shall be UL listed as type MC for use in circuits not exceeding 600 volts phase to phase at conductor temperatures of 90°C in dry locations, or 75°C in wet locations, 130°C for emergency overload conditions, and 250°C for short circuit conditions in wet or dry locations. Cables shall be designed and labeled for direct burial use.

16C.3 APPLICABLE SPECIFICATIONS. The following specifications form a part of this specification to the extent specified herein:

a. UL Standard 1569 for Metal-Clad Cables.

b. UL Standard 44 for Rubber Insulated Wires and Cables.

c. ICEA Publication Number S-66-524, NEMA Publication Number WC7 for Crosslinked-polyethylene insulated Wire and Cable.

d. IEEE 383 Type Tests of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations.

CABLE CONSTRUCTION. Cable construction shall include the following materials end construction:

a. Conductors. Class B stranded annealed uncoated copper per Part 2 of ICEA.

b. Separator. A suitable separator over the conductor may be used at the option of the manufacturer.

c. Insulation. XLP crosslinked polyethylene meeting the requirements of ICEA Part 3, Paragraph 3.6 and Type XHHW requirements of UL 44. Average thickness of insulation shall be as specified in UL 44 for Type XHHW conductors and in the Table 3-1 of ICEA. Minimum thickness at any point shall be not less than 90% of the specified average thickness.

d. Phase Identification. Insulated phase conductors shall be printed with the numeral "1", "2", and "3" on the surface of the insulation.

e. Assembly. Three phase conductors shall be cabled together with a Class B stranded, uncoated copper grounding conductor and suitable nonhygroscopic fillers to make round. Length of lay shall not exceed 35 times the phase conductor diameter. The grounding conductor shall comply with the requirements of UL Standard 1569. A suitable nonhygroscopic cable tape shall be applied over the assembly.

f. Inner PVC Jacket. PVC meeting the requirements of ICEA, Part 4 and the Sunlight Resistant requirements of UL 1569. Average jacket thickness shall be in accordance with UL 1569. Minimum thickness at any point shall be not less than 70 percent of the specified average thickness.

g. Armor. Galvanized steel interlocked armor shall be applied over the inner PVC jacket. Armor shall be in accordance with UL requirements for Type MC cable and Part 4 of ICEA.

h. Outer PVC Jacket. PVC meeting the requirements of ICEA, Part 4 and the Sunlight Resistant requirements of UL 1569. Average jacket thickness shall be in accordance with UL 1569. Minimum thickness at any point shall be not less than 70 percent of specified average thickness.

16C.5 TESTS. Conductors and completed cables shall be tested in accordance with UL requirements for Type MC cables having XHHW conductors.

16C.6 IDENTIFICATION. Cable shall be identified by surface marking indicating manufacturer's identification, conductor size and metal, voltage rating, UL symbol and type designation, year of manufacture, and "direct burial" designation.

16C.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.

16C.8 PACKAGING. All cable shall be provided on wooden or steel reels, and ends of all cable shall be sealed to prevent entry of moisture. All reels shall identify type, length, and year of manufacture of cable packaged on such reels. All such identification shall be clearly provided by the manufacturer.

16C.9 SUBMITTALS. For the specific cable that the contractor proposes to use, the contractor shall submit the manufacturer's complete cable specifications, including compliance with all cable requirements, codes, and standards referenced herein, and a drawing showing cable construction details. Submit these items, and receive the Contracting Officer's approval before installing any cable specified herein. (See Paragraph 1A.4 above.)

DIVISION 16 - ELECTRICAL
SECTION 16D
5000-VOLT POWER CABLE

16D.1 SCOPE. This section covers the material requirements for all contractor furnished single-conductor, 5000-volt power distribution cable required for direct earth burial installation. Cable manufactured per FAA Specification L-824 shall not be used for power distribution. Installation of power cable is covered in Section 16F.

16D.2 GENERAL REQUIREMENTS.

a. Cables shall be XLP-insulated, 5000-volt, single copper conductor, shielded power cable UL listed as Type MV-90. Cable shall be rated at 100 percent insulation level for use in grounded neutral circuits in wet or dry locations below grade at conductor temperatures of 90°C for continuous normal operations, 130°C for emergency overload conditions, and 250°C for short circuit conditions.

b. Cable construction shall include copper single conductor, conductor shield, XLP (thermosetting crosslinked polyethylene) insulation, metallic tape or wire shield over tape bedding, separator tape, and PVC (polyvinyl chloride) jacket.

16D.3 APPLICABLE SPECIFICATIONS. The following specifications shall form a part of this specification to the extent specified herein.

a. Underwriters Laboratories Standard 1072 for Medium-Voltage Solid-Dielectric Cable.

b. ICEA Publication Number S-66-524 and NEMA Publication Number WC7 for Crosslinked-Thermosetting-Polyethylene-Insulated Wire and Cable.

16D.4 CABLE CONSTRUCTION. Cable characteristics shall include the following materials and construction:

a. Conductors. Class B stranded annealed copper per Paragraphs 2.1 and 2.3 of ICEA.

b. Conductor Shielding. The conductor shall be covered with a layer of semiconducting tape or extruded conducting compound. The extruded conducting compound or tape layer shall be firmly bonded to the cable insulation, and shall meet the requirements of Paragraph 2.4 of ICEA.

c. Insulation. Directly over the conductor shielding shall be applied a homogeneous wall of XLP insulation. The average thickness of insulation shall be as specified in Table 3-1 of ICEA. Minimum thickness at any point shall be not less than 90 percent of the specified thickness. Physical and electrical properties of the insulation shall be in accordance with Paragraph 3.7 of ICEA.

d. Shielding.

(1) A thin uniform layer of black conducting polymeric coating shall be applied directly over the insulation. A semiconducting non-metallic tape shall be wrapped over this coating to act as a conductive bedding between coating layer and the metallic shielding. A special marker tape applied over the semiconducting tape shall identify the tape and coating layers as conducting.

(2) A metal shield shall be applied over the semiconducting tape. Shield shall be helically applied copper tape or concentrically and evenly spaced #22 AWG solid uncoated copper wires meeting requirements of ICEA paragraph 4.1.1.2.

e. Separator Tape. A suitable separator shall be applied over the cable shielding system.

f. Jacket. A polyvinyl chloride jacket shall be applied overall. This jacket shall meet the requirements of Paragraph 4.3.1 of ICEA and the Sunlight Resistant requirements of UL Standard 1072. The average thickness of the jacket shall be as specified in Table 4-6 of ICEA. The minimum thickness at any point shall be not less than 80 percent of that specified.

16D.5 IDENTIFICATION. Cable shall be identified by means of surface ink printing indicating manufacture, conductor size, insulation type, voltage rating, UL designations, and year of manufacture.

16D.6 TESTS. Cables shall be tested in accordance with ICEA S-66-524 and UL Standard 1072.

16D.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.

16D.8 PACKAGING. All cable shall be provided on wooden or steel reels, and ends of all cable shall be sealed to prevent entry of moisture. All reels shall identify type, length, and year of manufacture of cable packaged on such reels. All such identification shall be clearly provided by the manufacturer.

16D.9 SUBMITTALS. Prior to installing any cable specified herein, the contractor shall submit the following documents, for the specific cable that the contractor proposes to use, to the Contracting Officer, and receive approval therefrom for its use (see Paragraph 1A.4 above):

a. Manufacturer's complete cable specifications, including compliance to all cable requirements, codes, and standards referenced herein and drawing showing cable construction details.

b. Manufacturer's recommended practices for maximum cable pulling tensions and minimum bending radii.

DIVISION 16 - ELECTRICAL
SECTION 16E
CONTROL CABLE

16E.1 SCOPE. This section covers the material requirements for all contractor furnished exterior standard and gopher-resistant filled control (telephone) cable to be installed as shown on the drawings. Installation of control cables is covered in Section 16F.

16E.2 APPLICABLE SPECIFICATIONS.

a. United States Department of Agriculture, Rural Electrification Administration (REA), Specification PE-39 for "Filled Telephone Cable" (Bulletin 345-67) latest edition, including all addendums and attachments thereto, forms a part of these specifications and is applicable in its entirety.

b. Certain requirements, specified herein, supplement the requirements of Specification PE-39, and shall receive special attention by the cable manufacturer and contractor.

16E.3 GENERAL REQUIREMENTS.

a. Definition. The term "control cable" used throughout these specifications and on the project drawings is a general FAA term for cable used to transmit voice and control functions. The required cable is termed "telephone" or "telephone exchange" cable by the cable manufacturing industry.

b. Quality. All control (telephone) cables shall be the standard products of a single major cable manufacturer and shall be designed and manufactured according to the highest industry standards. All cables shall be free of any imperfection which could affect serviceability and design life.

16E.4 STANDARD CABLE CONSTRUCTION. Cable requirements, complying with these specifications and Specification PE-39, include the following materials and construction.

a. Conductors. #19 AWG solid annealed copper.

b. Conductor Insulation. Solid polypropylene or polyethylene color coded in accordance with telephone industry "standard" coding.

c. Twisted Pairs. Individual conductors twisted into pairs with varying lays to minimize crosstalk.

d. Forming of Cable Core. Cables having 25 pairs or less are assembled into a single cylindrical group. Cables having more than 25 pairs are assembled in units, each individually identified by color coded unit binders.

e. Filling Compound. Water resistant non-hardening compound to fill and seal all interstices between the conductor pairs.

f. Core Covering. Non-hygroscopic dielectric tape.

g. Flooding Compound. Water resistant and bonding compound to fill all voids between the core wrap and shield and between the shield and jacket.

h. Shield. Corrugated electrically continuous and longitudinally applied 0.008 inch coated aluminum or 0.005 inch copper.

i. Jacket. High molecular weight polyethylene or high-molecular weight ethylene copolymer.

16E.5 GOPHER-RESISTANT CABLE CONSTRUCTION.

a. General. If gopher-resistant cable is required by drawings or special specifications, cable construction shall comply with all construction requirements for standard cable in Subsection 16E.4 above (including conformance with REA Specification PE-39) excepting for item h, "Shield", which shall comply with the following:

b. Gopher-Resistant Shield. Corrugated electrically continuous and longitudinally applied overlapping metal shield consisting of one of the following materials:

(1) 0.010 inch copper.

(2) 0.006 inch copper/stainless steel/copper bimetallic alloy.

(3) 0.007 inch Alloy 194 for 6 pr #19 cable.

(4) 0.006 inch Alloy 194 for cables larger than 6 pr #19.

(5) 0.008 inch coated aluminum with 0.006 inch coated steel.

16E.6 CABLE IDENTIFICATION. In accordance with Specification PE-39, all cable shall have jacket printed at periodic intervals with the name of the manufacturer, manufacturer's standard designation, year of manufacture, number of pairs, conductor gauge, sequential length marks, and notation signifying compliance with Specification PE-39 (if not clearly referenced in the manufacturer's submittals). In addition, the gopher-resistant shield shall be clearly identified.

16E.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.

16E.8 PACKAGING. In accordance with Specification PE-39, all cable shall be stored and shipped on reels affording the required protection. Thermal wrapping shall be provided and ends of all cables shall be capped against exposure to moisture. All reels shall be labeled by the manufacturer and shall bear the manufacturer's name, year of manufacture, REA cable designation, description of cable, actual shipping length, and identification referenced to tests of record as required herein.

16E.9 TESTS.

a. All project cable furnished shall satisfy all test requirements of Specification PE-39. Records of all such tests shall be retained by the manufacturer, according to Paragraph 29 of Specification PE-39, and shall be promptly made available to the Federal Aviation Administration upon request. All tests shall be specifically and clearly referenced to all reels of cable furnished.

b. Basic cable design, for all project cable furnished, shall have proven acceptable to REA through "qualification testing" according to Paragraph 27 of Specification PE-39.

c. Electrical tests, according to paragraph 28.1 of Specification PE-39, shall be performed on 100 percent of all project cable furnished.

d. Quality assurance (capability) tests, according to Paragraph 28.2 of Specification PE-39, shall be performed on such periodic production basis so as to represent quality of all project cable furnished.

16E.10 SUBMITTALS. Prior to procuring any cable specified herein, the contractor shall submit the following documents for the specific cable that the contractor proposes to use, to the Contracting Officer, and receive written approval therefrom (see Paragraph 1A.4 above):

a. Manufacturer's complete cable specifications, including manufacturer's statement of compliance with REA Specification PE-39.

b. Drawing showing cable construction details.

DIVISION 16 - ELECTRICAL
SECTION 16F
CABLE INSTALLATION

16F.1 DESCRIPTION OF WORK. The extent of work is indicated on the drawings and by the provisions of this section. Included in this section are installation, splicing, and testing of power and control cables.

16F.2 GENERAL REQUIREMENTS.

a. Service Interruptions. Existing sources of power and control are indicated on the drawings. For circuits actively in use, the contractor shall coordinate temporary interruptions of service with users and suppliers, the Resident Engineer, and the airport management.

b. Cable Protection.

(1) All cable ends which will be exposed to weather, water, ground, or corrosive environment prior to termination, shall be sealed against these elements while awaiting termination or splicing. This requirement also applies to all cable ends in manholes or handholes. The sealing material shall be properly sized, easily removable heat shrinkable end caps (3M ICEC are acceptable), or electrical tape (see Paragraph 16A.19 above), with an application of brushed-on electrical coating.

(2) Cables shall not be bent at radii less than radii recommended by the manufacturer, or 10 times cable diameter (12 times diameter for armored cable), whichever is greater. Any cables damaged in any way by sharp bending shall be replaced.

(3) Special care should be taken when working with filled cables, especially when the temperature is below 35^{O}F. This type of cable becomes more difficult to bend and work as the temperature decreases, and there is a possibility of cable damage at temperatures near 0^{O}F.

c. 600-Volt Wire and Cable Color Coding.

(1) All single conductor 600 volt wire and cable for 120/240 volt power circuits shall be color coded black for line 1, red for line 2, and white for the neutral.

(2) For conductor sizes smaller than #8 AWG, conductor insulation shall be color coded. For sizes #8 AWG and larger, and for armored power cable, colored tape shall be used to identify the conductors if insulation is not color identified.

(3) Conductors shall be color-coded in junction boxes, square duct, terminal boxes, or any other place accessible to view. In no case shall green be used for other than grounding, nor white for other than the system grounded (neutral) conductor.

d. Designation of Armored Cable. On drawings and other contract documents, the letter A immediately following the AWG number of a cable, indicates that the cable is armored (e.g., 3/C #8A, 600V).

16F.3 DIRECT-EARTH BURIAL CABLE INSTALLATION.

a. Installation Method. Unless otherwise specified, outdoor cables running from one structure or item of equipment to another, shall be direct earth buried. Direct-earth burial cables shall be installed either by the trench and backfill method or by the cable plowing method in accordance with all the requirements specified herein.

b. General Requirements.

(1) Underground cables shall be installed in straight lines between terminating locations or points of directional change.

(2) Unless otherwise specified, cables shall be installed a minimum of 24 inches and 30 inches below finished grade on airport property and off airport lands, respectively.

(3) Wherever possible, cable shall be installed in one continuous length without splices from connection to connection. The number of splices shall be kept to a minimum. Cable ends shall be effectively sealed against moisture immediately after cutting any type of cable. See the MALSR splice restrictions of Paragraph 13A.6.

(4) The contractor shall prepare a schedule for installing each reel of underground cable and shall submit it to the Resident Engineer for approval before installing any cable. The plan shall be predicated on use of the longest practical lengths of cable, in order to minimize splicing.

(5) A cable loop of at least three feet shall be left on each end of every cable run, on at least one side of every splice, and at all points where cable is brought above ground. A 3-foot minimum surplus cable length shall be left on both sides of splices in handholes and light bases. The slack loop shall be installed with the same minimum depth requirements as the cable run. Where cable is brought above ground, enough additional slack cable shall be left to make the required connections.

c. Trench and Backfill Installation Method.

(1) Comply with all trenching, backfilling, compaction, and restoration requirements in Division 2.

(2) The contractor shall unreel the cable adjacent to or over the trench and manually place it in the trench. Do not pull the cable into the trench or drag it along the trench.

(3) Where more than one cable is installed in the same trench, maintain separation as hereinafter specified. Multiple cables shall be installed in the

same relative positions throughout the cable trench. Cables shall not be stacked, crossed or intertwined in any manner.

d. Cable Plowing Method.

(1) Vibratory cable plowing equipment, adequate for installation of the types of cables to be installed and for the depth required, may be used, provided that soil conditions are suitable, equipment is in good working order, and proper installation procedures are utilized.

(2) While cable is being plowed into place, one person in addition to the operator of the plowing vehicle shall be present to assure that the cables do not kink or bind tightly while entering the plow.

(3) If, during plowing operations, it appears that the soil contains sharp objects, rocks over 2 inches in diameter, or any other hazard to the cable, plowing shall be discontinued, and the Resident Engineer notified. The Resident Engineer shall determine whether plowing will be allowed to continue, or whether another cable placement method shall be used.

(4) The slice left by the plow shall be closed by tamping or other approved method, after cable placement, to minimize the disturbance of the surface by the slice.

e. Cable Separation - Direct Burial.

(1) Where new buried power cables cross over or under control or telephone cables, power cables shall be installed in a length of PVC duct extending two feet each side of the crossing. Minimum separation shall be twelve inches.

(2) Power cables of the same circuit may be laid together in the trench without separation, except as noted below. Series lighting cables may be considered being of the same circuit.

(3) Power cables, of the same or different circuits of less than 600 volts, may be laid together in the same trench without separation.

(4) All power cables, 5,000 volts and below, shall be separated from all control, telephone and coaxial type cables by a minimum of 6 inches.

(5) Power cable, of more than 5,000 volts, shall be separated from all other cables by a minimum of 12 inches.

(6) Control, telephone, and coaxial cables may be laid in the trench without separation from each other.

f. Buried Ground Wire (Counterpoise). Unless specified otherwise, all direct-earth burial power, control and coaxial cables shall include the installation of #6 bare copper ground wire (counterpoise) per Paragraph 16A.4e above.

g. Cable Markers.

(1) Cable runs shall be marked by concrete cable markers according to project drawings. Cable markers for underground cable shall be installed at all changes of direction in cable runs, at 300 feet intervals in straight-line cable run segments, and at all splice locations.

(2) Markers shall not be poured in place. The markers shall be installed flat in the ground immediately above the cable and with approximately one inch projecting above the surface. Impress additional circuit identification symbols on markers if so directed by the Resident Engineer. Existing cable markers removed or displaced shall be replaced after installation of new cable.

16F.4 CABLE INSTALLATION IN UNDERGROUND DUCTS AND CONDUIT.

a. Precautions.

(1) Because almost all cable failures are caused by mechanical damage occurring during installation, the contractor should employ workmen experienced in underground cable installation, and utilize all the proper and unique equipment necessary for successful cable installation. Excessive direct tension, excessive sidewall pressure, sidewall impact, abrasion, sharp bending, and moisture intrusion will either destroy or shorten the useful life of cables installed.

(2) The following conditions and installation procedures, capable of damaging cable, shall be avoided:

(a) Sediment in ducts.

(b) Scoring of duct bends by pulling ropes.

(c) Inadequate support of guiding pulleys and pull tubes, resulting in binding of mechanisms and misalignment.

(d) Inadequate cable and duct lubrication, especially at bends.

(e) Dragging cables over manhole frame edges, duct entrances, and ground or pavement surfaces.

(f) Exposure to pedestrian or vehicular traffic.

(g) Looping in and out of manholes to avoid splicing.

(h) Power pulling at locations other than at ends of cable.

(i) "Jerking" of cables caused by too weak rope that elongates under tension, exerts momentary sharp pull on cable, recovers, and elongates for another like cycle.

(j) Sheaves and pulleys that stop rolling during pull, due to inadequate support or lubrication.

(k) Inadequate sealing and mechanical protection of cable ends.

(l) Reel surface and edge damage from poor hoisting techniques.

(m) Pulling distances too great.

b. Installation Equipment. Major equipment items, required for installing cable in underground ducts, shall include the following:

(1) Power winch.

(2) Cable feed-in tubing guide capable of producing a uniform and rigid 3 and 4-foot and greater radius bend, and having a nominal diameter equal to that of the ducts.

(3) Single pulleys or sheaves providing a minimum cable bending radius (not overall sheave radius) of 10 times the largest cable diameter. Such sheaves shall be used for minor cable bends within "through cable" manholes and at feed-in manhole rims (if necessary). Sheaves shall have ball or roller bearings.

(4) Adjustable gang pulleys with three or more pulleys capable of producing up to a 4-foot smooth cable bending radius. Each pulley shall have minimum cable bending radius of 10 times the largest cable diameter.

(5) Lubrication equipment to pre-lubricate ducts, cables at guide-in tubing, and cables at intermediate pull-through manholes.

(6) Cable reel support equipment including stands, arbor, and braking mechanism.

(7) Dynamometer for measuring pulling tensions.

(8) Communications equipment.

(9) Pulling ropes or cords having the following characteristics:

(a) A working strength at least equal to the maximum allowable cable tensions as specified herein. "Working strength" is normally 10 to 14 percent of published rope "breaking strength".

(b) Rope or cord shall be a twisted or braided synthetic fiber unaffected by water and having a low level of elongation under load. Material shall have a texture non-injurious to plastic duct when pulled against bends. Wire rope, if proposed, shall have a smooth and rigidly adhering synthetic material covering.

(c) All pulling ropes or cords shall have swivel devices at cable attachment ends.

(10) Cable lubricant specifically manufactured for electrical and control (telephone) cables. Do not use soap lubricants or those containing soap which are harmful to polyethylene-sheathed cables.

(11) Cable pulling devices (secured to ends of cable as specified below).

c. Cable Pulling Devices.

(1) Pulling devices for securing cable to pulling rope shall be factory-installed pulling eyes, field-installed pulling eyes, or basket weave cable grips. All shall be provided with integral or separate swivels.

(2) Factory-installed pulling eyes necessitate that each cable pulling segment be cut to length by the cable manufacturer. Greater tensions and longer pulling lengths can be used with factory pulling eyes for straight duct bank segments.

(3) Field-installed pulling eyes for control cable shall be a 4-crimp series, sized to the cable. Power cable pulling eyes shall be a type secured to conductors and approved by the Resident Engineer.

(4) Basket weave cable pulling grips shall be carefully sized to the specific diameters of the cables to be installed. Use grips with a rotating eye feature for power and control (telephone) cables.

d. Duct Cleanout and Pre-Lubrication.

(1) If any new or existing underground duct or conduit displays any evidence of contamination by soil or other foreign matter, such ducts or conduit shall be cleaned with a stiff bristle brush, swabbed, and flushed clean with water under pressure, before proceeding with cable pulling operations. Even a minor amount of soil or sediment in the bottom area of a duct will greatly increase the coefficient of friction and pulling tension required. With soil contamination, cable lubricant is of little value. Therefore, it is of utmost importance that conduit be cleaned prior to installation of cable.

(2) It is the contractor's responsibility to determine whether ducts designated for occupancy should be cleaned. The contractor shall assume complete responsibility for any difficulties or damage to the cable in placing cable in ducts.

(3) In addition to cable lubrication as specified elsewhere, all ducts to receive cables under this contract, shall be pre-lubricated using the same lubricant as for cables. Lubrication shall be thoroughly applied with applicators designed for this purpose. Lubrication on cable only, will rub off to a large degree, especially at duct bank offsets at manholes.

e. Setting Up Cable Reels and Apparatus.

(1) The contractor shall inspect cable reels for flange protrusions which could damage the cable sheath. Also, the contractor shall inspect for any obstructions that could interfere with proper unwinding of the cable.

(2) Careful control shall be exercised in the movement of cable reels. Where it is necessary to roll a reel to a desired location, it shall be rolled in the direction indicated by the arrows painted on the reel flanges. The reel shall not be allowed to tilt. A substantial runway of heavy planks should be employed where uneven ground conditions exist that may cause the reel to tilt. Where it is necessary to move a reel of cable with heavy equipment, a cable reel sling or equivalent should be used.

(3) In conduit sections containing curves, the cable reel shall be set up at the manhole near the curve unless other conditions do not permit.

(4) Cable reels shall be set up on the same side of the manhole as the conduit section in which the cable is to be placed. The reel shall be made level and brought into proper alignment with the conduit section so that the cable may be passed from the top of the reel in a long smooth bend at maximum radius into the duct without twisting and making more than a 90-degree bend. This is of utmost importance in handling filled type cable in temperature ranges of 35°F and lower. Under no circumstances shall the cable be pulled from the bottom of a reel.

(5) It is essential that the cable reel be in proper alignment and level during the placing operation. Incorrect location of the reel will cause unnecessary binding which will result in uneven cable feed.

(6) Do not permit adjacent turns of cable on the reel to stick together and cause binding as the cable is payed off the reel. Feed the cable by rotating the reel manually.

(7) Other cable support equipment, such as pulleys, sheaves, and gang-pulley equipment shall be set up rigidly within intermediate manholes to smoothly guide cables to exiting ducts.

f. Attaching Pulling Grips. All pulling grips shall be stretched onto the cables such that the entire lengths of the grip woven material will exert tension on the cable, thereby distributing stress. If the end of any cable grip (furthest from the cable end) does not grip as tightly as the lead end, secure same to cable with a steel banding. Inspect cable grips frequently, and the first pull of control (telephone) cable in particular (in the first intermediate manhole), to ascertain that this requirement is fulfilled. If any uneven gripping is evident, banding will be required for all remaining cable installation of the applicable cable type and size.

g. Feeding and Pulling Cable.

(1) All cable shall be installed using methods that will prevent excessive and harmful stretching, twisting, and flexing of the cable. Such damaging treatment will mechanically weaken the cable and destroy the electrical properties immediately or in a short time.

(2) Cable may be pulled by hand or power winch. Pull rope shall be attached to cables with pulling eye or basket weave pulling grips (all equipped with swivels) for each cable pulled. Do not exceed maximum allowable pulling tension as hereinafter specified. Do not use cable manufacturer's maximum pulling tensions except for cable factory-installed pulling eyes.

(3) All splices shall occur in manholes only. Splices shall not be pulled into ducts or manholes.

(4) Cable feed-in tubing guide, same size as conduit, of suitable length shall be secured in the manhole between the cable reel and the face of the duct to protect the cable and guide it at the maximum possible smooth radius into the duct as it is payed off the reel.

(5) A cable lubricator (funnel) shall be placed around the cable just ahead of the cable feed-in guide to facilitate lubrication of the cable. The quantity of lubricant shall conform to the lubricant manufacturer's recommendations.

(6) Before starting to pull, check the equipment carefully to make sure that it is properly set up in order to minimize the chance of interruption once pulling has started. Tension shall be kept on both the cable reel and the pulling line at the start of the pull. Excessive slack and the twist of the pulling line may cause the connecting links to turn and catch in the duct. As far as possible, the cable shall be pulled in without stopping. A pulling speed of 80 to 100 feet per minute is recommended to minimize friction forces.

(7) A person experienced with cable handling shall be posted continuously at the cable reel while pulling cable. In addition to braking the reels and observing cable lubrication, he shall carefully inspect cable paying off the reel for cable sheath and other defects. If defects are noticed, the pulling operation shall be stopped immediately and the Resident Engineer promptly notified of the defect. Kinks and/or irregularities in the cable sheath shall be removed or corrected as directed by the Resident Engineer.

(8) Careful attention shall be paid to signals from the installation crew as the cable is being pulled so that pulling may be stopped instantly whenever necessary to avoid damage to the cable.

(9) If for any reason the pulling operation is halted between manholes, the winch operator shall not release the tension on the winch unless directed to do so. In restarting the pulling operation, the inertia of the cable shall be overcome by gradually increasing the tension in steps a few seconds apart until the cable once again is in motion.

(10) The leading end of the cable at intermediate manholes shall be guided into the duct and a feeder tube nozzle placed around the cable to prevent the cable from rubbing on the edge of the duct.

(11) All pulled ends shall be examined for evidence of damage due to the pulling operation. The cable sheath shall not be pulled beyond the cable core. Notify the Resident Engineer for inspection, and for repair or replacement action that must be taken where cracks or openings are found in the cable sheath following the pulling operations.

(12) Cable ends shall be kept sealed at all times using REA-approved cable end caps and electrical tape. After the cable has been placed, the exposed cable in the manholes should be wiped clean of cable lubricant with a cloth before leaving the manhole.

(13) All individual cable segments shall be pulled in one direction only. Both ends of a cut cable segment shall not be introduced into an intermediate manhole and pulled in two different directions. Also, no cable segments shall be pulled out of any manhole and introduced into the same manhole for a continuation of a cable segment pull. These unacceptable pulling practices, used to avoid splicing, result in abrasion from dragging over ground surfaces and manhole frame, exposure to pedestrian and vehicular

traffic, damage to cable layers from twisting and small bending radii when pulling cable loops through manhole frame. Shields of cables so pulled are almost always damaged.

(14) Sidewall cable pressure from duct bends, feed-in tubes, and pulleys, frequently govern the length of cable that can be pulled. The greater the radii, the less the sidewall pressure. Therefore, the contractor shall use the maximum radius at every manhole where a 90-degree pull is permitted. Adjustable gang pulleys with three or more pulleys shall be used for horizontal bends in manholes. Individual pulleys within the gang pulley device shall have a cable bending radius of minimum 10 times outside diameter of largest cable to be pulled. Width of pulleys shall be adequate to support the cable group to be pulled. Adjust gang pulleys to produce a smooth 90 degree curvature bend where such changes in direction occur.

(15) If cables will be spliced in a manhole where duct banks enter and leave 90 degrees apart, separate cable segments shall be introduced into the manhole and pulled in different directions unless pulling is permitted around a horizontal gang pulley within the manhole.

(16) Where more than one cable will be installed in a single duct, all shall be pulled into the duct concurrently.

h. Cable Spoil. All cable pulling ends shall be trimmed back to remove cable material always damaged by pulling eyes or basket weave pulling grips. To remove such spoil, cut each cable off a distance from the end equal to three times the length of pulling eye or twice the length of the basket weave pulling grip as a minimum. These amounts shall be cut off for all cables including those to be spliced or terminated by others.

i. Use of Dynamometer.

(1) The dynamometer shall be accurately calibrated and secured to properly indicate tension exerted on the cable. The dynamometer reading will usually give the resultant force exerted on the anchoring device, which shall be converted to the horizontal component to give correct value of pulling tension.

(2) Dynamometer readings shall be made only in the presence of the Resident Engineer. If any pulling tension is approaching the maximum allowable, and if in the judgment of the Resident Engineer, the allowable will be appreciably exceeded for the proposed run, pullingoperations shall be immediately stopped, and the cable run spliced in the preceding manhole.

j. Maximum Cable Pulling Tensions. Maximum allowable cable pulling tensions, as measured by dynamometer, shall not exceed the following values for single cables. For multiple cables, add the tension values for the number of cables being pulled. Use a pulling rope having a working strength [not breaking strength -- reference subsection 16F.4b(9)] at least equal to the "maximum allowable pulling tension" values below.

Cable	Maximum Allowable Pulling Tension (lbs)
1-1/C #8	125
1-1/C #6	200
1-1/C #4	325
1/1-C #2	500
1-6 PR #19	125
1-12 PR #19	250
1-25 PR #19	500

k. Separation of Cables Installed in Conduit or Duct.

(1) Power cables of the same voltage may be installed in the same duct.

(2) Power cables of less than 600 volts may be installed in the same duct.

(3) Power cables of less than 600 volts shall not be installed in the same duct with control, telephone, or coaxial type cables.

(4) Power cables of more than 600 volts shall not be installed in the same duct with control, telephone, coaxial, or power cables of less than 600 volts.

(5) Control, telephone, and coaxial cables may be installed in the same duct.

l. Cable Installation in Manholes or Handholes.

(1) Power and control cables shall be installed in separate manholes or handholes unless otherwise specified. If installed in same manhole, install power and control cables on opposite sides. At splice locations, use cable racks at different elevations to separate power and control cables.

(2) Cable racking surplus shall be pulled back by hand into intermediate manholes. Pull surplus one manhole at a time beginning near both ends of cable segment. Do not use power winch unless permitted by the Resident Engineer.

(3) Cables shall be carefully routed around manhole interiors, taking all necessary precautions to prevent sharp bending. Cable racks shall be plastic or galvanized steel with properly sized porcelain insulators for the latter. Fasten all cables to plastic racks with nylon ties and to steel racks by means of the insulators.

(4) Where a splice occurs, cable shall make one loop around the manhole, and the splice located near the center of the loop.

(5) Where power and control cables are installed in the same manhole, the entire exposed length of all power and control (telephone) cables shall be fireproofed by applying fire and arc proofing tape per Paragraph 16A.23 above.

16F.5 CABLE TAGGING.

a. All cables shall be tagged in each manhole and in each terminal cabinet with not less than two tags per cable, one near each duct entrance hole. Tags shall be attached to cables immediately after installation of each cable.

b. Tags shall be circular in shape and 2 inches in diameter. Material shall be minimum 0.020-inch thick copper or brass or 0.0625-inch thick lead. 1/4-inch high steel lettering dies or equivalent size engraving equipment shall be used to make the tags. Tags shall be secured firmly to cables with Number 14 AWG copper wire.

c. Tag markings shall consist of an abbreviation of the facility served by the cable and the letter "P" or "C" denoting power or control. The facility shall include the applicable runway. Where like multiple control cables are routed between the same facilities, further identify such cables throughout the run with a single-digit number following the letter "C". All individual-conductor power circuits shall be bundled under the same tag as opposed to separate tags for each conductor.

16F.6 SPLICING.

a. General Requirements.

(1) Splices shall be performed only by experienced and qualified cable splicers regularly engaged in this type of work.

(2) Cable armor and/or shielding shall be bonded together across splices to provide continuous electrical paths.

(3) Where a cable is cut preparatory to splicing, the work shall proceed without delay. When an unavoidable delay is encountered in completing a splice, the opened cable shall be protected to prevent the entrance of moisture and foreign matter.

(4) Any splicing material (such as resin) older than the do-not-use-after date on the package, shall be replaced with new material at the contractor's expense.

(5) Unless otherwise specified, where multiple runs of single-conductor underground power cables are spliced, each single-conductor cable shall be spliced in a separate envelope.

(6) Approved stress reduction methods shall be used in splicing all shielded high voltage power cables (5KV and higher voltage).

b. Underground Power Cable Splices (600 Volts or Less). All low voltage splices shall be encapsulated in pressure resin in clear plastic envelopes, except as otherwise specified in Paragraph 13A.6 above, on drawings, or in special specifications. All low voltage splices shall be made with compression connectors specified in Paragraph 13A.6 above, except as otherwise specified on drawings and in special specifications.

c. Underground Control (Telephone Cable) Splices.

(1) Kit and Resin. The splices shall consist of a rigid polypropylene mold body with a built-in spacer web to provide cable centering and proper compound coverage. The mold body shall be filled with a flexible polyurethane electrical compound capable of continuous operation at 90°C, with an emergency overload temperature rating of 130°C. Splices must have provisions for inline splicing of shielded or non-shielded plastic or rubber-

jacketed control (telephone) cables. The splices shall be rated for direct burial applications. For control cables with outside diameters between 0.25 inches and 3.25 inches, 3M Scotchcast Signal and Control Cable Inline Splicing kits of the 72N series are approved, as they are among kits which meet specifications.

(2) Connectors. Control cable splice connectors shall be in-line type, in which two conductors are spliced by laying one conductor in each end of the connector, and crimping the connector with a special tool selected to match the connector type and size. Before crimping,the connector is open on one side of its length. After crimping, the connector is closed all around its length. The connector bodies shall be made with a tin-plated phosphor bronze piece on the inside, to contact the cable conductors, and bonded polyester insulation on the outside, to insulate the connection. The insulation shall be color coded to denote wire size range. The cable splice connectors and tools shall incorporate the insulation displacement termination technique which uses a slotted, tin-plated contact to displace the conductor insulation, thus providing four redundant electrical contact points. Connectors which require prestripping the conductor shall not be used. AMP, Inc. (Harrisburg, PA) Picabond connectors sized for conductor size, and matching AMP tooling, are among products meeting the above specifications, and are approved.

d. Submittals. See Paragraph 1A.4 above. If the contractor –

(1) Intends to splice using materials different from those specified in Paragraphs b and c above, or

(2) Intends to splice a 5KV or higher voltage power cable, then the contractor shall submit to the Contracting Officer, shop drawings or catalog cuts for all splicing materials, tools, and dies. The contractor shall splice no cables before he has received the Contracting Officer's approval of these items.

16F.7 CONTROL (TELEPHONE) CABLE TERMINATIONS.

a. Cable Routing and Support.

(1) Cable jackets shall be removed within terminating enclosures such that no more than 2 inches of jacket material is visible within the enclosures. Ground shielding and armor as specified below.

(2) Exposed cable conductor bundles shall be lock-stitched laced together with nylon lacing twine spaced at approximate 5/8- inch intervals. Each bundle shall contain maximum 25 pairs of conductors which shall be neatly routed and secured to backing panels with nylon clamps.

b. Cable Pair Terminations.

(1) Terminated pairs shall have the same sequence on each terminal strip. (For terminal block specifications, see Paragraph 16A.19, above.) The color code termination sequence on the terminal strips shall be in accordance with the following schedule. The white mates shall start at the top or left-hand side of the terminal block with color continuing down or across the block according to the following schedule:

MATE COLORS	PRIMARY WIRE COLORS
WHITE	BLUE
"	ORANGE
"	GREEN
"	BROWN
"	SLATE
RED	BLUE
"	ORANGE
"	GREEN
"	BROWN
"	SLATE
BLACK	BLUE
"	ORANGE
"	GREEN
"	BROWN
"	SLATE
YELLOW	BLUE
"	ORANGE
"	GREEN
"	BROWN
"	SLATE
VIOLET	BLUE
"	ORANGE
"	GREEN
"	BROWN
"	SLATE

(2) When cables do not have the preceding color code, like pairs shall be terminated in the same sequence at both ends of the cable.

16F.8 CABLE ARMOR AND SHIELD GROUNDING.

a. Grounding Locations.

(1) Control cable armor and/or shielding shall be grounded at one end of each cable run only.

(2) Power cable armor shall be grounded at both ends of each cable run.

(3) Shielding and armor of control and power cables shall not be grounded at splice locations.

b. Grounding Procedures.

(1) Use #14 AWG stranded copper grounding conductors for grounding shielding and armor. Secure grounding conductors to shielding and armor by using UL-approved grounding connectors specifically designed for this purpose. Neatly tape ends of butted cable to conceal the connections.

(2) Attach crimp-type lugs of proper size to free ends of grounding conductors, and secure lugs to enclosure interior wall with a machine screw and nut.

16F.9 CABLE TESTING.

a. General Requirements.

(1) Both before and after installation, all contractor-furnished and Government-furnished power and control (telephone) cables shall be tested as required herein. Testing after installation shall be accomplished across splices.

(2) All testing shall be accomplished in the presence of the Resident Engineer. Furnish two signed and dated copies of all test results, clearly tabulated for all segments of cable tested, to the Resident Engineer.

(3) The contractor shall use his own test equipment, which shall bear current calibration certification from a certified instrument calibration laboratory.

(4) Any measured values not conforming to specified values shall be cause for rejection of the defective cable installation. After repair or replacement, if so required by the Resident Engineer, cable shall be retested and additional remedial work performed until satisfactory test results are obtained. All repair and replacement work shall be accomplished at no additional cost to the Government.

b. 600-Volt Power Cable Testing.

(1) Conductor continuity shall test positive.

(2) Armor continuity shall test positive.

(3) Dielectric strength/insulation resistance shall test 50 megohms minimum at 500 volts D.C. between the following:

(a) Conductor and ground for single-conductor cable.

(b) Individual conductors for multi-conductor armored cable.

(c) Individual conductors and grounded armor.

c. Control (Telephone) Cable Testing.

(1) Conductor continuity shall test positive.

(2) Shield continuity shall test positive.

(3) Armor continuity shall test positive.

(4) Dielectric strength/insulation resistance shall test 50 megohms minimum at 500 volts D.C. between paired conductors and between individual conductors and grounded shield.

(5) After installing control cable, the minimum number of acceptable paired conductors shall comply with the following:

(a) For 11 pair or less cable, all pairs shall test acceptable.

(b) For 12 to 25 pair cable, all pairs except one shall test acceptable.

SPECIFICATIONS SUPPLEMENTAL TO SPECIFICATIONS FAA-GL-840b AND FAA-GL-918C

8/24/07

1. Contractor-Furnished Frangible Couplings. The following specifications supersede Paragraph 16A.20 of Specification FAA-GL-918C. The Contractor shall furnish all the frangible couplings to be applied under this contract. All frangible couplings shall be 2"-diameter cast aluminum couplings having hexagonal clamping ring. The coupling shall accommodate 2"-diameter EMT conduit. The frangible couplings shall meet the requirements of either Military Specification MS-17814-1, or of FAA Drawing C-6046. The straight-thread Multi-Electric Cat. No. 961-A frangible coupling is among couplings meeting MS-17814-1. The tapered-thread Multi-Electric Cat. No. 961-AT frangible coupling is among couplings conforming to FAA Drawing C-6046. If the Contractor intends to furnish substitute frangible couplings, the Contractor shall submit to the Contracting Officer, catalog cuts demonstrating that the substitute couplings meet the above specifications. The Contractor shall furnish at least 110 each of the frangible couplings. The Contractor shall turn all spare frangible couplings over to the Resident Engineer, who will deliver them to FAA maintenance personnel.

2. MALS PAR-38 Lamps.

   A. Specifications. The following specifications override Paragraph 13A.5. The Contractor shall furnish fifty-five PAR-38 halogen incandescent spot lamps. The lamps shall be rated by the manufacturer to have 120-watt power, approximately 1900 lumens and 25000 center beam candlepower (CBCP), and 3000 hours average lamp life at 120 volts. Sylvania lamps of lamp designation 120PAR/CAP/SPL/SP and NAED (Vendor I.D. No.) code 14856 meet these specifications. If the Contractor intends to furnish lamps other than Sylvania No. 14856, the Contractor shall submit to the Contracting Officer the substitute lamp's candlepower distribution curve and manufacturer's technical data sheets demonstrating that the substitute meets the power, brightness, and lamp life and lumen maintenance criteria of the above specifications. The contractor shall also furnish a sample lamp, and shall demonstrate that it will fit the lamp aiming device supplied with the MALSR.

   B. Application. The Contractor shall install 45 of these lamps on the 5-light bar structures. The remaining 10 lamps shall be delivered to the Resident Engineer for use as spares. The installed lamps shall be aimed vertically to the aiming angles specified on the drawings.

3. CONTROL CABLE SHIELD GROUNDING. Control cable shield shall be grounded at each end of each cable run. This requirement overrides Specification FAA-GL-918C, Paragraph 16F.8a(1) and Specification FAA-GL-840B, Paragraph 16F.8a(1).

4. SUPPLEMENTAL LIGHTNING ARRESTER. If lightning arresters are not furnished with the MALSR equipment, or supplemental lightning arresters are required, the lightning arresters shall meet the following specifications:

   A. Voltage rating: 120/240 VAC, 3 wire, 1 phase, 50/60Hz.
      Each L (black wire) to N (neutral wire) 120 VAC.
      L (black wire) to L (black wire) 240VAC.
   B. Conduction starts @ 240V peak.
   C. Operation: Bipolar, same performance on either polarity of surge.
   D. Power consumption: None
   E. Power follow current: None
   F. Load or source KVA: Unlimited.
   G. Temperature range: -50°C to +80°C.
   H. Response: Less than one nanosecond.
   I. Extreme lightning and surge duty: 55 KVA each line to ground.
   J. Discharge voltage vs. surge current, each line to ground:

@	1.5 KA, 8x20us	420V peak
	5.0	520
	10.0	550
	20.0	700
	30.0	825
	50.0	970

   K. Life, each line to ground:

@	1.5KA, 8x20us	60,000 operations
	5.0	3,000
	10.0	300
	20.0	50
	30.0	15
	50.0	5

   Lightning and electrical surge arrester Model LPC 10262-6 from Lightning Protection Corporation (Goleta, CA) meets the above specifications.

5. Fluorescent Light Fixtures and Ballasts. The following specifications supersede Paragraph 16A.17f of Specification FAA-GL-918C.

   f. Interior Light Fixture and Lamps. Each interior light fixture shall be a surface-mounted, 120-volt, fluorescent light fixture having a high-gloss white painted steel chassis and a light-controlling acrylic lens enclosure. The lens (diffuser, refractor) enclosure shall be of a wraparound style that illuminates the ceiling as well as the room. The enclosure shall be hinged on one side, or shall pull down, for cleaning and maintenance. The fixture shall be nominally four feet long, and shall accommodate two 48"-long T-8 fluorescent lamp tubes. The ballast shall have a radio frequency suppressor. The ballast shall operate normally at temperatures above 20°F. The lamp tubes shall be 32-watt 48"-long T-8 fluorescent lamp tubes,

each with an initial rating of 2,850 lumens. The following 32-watt lamp tubes are among lamps which meet these specifications: General Electric Trimline, Philips TL70, and Sylvania Octron. The following light fixtures are among fixtures that meet the above specifications.

(1) Day-Brite Cat. No. HWN232-120-1/2-EB, with:

(a) Valmont Electric Cat. No. E232-P1 120 G01 two-lamp electronic ballast, rated at zero degrees F., and

(b) Valmont Electric Cat. No. 89G635RFI filter.

(2) Holophane Model No. HW-S-M-4-D-S-H71-042-LP-1-1 with RF suppressor

(3) Lithonia Model No. WA-2-32-120-GEB-RIF1

(4) Metalux Cat. No. W-232A-120-LEOC8-RIF1

If the contractor desires to furnish and install other light fixtures than those listed above, or a tandem connected and wired version of the 4'-long fixture listed above, the contractor shall submit catalog cuts of the fixture, and receive the Contracting Officer's approval before procuring.

6. NO ASBESTOS. No material containing asbestos shall be installed under this contract.

7. GROUNDING ELECTRODE. The following specifications supersede Paragraph 16A.4c of Specification FAA-GL-918C.

c. Grounding Electrode. Grounding electrodes (rods) shall be copper clad steel, 3/4-inch by 10 feet, except where otherwise specified. The top of the grounding electrode shall be a minimum of 12 inches below finished grade. Conductors shall be attached to electrodes with exothermic welds only, except where fire or explosion hazards exist, as near existing fuel tanks. Where such hazards exist, hydraulically crimped connections will be permitted as specified below.

8. ELECTRODE GROUND TESTING. The following specifications supersede Paragraph 16A.4h of Specification FAA-GL-918C.

h. Testing. Electrode grounds shall be tested for resistance at each location. Resistance to ground for each grounding location shall be 10 ohms or less. If this value is not achieved with the grounding electrodes as shown on the drawings, additional grounding electrodes spaced at least 6 feet apart, or electrode extensions of the same construction and diameter, shall be installed until the resistance value does not exceed the maximum of 10 ohms. A tabulated report of the final resistance value at each location shall be provided to the Resident Engineer.

9. AIR TERMINAL BRACE. The following specifications supersede Paragraph 16A.18c of Specification FAA-GL-918C.

   c. Air Terminal Brace Assembly. The air terminal brace assembly for a 36" air terminal shall be a 24"-long galvanized tripod assembly, with legs adjustable to accommodate any roof slope. Cat. No. 82 meets these specifications.

10. GROUND ROD CLAMPS. Paragraph 16A.18k, Ground Rod Clamps, of Specification FAA-GL-918C, is deleted.

11. CONTROL CABLE. The following specifications supplement Paragraph 16E of Specification FAA-GL-918C.

    Specification. Control cable shall be either:

    - REA Specification PE-39 cable meeting all the requirements of Section 16E, or
    - REA Specification PE-89 cable (having foamed polyethylene or propylene conductor insulation with a solid skin of the same material), meeting all requirements of Specification FAA-GL-918C Section 16E except the REA Specification PE-39 requirements.

12. FACILITY AC SURGE ARRESTER.

    The following paragraph supersedes Paragraph 16A.16d of Specification FAA-GL-918C.

    d. Arrester Meeting Specifications. For 120/240V, single phase, 60Hz applications, the Lightning Protection Corporation (Goleta, California) Model No. LPC 20206-7 AC surge arrester is one of the products that meet the above specifications. This arrester must be equipped with two Class J fuses, 60 amp, time-delay, 200KAIC (interrupting capacity), UL listed. If the contractor intends to furnish a substitute, or if a different power configuration must be accommodated, the contractor shall submit to the Contracting Officer, full manufacturer's literature on the substitute arrester, and shall not procure the substitute before receiving the Contracting Officer's approval. See Paragraph 1A.4 above.

    The following paragraph is added to Paragraph 16A.16e of Specification FAA-GL-918C.

    (4) Fuses. The surge arrester must be equipped with two Class J fuses, 60 amp, time-delay, 200KAIC (interrupting capacity), UL listed.

13. PAPI PLATE. The following paragraph supplements and supersedes Paragraph 13D.2 of Specification FAA-GL-918C.

    13D.2 SCREW ANCHOR FOUNDATION DESIGN AND USAGE. On drawings, screw anchor foundations are also called screw-in foundations and screw-in-anchor foundations.

a. Screw Anchor Foundations. The two most frequently used screw anchor foundations, are shown on Figures 1 and 2 at the end of this section. The Figure 1 foundation is commonly used for ILS, RVR, MALSR, and PAPI facilities. The Figure 2 foundation is commonly used for REIL facilities. A. B. Chance foundations, Cat. Nos. T112-0262 and T112-0676, are among the products that meet the requirements of Figures 1 and 2, respectively. These items are also known by Cat. Nos. CT112-0262, CT112-0676. The Chance Figure 1 foundation is known as an "Instant" foundation (formerly known as a streetlight foundation).

b. PAPI Plate. The PAPI plate of Figure 3 in Specification FAA-GL-918C does not describe the current A. B. Chance PAPI plate, Chance Cat. No. T112-0337 or CT112-0337. Figure 3 has a 26.65" dimension, and describes the old PAPI plate, which accommodated the AVW PAPI. The current (2002) PAPI plate, Chance Cat. No. T112-0337 or CT112-0337, has a 28" dimension in place of the 26.65" dimension. The current A.B. Chance PAPI plate is shown on A. B. Chance Drawing No. SA112-0337, Rev C dated 07-08-93, and accommodates the NBP PAPI, Type FA-10620, NSN 8200-00-600-82751.

14. STEEL SIDING. The following paragraph supplements and supersedes Paragraph 13E.8 of Specification FAA-GL-918C.

13E.8 STEEL SIDING. Furnish and install steel roof, siding, soffit, fascia, trim and accessories in accordance with manufacturer's instructions and the following material specifications. The standing seam metal roofing panels, siding panels, and soffit, fascia, and trim system shall be fabricated by one manufacturer as a complete system with warranties as specified below. The material shall be provided by the manufacturer with a detailed list of material and installation instructions. Substitutes require submittals per Paragraph 1A.4 above.

a. Steel Standing Seam Roofing System. Steel sheet shall be 22 gauge, grade 40 steel, hail and wind resistant, with a 30-year warranty on factory finish and a lifetime warranty on roofing material. Slim Seam metal roofing (16" coverage) from Fabral Metal Wall and Roofing Systems meets specifications. Color shall be white. Install Versa-Vent X-10 ridge cap sealer, 1-3/4" x 3" x 10' (for 1 1/2" rib height). For substitutions, make submittals per specifications.

b. Steel Siding. Steel siding shall be a structural exposed fastener wall system, 22-gauge, grade 40 steel, hail and wind resistant, with exposed fasteners and a 30-year warranty on factory finish.

Mighti-Rib PBR metal siding system from Fabral meets specifications. Color shall be white.

c. Soffit and Fascia. Soffit and fascia material shall be 24-gauge steel with hidden fasteners, continuously vented, with a 20-year warranty on factory finish. Posi-Lock metal soffit and fascia system from Fabral meets specifications. Color shall be white.

15. BURIED GUARD WIRE.

The following paragraph supplements and supersedes Paragraph 16A.4e of Specification FAA-GL-918C.

e. Buried Guard Wire. Buried cables (including armored cables) not completely enclosed in ferrous conduit, shall be protected by a bare copper guard wire. Unless specified otherwise, or shown otherwise on the drawings, the guard wire shall be #1/0 AWG. Embed the guard wire in the soil at least 10 inches directly above and parallel to the cables being protected. Where the width of the run of cables or ducts does not exceed 3 feet, install one guard wire centered over the cable or duct run. Where the cable or duct run is more than 3 feet wide, install two guard wires. Space the two guard wires at least 12 inches apart, and 12 to 18 inches inside the outermost wires or outermost edges of the duct. Weld the guard wire exothermically to a grounding electrode at each end, and to grounding electrodes at approximately 90-foot intervals. The spacing between the grounding electrodes shall vary by 10 to 20 percent, to prevent resonance.

The following paragraph supplements and supersedes Paragraph 16F.3f of Specification FAA-GL-918C.

f. Buried Guard Wire. Unless specified otherwise, all direct-earth burial power, control, and coaxial cables shall include the installation of #1/0 bare copper ground wire per Paragraph 16A.4e above.

16. PAR-38 LAMPHOLDER SOCKET RETENTION SCREWS. If DME Corp. MALSR equipment is furnished by either the FAA or the contractor, the contractor shall inspect the PAR-38 lampholders. It is probable that the heads of the socket retention screws furnished with the lampholders are too wide to fit into the socket recesses. If they are, the contractor shall furnish stainless steel 6-32 x 1 1/4" socket head cap screws to install the sockets in the lampholders. Two cap screws are required per PAR-38 lampholder.

17. CONTROL CABLE TERMINAL STRIPS. The following specifications supersede Paragraph 16A.19 of Specification FAA-GL-918C.

16A.19 CONTROL CABLE TERMINAL STRIPS. Unless specified otherwise, contractor-furnished control (telephone) cable terminal strips shall be units assembled from compatible components all from the same manufacturer. The individual blocks of the strips shall be miniature style (6mm O.C.) nylon blocks with screw-activated tubular conductor clamps. The blocks shall be rated for

a maximum voltage of at least 300 volts and a maximum current of at least 30 amperes. The conductor clamps shall accept wire sizes of at least from #22 to #14. Stab-in wire connection blocks shall not be used. The blocks shall be mounted in a standard 35mm DIN rail mounting channel. The assembled strip of blocks shall have a marking strip and holding plugs or end barriers. For terminating control cables on these strips, see Paragraph 16F.7 below. The following terminal strip components are among components which meet these specifications:

a. Square D: Block No. 9080GM6, with mounting channel and marking strip No. 9080GH60, with end barrier No. 9080GM6B.

b. Square D: Block No. AB1W435U, with mounting channel and marking strips of the AB1B6XX series, with end barrier No. AB1AC24 and end clamp No. AB1AB8P35.

c. Wieland: Block series WK4/U, type 57.504.0055.0 with mounting channel and marking tags of the WK4/U series, type No. 04.846.0153.0, 04.846.0253.0, 04.856.1153.0 with end plate No. 07.311.0155.0 and end clamp No. Z5.522.7453.0 or Z5.522.8553.0.

d. Allen-Bradley: Block No. 1492-J4, with mounting channel and marking strips of the 1492-M6X12 series, with end barrier 1492-EBJ3 and end clamp No. 1492-EAJ35.

e. Weidmüller: Block series WDU 4, type No. 1020100000, with mounting channel and marking strips of the Dekafix marking tags series, with end plate series WAP 2.5-10, type No. 1050000000 and end bracket WEW 35/2, type No. 1061200000.

18. CONDUIT. The following specifications supersede Paragraph 16A.3b of Specification FAA-GL-918C.

b. Except where specified otherwise, conduit exposed to the weather, in concrete, or below grade shall be galvanized rigid steel (GRS) with threaded joints. GRS conduit outer surfaces that contact the subgrade shall conform to Society for Protective Coatings Standard SSPP-PS 10.01, or shall be field wrapped with 0.01-inch thick pipe wrapping plastic tape applied with 50-percent overlap.