

A. GENERAL

1. THESE SPECIFICATIONS APPLY, IN ADDITION TO THOSE PROVIDED IN THE BASE CONTRACT, TO ALL FAA OWNED EQUIPMENT INSTALLED UNDER THIS CONTRACT. IF NO SPECIFICATION IS GIVEN IN THIS SECTION, SEE THOSE REQUIREMENTS PROVIDED IN THE BASE CONTRACT. IF THE REQUIREMENTS OF THIS SPECIFICATION CONFLICT WITH THOSE PROVIDED IN THE BASE CONTRACT, THE MORE STRINGENT REQUIREMENT SHALL GOVERN. THESE SPECIFICATIONS DO NOT APPLY TO ANY NON-FEDERAL EQUIPMENT INSTALLED UNDER THIS CONTRACT.
2. THE CONTRACTOR MUST FURNISH ALL LABOR, MATERIALS (EXCEPT GOVERNMENT FURNISHED), SERVICES, EQUIPMENT, INSURANCE, BONDS, SECURITY NOTIFICATIONS, LICENSES, PERMITS, AND FEES IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE AND LOCAL REGULATORY REQUIREMENTS TO COMPLETE THE SPECIFIED WORK. THE CONTRACTOR MUST PROVIDE ANY MISCELLANEOUS LABOR, EQUIPMENT AND/OR MATERIALS NOT SPECIFICALLY DETAILED OR SPECIFIED, BUT REQUIRED TO COMPLETE THE PROJECT.
3. THE FOLLOWING FAA STANDARDS APPLY:

FAA-C-1217H	SPECIFICATION FOR INTERIOR ELECTRICAL WORK
FAA-C-1391E	SPECIFICATION FOR UNDERGROUND CABLES
FAA-STD-019F	LIGHTNING PROTECTION, GROUNDING AND BONDING

UNLESS SPECIFICALLY INDICATED OTHERWISE, THE MOST CURRENT VERSION OF ALL STANDARDS IN EFFECT AT THE TIME OF CONTRACT AWARD APPLIES.

4. CALLOUTS ON THE CONSTRUCTION DRAWINGS INDICATE WORK TO BE DONE UNDER THIS CONTRACT UNLESS SPECIFICALLY NOTED "INSTALLED BY OTHERS" OR "EXISTING". CALLOUTS INDICATING WORK TO BE DONE DO NOT ALWAYS INCLUDE THE WORD "INSTALL" OR "NEW".
5. THE CONTRACTOR MUST PROVIDE THREE COMPLETE SETS OF RED-LINED AS-BUILT DRAWINGS TO THE RESIDENT ENGINEER AT THE END OF THE PROJECT. RED-LINED AS-BUILT DRAWINGS MUST BE PROVIDED WITHIN 5 DAYS OF FINAL INSPECTION. THE FOLLOWING COLOR CODES MUST BE USED:

GREEN -	TO INDICATED NEW OR CHANGED INFORMATION
RED -	TO INDICATED DELETIONS
BLUE -	TO INDICATE NOTES TO THE DRAFTSMAN

ANY ADDITIONAL DIAGRAMS AND/OR SCHEMATICS THAT WOULD BE HELPFUL FOR THE MAINTENANCE OF THE FACILITY SHOULD ALSO BE INCLUDED.

6. THE CONTRACTOR MUST NOT USE ANY ASBESTOS CONTAINING MATERIAL (ACM) AT ANY TIME DURING THE CONSTRUCTION. THE CONTRACTOR MUST VERIFY THAT ALL MATERIAL, INCLUDING THOSE SUPPLIED BY THIRD PARTIES, ARE ASBESTOS FREE MATERIALS. A WRITTEN CERTIFICATION LETTER MUST BE PROVIDED BY THE CONTRACTOR TO THE RESIDENT ENGINEER CERTIFYING THAT THE FINISHED WORK IS ASBESTOS FREE.
7. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO COORDINATE ANY FACILITY OUTAGES WITH THE APPROPRIATE FAA AND AIRPORT PERSONNEL. UNDER NO CIRCUMSTANCES DOES THE CONTRACTOR HAVE THE AUTHORITY TO DE-ENERGIZE ANY FAA EQUIPMENT.
8. CONTACT THE RESIDENT ENGINEER TO COORDINATE OUTAGES FOR POWER AND EQUIPMENT CONNECTIONS. THE FAA OPERATIONS AT THIS FACILITY ARE PROVIDING AIRCRAFT FLIGHT CONTROL AND ASSISTANCE INFORMATION WHICH IS REQUIRED FOR SAFETY OF THE AIRCRAFT AND THE PUBLIC. THEREFORE, ANY POWER LOSS TO FACILITY EQUIPMENT IS VERY SERIOUS AND MUST BE CAREFULLY COORDINATED WITH FACILITY PERSONNEL. UNSCHEDULED INTERRUPTIONS OF ELECTRICAL SERVICE TO FAA FACILITIES OR EQUIPMENT MAY CAUSE AIRCRAFT ACCIDENTS AND LOSS OF LIFE. WORK REQUIRING A TEMPORARY OR PERMANENT DE-ENERGIZING OF EQUIPMENT MUST BE SCHEDULED IN WRITING WITH THE ONSITE FAA MAINTENANCE PERSONNEL THROUGH THE RESIDENT ENGINEER. ONLY ONSITE FAA MAINTENANCE PERSONNEL ARE AUTHORIZED TO ENERGIZE, DE-ENERGIZE EQUIPMENT OR TO OPERATE A CIRCUIT BREAKER, SWITCH OR FUSE IN A FAA FACILITY. DETERMINE ALL INTERFACE REQUIREMENTS AND PROVIDE MATERIAL AND LABOR NEEDED TO COMPLETE ANY CONNECTIONS TO BE SCHEDULED DURING AN OUTAGE. WORK PROCEDURES MUST INCLUDE LOCK-OUT/TAG-OUT PROCEDURES IN ACCORDANCE WITH FAA ORDER 3900.64.

B. SITEWORK

1. PREPARATION/REMOVAL OF EXISTING PAVEMENTS-SHALL CONFORM TO ITEM P-101.
2. CLEARING AND GRUBBING-SHALL CONFORM TO ITEM P-151.
3. EXCAVATION, SUBGRADE, AND EMBANKMENT-SHALL CONFORM TO ITEM P-152.
4. CONTROLLED LOW STRENGTH MATERIAL (CLSM)-SHALL CONFORM TO ITEM P-153.
5. SUBBASE COURSE-SHALL CONFORM TO ITEM P-154 EXCEPT AS MODIFIED HEREIN:

- 5.1. SEPARATION GEOTEXTILE-GEOTEXTILE MUST MEET THE FOLLOWING REQUIREMENTS:

PROPERTY	MINIMUM REQUIREMENT		
WEIGHT	6.0 OZ/SQ.YD	(ASTM D-3776-79)	
TENSILE STRENGTH	205 LBS	(ASTM D-4632)	
GRAB ELONGATION	50% (MAX)	(ASTM D-4632)	
TRAPEZOID TEAR STRENGTH	80 LBS	(ASTM D-1117-80)	
PUNCTURE STRENGTH	525 LBS	(ASTM D-3787-80)	
WATER FLOW RATE	110 GAL/MIN/SF	(CFMC GET-2)	
UV RESISTANCE	70%	(ASTM D-4355) (600HRS)	

- 5.2. COMPACTION-REQUIRED FIELD DENSITY OF COMPACTED SUBBASE SHALL BE AT LEAST 95% OF MAXIMUM DRY DENSITY.

C. BASE COURSES

1. CRUSHED AGGREGATE BASE COURSE-SHALL CONFORM TO ITEM P-209. EXCEPT AS MODIFIED HEREIN:

- 1.1. GRADATION OF AGGREGATE BASE- SHALL MEET THE FOLLOWING REQUIREMENTS:

SIEVE #	% PASSING BY WEIGHT			
	CLASS 1	CLASS 5	CLASS 6	
2 1/2"	100	----	----	
2"	95-100	----	----	
1 1/2"	----	100	----	
1"	----	95-100	----	
3/4"	----	----	100	
3/8"	----	----	57-81	
#4	30-65	30-70	36-60	
#40	----	----	6-25	
#200	3-15	3-15	0-6	

- 1.2. GEOTEXTILE FABRIC- REQUIREMENTS OF B.5.1 GOVERN
- 1.3. COMPACTION-REQUIRED FIELD DENSITY OF COMPACTED BASE SHALL BE AT LEAST 95% OF MAXIMUM DRY DENSITY.
- 1.4. APPLICATION OF REQUIREMENTS-THE REQUIREMENTS OF P-209 AS MODIFIED HEREIN APPLY TO BASE COURSES AND AGGREGATE SURFACING.

D. FLEXIBLE PAVEMENTS

1. ASPHALT MIX PAVEMENT-SHALL CONFORM TO ITEM P-401. EXCEPT AS MODIFIED HEREIN:

- 1.1. ASPHALT AGGREGATE GRADATION-SHALL CONFORM TO THE FOLLOWING:

ASPHALT AGGREGATE GRADATION		PERCENT PASSING (BY WEIGHT)	
SIEVE SIZE			
3/4		100	
1/2		76-96	
3/8		69-89	
NO. 4		53-73	
NO. 8		38-60	
NO. 16		26-48	
NO. 30		18-38	
NO. 50		11-27	
NO. 100		6-18	
NO. 200		3-6	

- 1.2. ASPHALT CEMENT BINDER-SHALL BE PG 64-28

- 1.3. ALTERNATIVE MIX DESIGN-A MIX DESIGN ACCEPTED BY THE STATE DOT FOR USE IN THE PROJECT LOCATION MAY BE SUBSTITUTED AT THE CONTRACTOR'S REQUEST. THIS REQUEST MUST BE SUBMITTED TO THE PROJECT ENGINEER DURING THE SUBMITTAL PROCESS.

E. CONCRETE

1. CONCRETE-SHALL CONFORM TO ITEM P-610 EXCEPT AS MODIFIED HEREIN:

1.1. FORMS

- 1.1.1. CONCRETE FORMS-ALL CONCRETE STRUCTURES MUST BE FORMED TO FULL DEPTH, EXCLUDING CYLINDRICAL PIERS WHICH MUST BE FORMED TO A MINIMUM DEPTH OF 1' BELOW GRADE WHEN FREESTANDING. WHEN USED AS SUPPORT FOR A SLAB OR OTHER STRUCTURE, CYLINDRICAL FORMWORK IS NOT REQUIRED.
- 1.1.2. FORM TIES-MUST BE OF A TYPE AS TO LEAVE NO METAL CLOSER TO THE SURFACE THAN 1".
- 1.1.3. FORM REMOVAL- FORMS SHALL NOT BE REMOVED UNTIL CONCRETE HAS REACHED 30% OF THE SPECIFIED 28-DAY COMPRESSIVE STRENGTH.

1.2. REINFORCING

- 1.2.1. REINFORCING STEEL-SHALL BE NEW, CLEAN, UNDAMAGED AND UNLESS OTHERWISE INDICATED CONFORM TO ASTM A-615, GRADE 60.
- 1.2.2. TIE WIRE, CHAIRS, AND SPACERS- ALL DEVICES NECESSARY TO PROPERLY SPACE, SUPPORT AND FASTEN STEEL REINFORCEMENTS IN PLACE DURING CONCRETE PLACEMENT MUST CONFORM TO ACI 315. TIE WIRE MUST BE 16 GAUGE OR LARGER ANNEALED IRON WIRE.
- 1.2.3. BENDS-ALL BENDS IN BARS AND TIES MUST BE COLD BENT. NO BENDS MAY BE MADE IN BARS OR TIES PARTIALLY EMBEDDED IN CONCRETE.
- 1.2.4. PLACEMENT-STEEL REINFORCEMENT MUST BE ACCURATELY PLACED AT THE SPACING AND IN THE SIZES INDICATED ON THE APPLICABLE DRAWINGS AND SECURED AGAINST DISPLACEMENT DURING THE POUR OPERATIONS. REINFORCEMENT MUST BE PLACED WITHIN +1/2 INCH OF THE INDICATED DIMENSIONS.

1.3. CAST IN PLACE CONCRETE

- 1.3.1. AGGREGATE-MUST CONFORM TO ASTM C-33 EXCEPT THE MAXIMUM AGGREGATE SIZE SHALL BE 3/4".
- 1.3.2. ADMIXTURES-AIR ENTRAINING ADMIXTURES MUST CONFORM TO ASTM C 260. ADMIXTURES USED FOR WATER REDUCING AND RETARDING MUST CONFORM TO ASTM C 494, TYPE A OR TYPE D.
- 1.3.3. SLUMP-THE CONCRETE MUST HAVE A SLUMP OF 3 TO 4 INCHES.
- 1.3.4. STRENGTH-UNLESS OTHERWISE INDICATED ON THE CONSTRUCTION DRAWINGS, TYPE I CONCRETE MUST HAVE A 28 DAY COMPRESSIVE STRENGTH OF 4,000 PSI AND TYPE III MUST HAVE A 7 DAY COMPRESSIVE STRENGTH OF 4,000 PSI.
- 1.3.5. AIR CONTENT-AIR ENTRAINING FOR ALL CONCRETE SHALL BE 4 TO 8 PERCENT.
- 1.3.6. JOINT SEALANT-USE ONE-PART SELF-LEVELING POLYURETHANE SEALANT SUCH AS SONOLASTIC SL1 BY SONNEBORN (OR APPROVED EQUAL). PRODUCT MUST COMPLY WITH FEDERAL SPECIFICATION TT-S-00230C, TYPE 1 CLASS A; ASTM C 920, TYPE S, CLASS 25, USE U, T, M.
- 1.3.7. SEALING-APPLY A CONCRETE CURING COMPOUND (SEALMASTER OR AS APPROVED) AS DIRECTED BY THE MANUFACTURER AND AS APPROVED. CONCRETE CURING COMPOUND SHOULD GENERALLY BE APPLIED ONCE THE CONCRETE IS FIRM ENOUGH TO WALK ON WITH NO SURFACE WATER PRESENT (ABOUT ONE HOUR AFTER FINAL TROWELLING OR WHEN APPLICATION WILL NOT MAR SURFACE).
- 1.3.8. ANCHOR BOLTS AND PLATES-ANCHOR BOLTS MUST BE INSTALLED IN CONCRETE PRIOR TO THE CONCRETE SETTING, UNLESS OTHERWISE INDICATED, AND AT A TIME AND MANNER TO ASSURE THAT THERE IS NO VOIDS AROUND THE BOLTS. EPOXIED ANCHORS SHALL NOT BE INSTALLED PRIOR TO CONCRETE REACHING 30% OF ITS DESIGNATED COMPRESSIVE STRENGTH. ANCHOR BOLTS AND PLATES MUST BE SET LEVEL AND PLUMB, AND WITHIN A TOLERANCE NECESSARY FOR THEIR PROPER ALIGNMENT AND TO THE PLUMB, AND WITHIN A TOLERANCE NECESSARY FOR THEIR PROPER ALIGNMENT AND TO THE FRANGIBLE STRUCTURE THEY SUPPORT. ALL BOLTS AND OTHER HARDWARE SHALL BE HOT-DIPPED GALVANIZED OR STAINLESS STEEL (AS INDICATED) AND SHALL BE CONTRACTOR FURNISHED (UNLESS OTHERWISE INDICATED TO BE GOVERNMENT FURNISHED).
- 1.3.9. EMBEDDED COUPLINGS-COUPPLINGS EMBEDDED IN CONCRETE SHALL BE INSTALLED SO THAT THE TOP OF THE COUPLING SET 1/8" ABOVE THE TOP OF CONCRETE AND CONDUITS TO BE EXTENDED FROM THE COUPLING ARE LEVEL AND PLUMB.

F. LIGHTNING PROTECTION, GROUNDING & BONDING

1. PRODUCTS

- 1.1. GENERAL-ALL LIGHTNING PROTECTION COMPONENTS AND CONDUCTOR MATERIAL MUST BE COPPER CLASS II. COPPER MATERIALS MUST NOT BE USED ON ALUMINUM SURFACES. ALL MATERIALS MUST BE NEW, THE STANDARD PRODUCTS OF MANUFACTURER'S REGULARLY ENGAGED IN THE PRODUCTION OF SUCH MATERIALS, AND OF THE MANUFACTURER'S LATEST DESIGNS THAT COMPLY WITH THOSE SHOWN ON THE DRAWINGS AND AS SPECIFIED HEREIN. ALL LIGHTNING PROTECTION CONDUCTORS AND HARDWARE MUST CARRY THE UNDERWRITERS' LABORATORIES, INC. LABEL OR HAVE FACTORY CERTIFICATES THAT THE MATERIAL COMPLIES WITH THE UNDERWRITERS' LABORATORIES, INC. NO ALUMINUM OR OTHER DISSIMILAR MATERIALS MUST BE USED. ALL MATERIALS USED IN THIS INSTALLATION MUST BE IN STRICT ACCORDANCE WITH NFPA 780 AND FAA-STD-19F.
- 1.2. GROUNDING BUS BARS-SOLID COPPER BUS BARS FOR USE IN HANDHOLES, MANHOLES, OR VAULTS MUST BE 4 INCHES BY 18 INCHES AND ¼ INCH THICK WITH INSULATOR STAND OFFS.
- 1.3. AIR TERMINALS- AIR TERMINALS MUST BE SOLID COPPER. COPPER AIR TERMINALS MAY BE NICKEL PLATED. AIR TERMINALS MUST BE A MINIMUM OF 24 INCHES (305 MM) IN HEIGHT, AT LEAST 5/8 INCHES (12.7 MM) IN DIAMETER, AND MUST HAVE A "BULLET" OR TIP POINT. ALSO SEE FAA-STD-19F (SECTION 4.3.6).
- 1.4. CONDUCTORS-ALL CONDUCTORS USED IN A LIGHTNING PROTECTION SYSTEM (MAIN, ROOF, HALO LOOP, DOWN CONDUCTORS) MUST BE CLASS 2 MAIN SIZED CONDUCTORS AS DEFINED BY NFPA 780 OR LARGER. SEE FAA-STD-19F (SECTION 4.3.3). UNLESS OTHERWISE INDICATED DOWN CONDUCTORS MUST BE THOMPSON 28R OR APPROVED EQUAL.
- 1.5. FASTENERS-FASTENERS USED AS A COMPONENT OF THE LIGHTNING PROTECTION SYSTEM MUST BE COPPER OR BRONZE. GALVANIZED OR PLATED MATERIALS MUST NOT BE USED.
- 1.6. FITTINGS-BONDING DEVICES, CABLE SPLICERS, AND MISCELLANEOUS CONNECTORS MUST BE SUITABLE FOR USE WITH THE INSTALLED CONDUCTOR AND MUST BE COPPER OR BRONZE WITH BOLT PRESSURE CONNECTIONS TO THE CABLE. CAST OR STAMPED CRIMP TYPE FITTINGS MUST NOT BE USED. COMPRESSION FITTINGS MAY ONLY BE USED ABOVEGROUND AND IN VAULTS. ANY GROUNDING CONNECTIONS WHICH WILL BE BURIED MUST BE EXOTHERMICALLY WELDED.
- 1.7. GROUND RODS-GROUND RODS MUST BE COPPER OR COPPER CLAD STEEL, 3/4" DIAMETER AND A MINIMUM LENGTH OF 10 FEET. COPPER CLADDING MUST BE 1/64 INCH MINIMUM THICK. ALSO SEE FAA-STD-19F (SECTION 4.4.4.1).
- 1.8. FACILITY COUNTERPOISE (EARTH ELECTRODE SYSTEM)-A NO. 4/0 AWG BARE COPPER GROUND CONSISTING OF 28 STRANDS AND WITH A CROSS SECTIONAL AREA OF 211,500 CM CONNECTED TO GROUND RODS MUST FORM THE EES.
- 1.9. JORDAN DISSIPATION PLATES-AT LEAST 24"x24"x1/4 INCHES THICK COPPER PLATES AND COMPLY WITH THE CUT OUT REQUIREMENTS OF FAA-STD-19.
- 1.10. GROUNDING CONDUCTORS-THE GROUNDING ELECTRODE CONDUCTOR MUST HAVE GREEN COLORED INSULATION AND SIZED AS SHOWN ON THE CONTRACT DRAWINGS. WHERE NOT SHOWN, THE CONDUCTOR MUST BE SIZED IN ACCORDANCE WITH TABLE 250-95 OF THE NATIONAL ELECTRICAL CODE EXCEPT THAT IT MUST NOT BE SIZED SMALLER THAN NO. 6 AWG. THE GROUNDING CONDUCTOR FOR THE BULKHEAD PLATES MUST BE A NO. 4/0 AWG BARE COPPER CABLE.
- 1.11. BONDING JUMPERS-BONDING JUMPERS USED IN INTERIOR LOCATIONS TO BOND SECTIONS OF METAL OBJECTS MUST BE INSULATED COPPER AND SIZED IN ACCORDANCE WITH TABLE 250-95 OF THE NEC.

- 1.12. ADHESIVE-MASTIC MUST BE OF THE TYPE SUITABLE FOR BONDING TO FIBERGLASS OR STEEL SURFACE OF SHELTERS.

- 1.13. OTHER HARDWARE-FASTENERS MUST BE OF THE SAME MATERIALS AS THE CONDUCTOR BASE MATERIAL OR COPPER IN MOST CASES. FASTENERS MUST NOT BE MADE OF ALUMINUM, GALVANIZED STEEL OR PLATED MATERIALS. BONDING DEVICES, CABLE SPLICES AND CONNECTORS MUST BE SUITABLE FOR USE WITH THE INSTALLED CONDUCTOR AND BE COPPER OR BRONZE WITH BOLT PRESSURE CONNECTIONS.

2. EXECUTION

- 2.1. GENERAL -THE GROUNDING SYSTEM FOR THE FACILITY MUST BE AS INDICATED ON THE CONTRACT DRAWINGS, AS SPECIFIED IN FAA STD 19F, AS REQUIRED BY THE APPLICABLE DOCUMENTS AND AS SPECIFIED HEREIN. IN THE EVENT OF CONFLICTING REQUIREMENTS, THE MOST STRINGENT SHALL APPLY.
- 2.2. AIR TERMINAL ASSEMBLY-INSTALL ASSEMBLY AND AIR TERMINAL AS SHOWN ON THE DRAWINGS. TOP OF AIR TERMINAL MUST BE AS SHOWN ON THE DRAWINGS AND IN NO CASE LESS THAN 10-INCHES ABOVE ANY ANTENNAS, OBSTRUCTION LIGHTS, ETC. ANCHOR ANTENNA DOWN CONDUCTOR TO MOST EVERY 3 FEET WITH U-BOLT PIPE CLAMPS, THOMPSON NO. 803, OR EQUAL. THE TIP OF VERTICAL AIR TERMINALS MUST NOT BE LESS THAN 5 FEET ABOVE ADJACENT WALKING OR WORKING SURFACES TO AVOID THE RISK OF PERSONNEL INJURY.
- 2.3. DOWN CONDUCTORS- DOWN CONDUCTORS MUST BE ROUTED DOWN THE OUTSIDE LEGS OF THE TOWER WHEREVER PRACTICAL UNLESS SHOWN OTHERWISE ON THE PROJECT DRAWINGS. INSTALL DOWN CONDUCTOR IN A NEAT MANNER, PARALLEL OR PERPENDICULAR OR PLUMB TO TOWER/BUILDING SURFACES, WITHOUT KINKS OR EXCESSIVE SAG OR BUCKLING BETWEEN FASTENING POINTS. INSTALL DOWN CONDUCTORS AWAY FROM POWER AND SIGNAL CABLES. DOWN CONDUCTORS MUST MAINTAIN A HORIZONTAL OR DOWNWARD COURSE AND BE SUPPORTED WITH FASTENERS EVERY 3 FEET. BEND RADIUS MUST NOT BE LESS THAN 8 INCHES. BENDS LESS THAN 90 DEGREES ARE NOT ALLOWED. DOWN CONDUCTORS MUST BE EXOTHERMICALLY WELDED TO A 4/0 AWG COPPER CONDUCTOR PRIOR TO ENTERING THE GROUND AT NOT LESS THAN 18 INCHES ABOVE GROUND LEVEL. THE 4/0 AWG COPPER CONDUCTOR MUST ENTER THE GROUND AND BE WELDED TO GROUND ROD THAT IS EXOTHERMICALLY WELDED TO THE EES. SEE FAA-STD-19F (SECTION 4.3.5.1).
- 2.4. STRUCTURAL STEEL-GROUND STRUCTURAL STEEL TO THE EARTH ELECTRODE SYSTEM WITH A #4/0 BARE COPPER CABLE. CONNECT #4/0 CABLE WITH A CLAMP AT THE BASE OF MEMBER AND WITH AN EXOTHERMIC WELD AT THE COUNTERPOISE.
- 2.5. GROUND RODS-GROUND RODS MUST BE DRIVEN FULL LENGTH INTO THE EARTH SO THAT THE TOP IS A MINIMUM OF 12 INCHES BELOW FINISHED GRADE. GROUND RODS MUST BE LOCATED 2 TO 6 FEET OUTSIDE THE FOUNDATION OR EXTERIOR FOOTING OF THE STRUCTURE. WHERE GROUND RODS CANNOT BE DRIVEN BECAUSE OF SOIL CONDITIONS, A GROUND PLATE MUST BE INSTALLED, AND WILL BE SUBSTITUTED AT THE RATE OF ONE GROUND PLATE PER GROUND ROD.
- 2.6. METAL CONDUITS-CONDUITS MUST BE TERMINATED WITH AN INSULATED, GROUNDING BUSHING AT ALL JUNCTION BOXES, HANDHOLES AND BUILDING ENTRIES. CONDUITS IN ENCLOSURES MUST BE INTERCONNECTED WITH A SINGLE, GROUNDING CONDUCTOR. AT JUNCTION BOXES, CONDUITS MUST BE GROUND TO THE ENCLOSURE. AT HANDHOLES, THE CONDUITS MUST BE GROUND TO THE GROUND PLATE. AT BUILDING ENTRIES, METAL CONDUITS MUST BE GROUND TO THE MULTI-POINT GROUND PLATE.
- 2.7. METAL BODIES-METAL BODIES (DOWNSPOUTS, GUTTERS, VENTS, LADDERS, ETC.) WITHIN 6 FEET OF AN EXPOSED LIGHTNING PROTECTION SYSTEM MUST BE BONDED TO THE LIGHTNING PROTECTION SYSTEM WITH CLASS II SECONDARY CONDUCTORS AND APPROVED UL FITTINGS AND SPLICES. ALL OTHER METAL BODIES SHALL BE CONNECTED TO THE EES WITH #2 OR LARGER GROUNDING CONDUCTORS.
- 2.8. DUCT BANKS-THE CONTRACTOR MUST INSTALL A #1/0 AWG BARE COPPER CONDUCTOR A MINIMUM OF 10 INCHES ABOVE THE CABLES AND EXOTHERMICALLY WELD IT TO THE EARTH ELECTRODE SYSTEM OR A GROUND ROD AT EACH END. WHEN THE WIDTH OF THE CABLE RUN OR DUCT DOES NOT EXCEED 3 FT (90 CM), ONE GUARD WIRE, CENTERED OVER THE CABLE RUN OR DUCT, SHALL BE INSTALLED. WHEN THE CABLE RUN OR DUCT IS MORE THAN 3 FEET (90 CM) IN WIDTH, TWO GUARD WIRES MUST BE INSTALLED. THE GUARD WIRES MUST BE SPACED AT LEAST 12 INCHES (30 CM) APART AND BE NOT LESS THAN 12 INCHES (30 CM) NOR MORE THAN 18 INCHES (45 CM) INSIDE THE OUTERMOST WIRES OR THE EDGES OF THE DUCT. THE GUARD WIRE MUST BE BONDED TO THE EES AT EACH END AND TO GROUND RODS AT APPROXIMATELY 99-FOOT INTERVALS USING EXOTHERMIC WELDS. THE SPACING BETWEEN GROUND RODS MUST VARY BY 10% TO 20% TO PREVENT RESONANCE. INSTALL THE GROUND RODS AT APPROXIMATELY 6 FEET (2 M) ON EITHER SIDE OF THE TRENCH.
- 2.9. BULKHEAD PLATES-THE BULKHEAD PLATE IN THE JUNCTION BOX MUST BE BONDED TO THE EARTH ELECTRODE SYSTEM WITH A NO. 4/0 AWG BARE COPPER CABLE. CONNECT TO EARTH ELECTRODE SYSTEM USING EXOTHERMIC WELDS.
- 2.10. MAIN GROUND PLATE- INSTALL MAIN GROUND PLATE AS SHOWN ON THE DRAWINGS AND AS SPECIFIED IN FAA-STD-19F (SECTION 4.7.2).
- 2.10.1. THE MAIN GROUND PLATE MUST BE CONNECT TO THE EES WITH TWO 4/0 AWG STRANDED COPPER CONDUCTORS. ONE OF THE CONDUCTORS MUST BE 30% LONGER THAN THE OTHER. ALL SIGNAL GROUNDING MUST TERMINATE ON THIS PLATE.
- 2.11. GROUNDING CONNECTIONS-ALL EQUIPMENT, ARMORED CABLE, GRS CONDUIT AND ALL OTHER EXPOSED, NON-CURRENT CARRYING METAL PARTS OF ELECTRICAL EQUIPMENT MUST BE GROUND BY AN EQUIPMENT GROUNDING CONDUCTOR SIZED AS DESIGNATED IN THE DRAWINGS AND SPECIFICATIONS, BUT IN NO CASE SMALLER THAN THAT REQUIRED BY TABLE 250-95 OF THE NEC. BARE CONDUCTORS MUST NOT BE PERMITTED EXCEPT FOR WHERE SHOWN ON THE DRAWINGS. ALL CONNECTIONS TO THE EQUIPMENT TO BE GROUNDED MUST BE MADE WITH A GROUND CONNECTOR SPECIFICALLY INTENDED FOR THAT PURPOSE. CONNECTING SCREWS OR MOUNTING BOLTS ARE NOT SUITABLE FOR USE AS GROUNDING CONNECTIONS. CONNECTIONS TO GROUND ELECTRODES AND ALL OTHER UNDERGROUND CONNECTIONS MUST BE EXOTHERMIC WELDED EXCEPT AT ACCESS WELLS. CONNECTIONS AT ACCESS WELLS MUST BE MADE USING PRESSURE CONNECTORS OR CLAMPS. SOFT SOLDERED OR BRAZED CONNECTIONS MUST NOT BE USED FOR ANY PART OF THE POWER GROUNDING SYSTEM, EES OR THE LIGHTNING PROTECTION SYSTEM (AIR TERMINALS, ROOF CONDUCTORS, DOWN CONDUCTORS, FASTENERS, AND CONDUIT). SOFT SOLDER MUST ONLY BE USED TO IMPROVE CONDUCTIVITY AT JOINTS ALREADY SECURED WITH MECHANICAL FASTENERS. SOFT SOLDER MUST NOT BE USED TO PROVIDE MECHANICAL RESTRAINT.
- 2.12. OTHER HARDWARE-INSTALL HARDWARE IN A NEAT MANNER, PARALLEL OR PERPENDICULAR OR PLUMB WHERE FASTENED TO SURFACES. PRIOR TO BONDING TO SURFACES, ALL CONNECTION POINTS MUST BE CLEANED OF PAINT, INSULATION AND OTHER NON-CONDUCTING MATERIALS OVER AN AREA THAT EXTENDS AT LEAST ¼ INCH BEYOND THE BONDING SURFACE OF THE LARGER MEMBER.
- 2.13. UNDERGROUND CONNECTIONS-NO PART OF THE UNDERGROUND CABLE OR CONNECTIONS MUST BE CONCEALED UNTIL THE RESIDENT ENGINEER HAS INSPECTED, TESTED AND APPROVED THE GROUND RODS OR PLATES, CONDUCTORS AND CONNECTIONS IN THAT PART OF THE SYSTEM. ANY FAULTY CONNECTIONS OR ITEMS MUST BE CORRECTED OR REPLACED AS DIRECTED BY THE RESIDENT ENGINEER
- 2.14. HANDHOLES
- 2.14.1. HANDHOLE BUS BARS-BUS BARS MUST BE INSTALLED APPROXIMATELY 12 INCHES OFF THE VAULT FLOOR SO AS TO NOT INTERFERE WITH CONDUIT. ALL GROUNDING CONNECTIONS IN THE VAULT MUST CONNECT TO THE BAR WITH MECHANICAL TWO HOLE LONG BARREL LUGS HYDRAULICALLY CONCENTRICALLY CRIMPED WITH A MINIMUM 12-TONS OF FORCE. APPROPRIATE DIES MUST BE USED FOR EACH CABLE SIZE. CONNECT A BARE COPPER 4/0 AWG FROM THE BUS BAR TO THE NEAREST GROUND ROD. THE 4/0 MUST BE EXOTHERMICALLY WELDED TO THE GROUND ROD.
- 2.14.2. GALVANIZED RIGID METAL CONDUIT (GRMC)-GALVANIZED RIGID METAL CONDUIT ENTERING A HANDHOLE MUST BE EQUIPPED WITH AN INSULATED GROUNDING BUSHING. INSTALL A GREEN NUMBER 6 AWG FROM THE BUSHING TO THE BUS BAR IN THE VAULT. IN ALL OTHER LOCATIONS GRMC MUST TERMINATE WITH AN INSULATED GROUNDING BUSHING AND A NUMBER 6 AWG GROUND, IN LOCATIONS WHERE AN INSULATED GROUNDING BUSHING CANNOT BE USED, SUCH AS UNDERGROUND GRMC TO PVC TRANSITIONS, A BARE COPPER NUMBER 6 AWG MUST BE EXOTHERMICALLY WELDED TO THE GRMC WITH THE OTHER END OF THE CONDUCTOR CONNECTED TO THE EES.
- 2.15. JORDAN DISSIPATION PLATES-THESE PLATES SHOULD BE INSTALLED IN A VERTICAL PLANE TO TAKE ADVANTAGE OF SEASONAL MOISTURE AND TEMPERATURE CHANGES IN THE SOIL. INSTALL THE PLATES AT THE SAME DEPTH OR DEEPER THAN THE INTERCONNECTING CONDUCTOR, BUT MAINTAIN A MINIMUM OF ONE-FOOT OF NATIVE SOIL ABOVE THE UPPER EDGE OF THE PLATE. ATTACHMENT TO THE EES MUST BE WITH A 4/0 AWG BARE STRANDED COPPER CONDUCTOR, EXOTHERMICALLY WELDED TO THE EES AND THE PLATE. FOR MAXIMUM PERFORMANCE, THE ATTACHMENT POINT AT THE PLATE MUST BE AT THE CENTER OF THE PLATE, NOT NEAR THE EDGE OR THE CORNERS.

3. TESTING

- 3.1. EARTH RESISTANCE TEST- THE CONTRACTOR MUST MEASURE THE EARTH ELECTRODE GROUNDING RESISTANCE OF THE INSTALLED COUNTERPOISE. TEST MUST BE A 3-POINT EARTH RESISTANCE TEST. THE MAXIMUM RESISTANCE ACCEPTABLE MUST BE 10 OHMS. IF THE MEASURED RESISTANCE TO GROUND IS NOT TEN OHMS OR LESS, ADDITIONAL GROUNDING ELECTRODES MUST BE INSTALLED. THE CONTRACTOR MUST PROVIDE TWO SETS OF THE GROUNDING ELECTRODE TEST TO THE FAA.

G. ELECTRICAL MATERIALS AND METHODS

1. PRODUCTS

- 1.1. GENERAL-THE CONTRACTOR-MUST FURNISH ALL MATERIALS NOT SPECIFICALLY SHOWN AS GFM OR GFE TO COMPLETE THE WORK. MATERIALS REQUIRED FOR INSTALLING THE GFE, INCLUDING LUGS, TERMINATIONS, MOUNTING HARDWARE, ANCHORING, ETC. MUST BE PROVIDED BY THE CONTRACTOR AT NO ADDITIONAL COST. MATERIALS AND EQUIPMENT MUST COMPLY WITH ALL CONTRACT REQUIREMENTS. MATERIALS FURNISHED BY THE CONTRACTOR MUST BE NEW, THE STANDARD PRODUCTS OF MANUFACTURERS REGULARLY ENGAGED IN THE PRODUCTION OF SUCH MATERIALS, AND OF THE MANUFACTURER'S LATEST DESIGNS THAT COMPLY WITH THE SPECIFICATION REQUIREMENTS. ALL MATERIALS FOR INSTALLATION IN WET LOCATIONS MUST BE LISTED AND LABELED BY UNDERWRITERS LABORATORY (UL) AS SUITABLE FOR WET LOCATIONS. ALL OTHER MATERIALS PROVIDED BY THE CONTRACTOR MUST BEAR THE LABEL OF UL IF THE MATERIALS ARE NORMALLY EVALUATED AND LABELED BY UL. ALL MATERIALS AND PRACTICES MUST BE IN STRICT COMPLIANCE WITH FAA-C-1217, AND FAA-STD-19.
- 1.2. MATERIAL SUBSTITUTIONS-THE SPECIFIC PRODUCTS OF MANUFACTURERS ARE SPELLED OUT IN SEVERAL INSTANCES IN THIS CONTRACT. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO DEMONSTRATE THAT ANY PRODUCT SUBSTITUTIONS THAT ARE MADE DO NOT AFFECT THE CONSTRUCTABILITY OR QUALITY OF THE WORK.
- 1.2.1. ALL FUSES AND CIRCUIT BREAKERS INCLUDED WITHIN THIS ELECTRICAL POWER DISTRIBUTION SYSTEM HAVE BEEN ANALYZED WITH DESIGN SHORT CIRCUIT AND PROTECTIVE DEVICE COORDINATION STUDIES. ANY CHANGES OR OTHER MANUFACTURER COMPONENTS THAT ARE DIFFERENT THAN THOSE SPECIFIED IN THESE SPECIFICATIONS COULD COMPROMISE THE DESIGN ANALYSIS FOR THIS MODIFICATION. ALL PROTECTIVE DEVICES OBTAINED BY THE CONTRACTOR FOR INSTALLATION AS PER THIS SPECIFICATION MUST BE AS SPECIFIED, OR A COORDINATION STUDY MUST BE PERFORMED BY A PROFESSIONAL ENGINEER AT THE CONTRACTOR'S EXPENSE, AND IS SUBJECT TO SUBMITTAL AND APPROVAL BY THE SITE REPRESENTATIVE. SUBMIT TIME VS. CURRENT CURVES AND ALL MANUFACTURERS' SPECIFICATIONS FOR THESE DEVICES FOR APPROVAL.
- 1.3. CONDUIT-MINIMUM CONDUIT SIZE SHALL BE 3/4 INCH UNLESS OTHERWISE SPECIFIED.
- 1.3.1. ELECTRIC METALLIC TUBING (EMT)-EMT MUST CONFORM TO UL 797. EMT MAY BE USED ONLY IN DRY INTERIOR LOCATIONS, AND WHERE NOT SUBJECT TO PHYSICAL DAMAGE OR WHERE SPECIFICALLY SHOWN. FITTINGS USED WITH EMT MUST BE STANDARD COMPRESSION-TYPE. WHERE EMT ENTERS ENCLOSURES A THREADED CONNECTOR MUST BE USED TO BOND THE CONDUIT TO THE ENCLOSURE. INDENTOR TYPE, SET-SCREW TYPE FITTINGS ARE NOT ACCEPTED. EMT CONNECTIONS MUST INCLUDE INSULATED GROUNDING BUSHINGS. EMT MUST NOT BE USED ON CIRCUITS ABOVE 600 VOLTS, NOR IN SIZES GREATER THAN 3 INCHES IN DIAMETER.
- 1.3.2. ZINC COATED RIGID STEEL CONDUIT (GRMC/GRS/GRC) -RSC MUST CONFORM TO UL 6. RSC MAY BE USED IN ALL LOCATIONS AND MUST BE USED FOR ALL UNDERGROUND SERVICE CONDUCTORS. ALL GALVANIZED RIGID METAL CONDUIT (GRMC) INSTALLED MUST BE PVC COATED EXTERIOR POLYURETHANE COATED INTERIOR. GRMC MUST CONFORM TO STEEL STRUCTURES PAINTING COUNCIL STANDARD, SSPC-PS 10.01. ALL FITTINGS MUST BE PVC COATED EXTERIOR POLYURETHANE COATED INTERIOR AND CONFORM TO STEEL STRUCTURES PAINTING COUNCIL STANDARD, SSPC-PS 10.01. REPAIRS TO DAMAGED COATING MAY BE MADE BY FIELD WRAPPING WITH 0.01 INCH THICK PIPE WRAPPING PLASTIC TAPE APPLIED WITH A 50 PERCENT OVERLAP. ALL FITTINGS USED WITH RIGID STEEL CONDUIT MUST BE THE THREADED TYPE, THE SAME MATERIAL AS THE CONDUIT. UNLESS OTHERWISE INDICATED CONDUIT STRAPS AND UNISTRUT USED TO MOUNT GRS CONDUIT MUST BE TYPE 316 SS. WHERE CONDUITS ENTER ENCLOSURES WITHOUT THREADED HUBS, MYERS HUB TYPE CONNECTORS MUST BE USED TO SECURELY BOND THE CONDUIT TO THE ENCLOSURE. IN ADDITION, AN INSULATED GROUNDING BUSHING MUST BE INSTALLED ON THE INTERIOR THREAD END OF THE CONDUIT TO PROTECT CONDUCTOR INSULATION.
- 1.3.3. PVC CONDUIT -POLYVINYL CHLORIDE (PVC) CONDUIT SHALL BE SCHEDULE 80, HEAVY WALL RIGID PLASTIC WITH FITTINGS AND ACCESSORIES DESIGNED FOR DIRECT EARTH BURIAL. MANUFACTURED TO NEMA TC-2 AND FEDERAL SPECIFICATION WW-C-1094; UL LISTED. EXPOSED PVC CONDUIT MUST BE SUNLIGHT RESISTANT.
- 1.3.4. LIQUIDTIGHT METALLIC CONDUIT-LIQUIDTIGHT METALLIC CONDUIT MUST BE UL LISTED FOR ITS INTENDED USE. IF THE CONDUIT CONTAINS A CIRCUIT PROTECTED BY AN OVERCURRENT DEVICE RATED FOR 30A OR MORE, LIQUIDTIGHT GROUNDING TYPE FITTINGS MUST BE USED AT EACH END OF THE CONDUIT WITH AN EXTERIOR GREEN NUMBER 6 AWG CONDUCTOR ROUTED ALONG THE OUTSIDE OF THE CONDUIT AND CONNECTED AT EACH END.
- 1.4. CONDUCTORS
- 1.4.1. UN-INSULATED CONDUCTORS -ALL UN-INSULATED CONDUCTORS MUST BE COPPER AND MUST ONLY BE USED WHERE SPECIFICALLY IDENTIFIED WITHIN THE CONTRACT DRAWINGS. UNINSULATED CONDUCTORS MUST COMPLY WITH FEDERAL SPECIFICATIONS A-A-59551.
- 1.4.2. INSULATED CONDUCTORS-ALL POWER CABLE FURNISHED FOR INSTALLATION MUST BE SOFT DRAWN OR ANNEALED COPPER CONDUCTOR AND MUST COMPLY WITH FEDERAL SPECIFICATIONS A-A-59551. UNLESS SPECIFICALLY INDICATED ON THE CONSTRUCTION DRAWINGS INSULATION MUST BE THERMOPLASTIC OR THERMOSETTING INSULATION, TYPE XHHW-2 FOR GENERAL USE AND TYPE THHN FOR USE IN DRY AREAS ONLY. CONDUCTORS NO. 10 AND SMALLER MUST BE SOLID AND CONDUCTORS NO. 8 AND LARGER MUST BE STRANDED UNLESS OTHERWISE INDICATED. MINIMUM BRANCH CIRCUIT CONDUCTOR SIZE SHALL BE NO. 12 AWG.
- 1.4.3. MULTI-PAIR COMMUNICATION/SIGNAL CABLE-CABLE SHALL BE 6, 12 OR 25 PR #19 GAUGE COPPER SHIELD IN ACCORDANCE WITH RURAL ELECTRIC ASSOCIATION PE-39. THE NUMBER OF PAIRS FOR EACH APPLICATION IS SHOWN ON THE DRAWINGS. MULTI-PAIR CABLE MUST HAVE BOTH INDIVIDUAL SHIELDING FOR EACH PAIR AND AN OVERALL CABLE SHIELD.
- 1.4.4. FIBER OPTIC CABLE-CABLE SHALL BE 24 FIBER SINGLE MODE (OS2) WITH A DOUBLE JACKET. IT MUST BE RATED FOR INSTALLATION IN DUCT AND BE FREE OF HAZARDOUS SUBSTANCES ACCORDING TO ROHS 2011/65/EU. IT MUST FULLY MEET THE REQUIREMENTS OF FAA-E-2761C.

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SPECIFICATIONS & REQUIREMENTS					
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G. ELECTRICAL MATERIALS AND METHODS (CONT.)

- 14.4. WIRE DELIVERY-WIRE AND CABLE MUST BE DELIVERED TO THE PROJECT SITE IN ORIGINAL BOXES AND FACTORY REELS. INSULATION MUST HAVE REPETITIVE MARKINGS STATING THE MANUFACTURER, SIZE, TYPE OF INSULATION, ETC.
15. TAPE -ELECTRICAL TAPE MUST BE 3M OR APPROVED EQUAL AND BE SUITABLE FOR THE APPLICATION. PLASTIC TAPE MUST CONFORM TO FEDERAL SPECIFICATION HH-I-595 AND RUBBER TAPE MUST CONFORM TO SPECIFICATION HH-I-553.
16. OUTLET BOXES - SHEET STEEL-UNLESS OTHERWISE INDICATED BOXES MUST BE EITHER THE CAST METAL HUB TYPE (FOR RECEPTACLES) CONFORMING TO FEDERAL SPECIFICATION W-C-596 OR MUST BE ONE PIECE GALVANIZED STEEL (NEMA-1 AND 2 FOR DRY AND INTERIOR LOCATIONS AND NEMA 3 AND 4 FOR WET AND EXTERIOR LOCATIONS) TYPE CONFORMING TO FEDERAL SPECIFICATION W-J-800. WHERE NOT SIZED ON THE DRAWINGS, BOXES MUST BE SIZED IN ACCORDANCE WITH THE NEC. BOXES MUST BE PROVIDED IN THE WIRING OR RACEWAY SYSTEM FOR PULLING WIRES, MAKING CONNECTIONS, AND MOUNTING DEVICES. EACH BOX MUST HAVE THE VOLUME REQUIRED BY THE NATIONAL ELECTRICAL CODE FOR THE NUMBER OF CONDUCTORS IN THE BOX. EACH OUTLET AND SWITCH BOX MUST INCLUDE A GROUNDING PIGTAIL. BOXES INSTALLED FOR CONCEALED WIRING MUST BE PROVIDED WITH EXTENSION RINGS OR PLASTER COVERS. BOXES MUST NOT BE SUPPORTED FROM SHEET METAL ROOF DECKS. BOXES AND SUPPORTS MUST BE FASTENED WITH BOLTS AND EXPANSION SHIELDS ON CONCRETE OR BRICK. WITH TOGGLE BOLTS ON HOLLOW MASONRY UNITS. IN OPEN OVERHEAD SPACES, CAST METAL BOXES THREADED TO RACEWAYS, NEED NOT BE SEPARATELY SUPPORTED. ALL EXTERIOR ABOVE GROUND RECEPTACLES AND JUNCTION BOXES MUST BE WEATHERPROOF.
17. RECEPTACLES-ALL RECEPTACLES MUST BE SPECIFICATION GRADE IN ACCORDANCE WITH NEMA STD WD-1 WITH SCREW-TYPE TERMINALS AND RATED FOR 20 AMPS AND 125 VOLTS. RECEPTACLES WITH PUSH-IN CONNECTIONS OR A COMBINATION OF SCREW-TYPE AND PUSH-IN CONNECTIONS ARE NOT ACCEPTABLE. RECEPTACLE MUST BE PROVIDED WITH SCREW TERMINAL FOR LANDING A GROUNDING CONDUCTOR. ALL RECEPTACLES LOCATED OUTSIDE OR IN DAMP LOCATIONS SHALL BE GFCI-TYPE.
18. LIGHTING AND POWER PANELBOARDS-PANELBOARDS MUST BE OF THE SIZE AND TYPE INDICATED ON THE CONSTRUCTION DRAWINGS. PANEL MUST BE DEAD FRONT TYPE, MUST CONFORM TO FEDERAL SPECIFICATION W-P-115, TYPE I, CLASS 1, AND MUST BE UL LISTED UNLESS SPECIFIED OTHERWISE. MANUFACTURES MUST BE AS INDICATED OR AN APPROVED SUBSTITUTION. BUSSES MUST BE COPPER WITH TIN COATING. FRONT COVERS MUST BE "DOOR-IN-DOOR" CONSTRUCTION ALLOWING ACCESS TO CIRCUIT BREAKER TERMINATION BY OPENING A HINGED COVER. DOORS MUST BE LOCKABLE AND BE SUPPLIED WITH LOCKS. DOORS OVER 48 INCHES HIGH MUST HAVE AUXILIARY FASTENERS ON TOP AND BOTTOM. ALL PANELBOARD DOORS, WHICH INCLUDE LOCKS, MUST HAVE FLUSH TYPE CYLINDER LOCKS AND CATCHES, KEYS ALIKE, WITH TWO KEYS FURNISHED WITH EACH LOCK. GROUND AND NEUTRAL BUSSES MUST BE PROVIDED BY THE MANUFACTURER AS PART OF THE PANEL ASSEMBLY. THE PANELBOARD MUST BE CONSTRUCTED OF CODE GAGE GALVANIZED SHEET METAL AND MUST BE FINISHED WITH A RUST INHIBITING PRIME COAT AND TWO COATS OF LIGHT GRAY ENAMEL.
- 18.1. CIRCUIT BREAKERS-ALL CIRCUIT BREAKERS MUST BE THE QUICK-MADE, QUICK-BREAK, BOLT ON, THERMAL MAGNETIC TYPE, MUST CONFORM TO FEDERAL SPECIFICATION W-C-375, AND MUST BE U.L. LISTED. CIRCUIT BREAKERS MUST BE RATED FOR THE VOLTAGE OF THE CIRCUIT ON WHICH THEY ARE USED, AND MUST HAVE A MINIMUM INTERRUPTING RATING OF 10,000 AMPERES, SYMMETRICAL FOR BRANCH BREAKERS, AND 22,000 AMPERES, SYMMETRICAL FOR MAIN BREAKERS UNLESS OTHERWISE INDICATED. ALL CIRCUIT BREAKERS MUST HAVE A TRIP INDICATING FEATURE. SINGLE POLE BREAKERS MUST BE A FULL SIZE MODULE, AND TWO AND THREE POLE BREAKERS MUST BE SIZED IN EVEN MULTIPLES OF A SINGLE POLE BREAKER. A SUBMITTAL IS REQUIRED FROM THE CONTRACTOR FOR CHARACTERISTIC CURVES FOR MAIN AND BRANCH CIRCUIT BREAKERS. BREAKERS MUST BE SIZED SO THAT TWO SINGLE POLE BREAKERS MUST NOT BE CAPABLE OF FITTING IN A SINGLE HOUSING. MULTI-POLE CIRCUIT BREAKERS MUST HAVE AN INTERNAL COMMON TRIP MECHANISM. ALL CIRCUIT BREAKERS AND THE PANELBOARDS IN WHICH THE BREAKERS ARE INSTALLED MUST BE MADE BY THE SAME MANUFACTURER AND MUST BE UL LISTED FOR THE PANELBOARD. SELF-ENCLOSED CIRCUIT BREAKERS MUST BE MOUNTED IN NEMA OS-1, TYPE 1 ENCLOSURES WITH TRIP RATING, VOLTAGE RATING, AND NUMBER OF POLES AS INDICATED ON DRAWINGS.
- 18.2. BUS BARS-ALL BUSES (PHASE, NEUTRAL, & GROUND) MUST BE COPPER. BUS CAPACITY MUST BE AS INDICATED ON THE DRAWINGS. CIRCUIT BREAKER CURRENT CARRYING CONNECTIONS TO BUS MUST BE OF THE BOLTED TYPE, AND FACTORY ASSEMBLED. STAB IN TYPES ARE NOT ACCEPTABLE. BUS BAR CONNECTIONS TO CIRCUIT BREAKERS MUST BE OF THE SEQUENCE PHASE TYPE. THE NEUTRAL BUS MUST BE INSULATED FROM PANELBOARDS. ALL PANELBOARDS MUST HAVE AN UNINSULATED GROUND BUS BOLTED TO THE CABINET, WITH PROVISION FOR INDIVIDUAL BRANCH CIRCUIT GROUND CONDUCTOR CONNECTIONS, ADEQUATE IN SIZE TO ACCOMMODATE PRESENT AND FUTURE EQUIPMENT GROUNDING CONDUCTORS. ISOLATE GROUND BUS FROM THE NEUTRAL BUS EXCEPT AT THE SDM. THE GROUND BUS BAR MUST BE STRUCTURALLY INTEGRAL TO THE PANELBOARD OR ATTACHED TO THE PANELBOARD WITH A BOLT, NUT AND LOCK WASHER. IF THE GROUND BUS BAR IS MOUNTED TO THE ENCLOSURES WITH SCREW THREADS ONLY, A SEPARATE, BOLTED GROUND LUG MUST BE INSTALLED ON THE PANELBOARD AND BONDED TO THE GROUND BUS BAR.
- 18.3. DIRECTORY-DIRECTORIES MUST BE TYPED TO INDICATE THE LOAD SERVED BY EACH CIRCUIT AND MUST BE MOUNTED IN A HOLDER WITH PROTECTIVE COVERING. THE DIRECTORY MUST BE ARRANGED SO THAT THE TYPED ENTRIES SIMULATE THE CIRCUIT BREAKER POSITIONS IN THE PANELBOARD. CIRCUITS MUST BE CONNECTED AS INDICATED ON DRAWING. ANY CHANGES MUST BE "AS-BUILT" ON THE DRAWINGS AND A NEW DIRECTORY MUST BE TYPED TO REFLECT THE CHANGE.
19. WARNING TAPES-A PLASTIC WARNING TAPE MUST BE CONTINUOUS IMPRINTED WITH THE APPROPRIATE LEGEND AND MUST BE LOCATED 10 INCHES (MAX) BELOW FINISHED GRADE. TAPE MUST BE FOIL BACKED AND A MINIMUM OF 6" WIDE.
10. EARTH ELECTRODE SYSTEM (COUNTERPOISE)/LIGHTNING PROTECTION SYSTEM
- 10.1. GROUNDING CONDUCTOR-GROUNDING CONDUCTOR MUST BE FORMED WITH #40 AWG 19 STRAND BARE COPPER CONDUCTOR.
- 10.2. GROUND RODS-GROUND RODS MUST BE 3/4 INCH BY 10 FEET COPPER OR COPPER CLAD STEEL.
- 10.3. GUARD WIRE CONDUCTOR-MUST BE #10 AWG 19 STRAND BARE COPPER.
11. FRANGIBLE COUPLINGS-FRANGIBLE COUPLINGS FOR EMT MUST BE FLIGHT LIGHT INC PART # 75-59E OR 66-961AT, OR MULTIELECTRIC PART # 961-AG OR EQUAL.
12. HEAVY DUTY DISCONNECTS-SAFETY SWITCHES MUST BE HEAVY-DUTY "HD" TYPES, UNLESS OTHERWISE INDICATED SWITCHES INSTALLED OUTDOORS, OR IN DAMP OR WET LOCATIONS, MUST BE MOUNTED IN NEMA 4X ENCLOSURES. SWITCH MUST BE OF THE VOLTAGE AND CURRENT RATINGS INDICATED ON THE DRAWINGS, AND EACH MUST BE CAPABLE OF INTERRUPTING TEN (10) TIMES THE FULL RATED LOAD CURRENT. THE SWITCHES MUST BE OF THE QUICK-MAKE, QUICK-BREAK TYPE, AND ALL PARTS MUST BE MOUNTED ON INSULATING BASES TO PERMIT REPLACEMENT OF ANY PART FROM FRONT OF THE SWITCH. ALL CURRENT CARRYING PARTS MUST BE HIGH-CONDUCTIVITY COPPER, DESIGNED TO CARRY A RATED LOAD WITHOUT EXCESSIVE HEATING. SWITCH CONTACTS MUST BE SILVER-TUNGSTEN TYPE OR PLATED TO PREVENT CORROSION, PITTING AND OXIDATION, AND TO ASSURE SUITABLE CONDUCTIVITY. SWITCHES MUST HAVE REJECTION FUSE BLOCKS TO PREVENT REPLACEMENT BY LOWER RATED FUSES AND MUST BE CAPABLE OF BEING LOCKED IN THE ON AND OFF POSITION. THE CONTRACTOR MUST INSTALL SWITCHES MEET THE APPLICABLE REQUIREMENTS OF THE NATIONAL ELECTRICAL CODE (NEC). THE SERVICE ENTRANCE DISCONNECT MUST BE UL RATED FOR SERVICE EQUIPMENT.
- 12.1. FUSES-A COMPLETE SET OF FUSES MUST BE INSTALLED AND ONE SET OF SPARES MUST BE FURNISHED FOR EACH FUSIBLE DEVICE. FUSES MUST HAVE A VOLTAGE RATING NOT LESS THAN THE CIRCUIT VOLTAGE. FUSE TYPES MUST BE AS INDICATED IN THE CONSTRUCTION DRAWINGS.
13. JUNCTION AND PULL BOXES-INDOOR JUNCTION AND PULL BOXES FOR ELECTRICAL WORK MUST BE CODE GAUGE SHEET STEEL AND PROVIDED WITH A FLAT SCREW COVER. UNLESS OTHERWISE INDICATED EXTERIOR JUNCTION BOXES MUST BE NEMA 4X TYPE. POWER AND CONTROL WIRING MUST NOT OCCUPY THE SAME JUNCTION BOX.
14. WIREWAYS-SQUARE DUCT TYPE WIREWAYS MUST CONFORM TO UL STANDARD 870. WIREWAYS MUST BE SIZED AS SHOWN ON THE CONSTRUCTION DRAWINGS AND MUST BE HINGED COVER TYPE. WIRING GUTTERS MUST BE ELECTRICALLY BONDED TOGETHER, UNLESS OTHERWISE INDICATED EXTERIOR WIREWAYS MUST BE NEMA 4X TYPE.

- 1.16. SURGE SUPPRESSION EQUIPMENT (SPD, TVSS)-SURGE ARRESTERS MUST BE INSTALLED ON THE LOAD END OF THE SERVICE DISCONNECT AS CLOSE AS POSSIBLE TO THE SERVICE TERMINALS. SEPARATE TERMINATING LUGS MUST BE PROVIDED WITHIN THE SERVICE DISCONNECT FOR THE SURGE ARRESTER. THE ARRESTER INPUT MUST BE INTERNALLY FUSED FOR SHORT CIRCUIT PROTECTION AND MUST INCLUDE DISCONNECT CAPABILITY. THE ENCLOSURE DOOR MUST INCLUDE INDICATING LIGHTS TO DEMONSTRATE THAT EACH SUPPRESSION DEVICE IS FUNCTIONAL. EACH SUPPRESSION DEVICE WITHIN THE ARRESTER MUST BE REPLACEABLE AS A UNIT. OUTDOOR ARRESTERS MUST COME WITH A NEMA 4 ENCLOSURE AND ENCLOSURE PENETRATIONS MUST BE WATERTIGHT. INDOOR ARRESTERS MUST COME WITH A NEMA 12 ENCLOSURE. IF CONNECTED TO A PANEL, THE SPD MUST BE INSTALLED ON A DEDICATED CIRCUIT. THE SPD MUST BE LOCATED AS CLOSE AS POSSIBLE TO THE PANEL BOARD WITH THE WIRES BEING AS SHORT AND STRAIGHT AS POSSIBLE. KINKS AND SHARP BENDS MUST BE AVOIDED. ARRESTERS MUST BE TESTED IN ACCORDANCE WITH ANSI/IEEE C62.11. IN ADDITION THE ARRESTER MUST MEET ALL REQUIREMENTS OF FAA-STD-019.
- 1.17. MANHOLES AND HANDHOLES-HANDHOLES AND MANHOLES MUST COMPLY WITH FAA-C-1391. MANHOLES/HAND HOLES, FRAMES, AND LIDS LOCATED WITHIN THE AIRPORT RUNWAY/TAXIWAY SAFETY AREAS (RSA/STA) MUST BE OF THE AIRCRAFT-RATED TYPE, DESIGNED AND CERTIFIED FOR 100,000 LB (45,000 KG) WHEEL LOADS WITH 250 PSI (1.72 MPA) TIRE PRESSURE. (REFER TO FAA ADVISORY CIRCULAR 150/5220-6, APPENDIX 9, DESIGN OF STRUCTURES FOR USE OF AIRPLANES). OUTSIDE THE RSA/STA, H-20 HIGHWAY-RATED MANHOLE AND HAND HOLE COMPONENTS ARE PERMITTED. LOADING MUST MEET BASIC H-20 LOADING REQUIREMENTS PER AASHTO H-20. HB-17, STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGE THE LIVE LOAD MUST BE THAT LOADING WHICH PRODUCES THE MAXIMUM BENDING AND SHEAR MOMENTS IN THE STRUCTURE. H-20 DESIGN WHEEL LOAD IS A MINIMUM OF 16,000 POUNDS, OR 80 PSI. FOR THE SAFETY MARGIN, THE CASTING MUST MEET AASHTO M306, WHICH REQUIRES THAT IT PASS A PROOF LOAD TEST OF 40,000 LB APPLIED ON A 9X9-IN. PAD IN THE CENTER OF THE CASTING.
- 1.18. ANTI-SEIZE LUBRICANT-LUBRICANT MUST BE ALUMINUM OR COPPER BASED AND MUST BE RATED FOR A TEMPERATURE RANGE OF -30°F TO 1600°F. ANTI-SEIZE MUST BE APPLIED ON ALL THREADS LOCATED OUTDOORS AND ON ALL SS THREADS REGARDLESS OF LOCATION.
2. EXECUTION
- 2.1. GENERAL--THE RULES, REGULATIONS AND REFERENCE SPECIFICATIONS ENUMERATED IN SECTION MUST BE CONSIDERED AS MINIMUM REQUIREMENTS. FAA REQUIREMENTS OFTEN EXCEED THOSE OF OTHER STANDARD ORGANIZATIONS SUCH AS NEC. ADHERENCE TO OTHER STANDARDS SHALL NOT RELIEVE THE CONTRACTOR FROM FURNISHING AND INSTALLING HIGHER GRADES OF MATERIALS AND WORKMANSHIP WHEN SO REQUIRED BY THIS SPECIFICATION OR ON THE DRAWINGS. ALL MATERIALS AND EQUIPMENT MUST BE INSTALLED IN ACCORDANCE WITH THE CONTRACT DRAWINGS AND THE RECOMMENDATIONS OF THE MANUFACTURERS, APPROVED BY THE RESIDENT ENGINEER. THE INSTALLATION MUST BE ACCOMPLISHED BY SKILLED WORKMEN REGULARLY ENGAGED IN THIS TYPE OF WORK. ELECTRICIANS MUST BE PROPERLY LICENSED FOR THE TYPE OF WORK BEING PERFORMED. ALL INSTALLATION PRACTICES AND MATERIALS MUST CONFORM TO NFPA 70, FAA-C-1217, FAA-STD-19, AND FAA-C-1391.
- 2.2. WORKING CLEARANCES-ALL ELECTRICAL EQUIPMENT INSTALLED UNDER THIS PROJECT MUST BE IN COMPLIANCE WITH NEC ARTICLE 110-26. IN NO CASE MUST THE WORKING CLEARANCES OF EXISTING EQUIPMENT BE INFRINGED UPON BY NEW EQUIPMENT INSTALLED UNDER THIS CONTRACT. IF IT APPEARS THAT WORKING CLEARANCES WILL BE VIOLATED THE CONTRACTOR MUST IMMEDIATELY INFORM THE RESIDENT ENGINEER OF THE CONFLICT.
- 2.3. CONTRACT DRAWINGS-WHERE THE ELECTRICAL DRAWINGS INDICATE, (DIAGRAMMATICALLY OR OTHERWISE) THE WORK TO BE COMPLETED AND INTENDED FUNCTION, THE CONTRACTOR MUST FURNISH ALL EQUIPMENT, MATERIAL, AND LABOR TO COMPLETE THESE INSTALLATIONS, AND ACCOMPLISH THESE INDICATED FUNCTIONS. FURTHER, THE CONTRACTOR MUST BE RESPONSIBLE FOR TAKING THE NECESSARY ACTIONS TO ENSURE THAT ALL ELECTRICAL WORK IS COORDINATED AND COMPATIBLE WITH ALL OTHER PROJECT WORK. MINOR DEPARTURES FROM EXACT DIMENSIONS SHOWN IN ELECTRICAL PLANS MAY BE PERMITTED WHERE REQUIRED TO AVOID CONFLICT OR UNNECESSARY DIFFICULTY IN PLACEMENT OF A DIMENSIONED ITEM, PROVIDED ALL CONTRACT REQUIREMENTS ARE MET. THE CONTRACTOR MUST PROMPTLY OBTAIN APPROVAL FROM THE RESIDENT ENGINEER PRIOR TO UNDERTAKING ANY SUCH PROPOSED DEPARTURE.
- 2.4. WORKMANSHIP-ALL MATERIALS AND EQUIPMENT MUST BE INSTALLED IN ACCORDANCE WITH THE CONTRACT DRAWINGS AND MANUFACTURER'S INSTALLATION INSTRUCTIONS. THE INSTALLATION MUST BE ACCOMPLISHED BY QUALIFIED WORKERS REGULARLY ENGAGED IN THIS TYPE OF WORK. ALL ELECTRICAL WORK MUST BE PERFORMED BY A LICENSED ELECTRICIAN.
- 2.5. LOCKOUT/TAG OUT-ELECTRICAL WORK MUST NOT BE PERFORMED ON PANEL BOARDS, SWITCHES AND OTHER DEVICES WHEN THEY ARE ELECTRICALLY CHARGED (HOT). A LOCKOUT/TAG OUT PROCEDURE MUST BE FOLLOWED TO MAKE CERTAIN THAT ELECTRICAL DEVICES ARE DEACTIVATED. THE CONTRACTOR MUST PROVIDE A WRITTEN COPY OF THE LOCKOUT/TAG OUT PROCEDURE TO THE RESIDENT ENGINEER BEFORE ELECTRICAL WORK BEGINS. ANY PLANNED HOT WORK WILL BE GOVERNED BY SPECIAL CONTRACT PROVISIONS COVERED ELSEWHERE.
- 2.6. CIRCUIT NUMBERING -ALL CONDUCTORS, INCLUDING NEUTRAL AND GROUND CONDUCTORS, MUST BE IDENTIFIED AT BOTH ENDS OF THE CONDUCTOR WITH PANEL AND CIRCUIT NUMBER INDICATED. SHRINK EMBOSSED, CIRCUIT NUMBERING LABELS MUST BE USED. THE CONTRACTOR MUST PROVIDE AN UPDATED PANEL DIRECTORY IN PANELS WHERE CIRCUITS ARE CHANGED. THE DIRECTORY MUST BE TYPED ON A PANEL DIRECTORY SPECIFIC TO THE BRAND OF ELECTRICAL PANEL.
- 2.7. SPLICES-SPLICES MAY ONLY BE MADE THAT AT THOSE LOCATIONS DESIGNATED ON THE CONSTRUCTION PLANS. ANY SPLICES NOT INDICATED ON THE CONSTRUCTION PLANS MUST BE APPROVED IN ADVANCE BY THE PROJECT ENGINEER. SPLICES MUST BE MADE ONLY AT OUTLETS, JUNCTION BOXES OR ACCESSIBLE RACEWAYS AND MUST CONFORM TO FEDERAL SPECIFICATION WA-A-59213. SPLICES IN STRANDED WIRE, AND WIRE NO. 8 AND LARGER, MUST BE MADE WITH LONG BARREL COMPRESSION CONNECTORS. SPLICES IN WIRE NO. 10 AND SMALLER (SOLID) MUST BE MADE WITH WIRE NUTS. INSULATED WIRE NUTS MUST BE TAPED FOR MECHANICAL INTEGRITY. IN EITHER CASE, THE SPLICE MUST BE MADE BOTH MECHANICALLY AND ELECTRICALLY SECURE AND COMPLY WITH PARAGRAPH 110-14 (A) OF THE NATIONAL ELECTRICAL CODE. ALL SPLICES MUST BE MADE AT ACCESSIBLE JUNCTION AND OUTLET BOXES EXCEPT WHERE DIRECT BURIAL SPLICES ARE INDICATED. ALL SPLICES, INCLUDING THOSE MADE WITH INSULATED WIRE NUTS, MUST BE INSULATED WITH ELECTRICAL TAPE OR SHRINK TUBING TO AN INSULATION VALUE LEVEL EQUAL TO OR GREATER THAN THAT OF THE FACTORY INSULATED CONDUCTORS. IN CASES WHERE MORE THAN ONE CABLE MUST TERMINATE AT THE SAME CONNECTION POINT, USE POLARIS TYPE CONNECTORS IF THERE IS ROOM FOR THIS CONFIGURATION, OR A SPECIAL TERMINAL MUST BE USED WITH MULTIPLE BARRELS PROVIDED FOR MULTIPLE CABLE TERMINATION. TWO OR MORE CABLES ARE NOT ALLOWED TO TERMINATE WITH ONE SINGLE LUG DESIGNED FOR ONLY ONE SINGLE TERMINATION. SPLICES MADE IN POLE BASES, HANDHOLES, MANHOLES, OR DIRECT BURIED MUST BE MADE USING A CAST RESIN SPLICE KIT DESIGNED FOR DIRECT BURIAL MANUFACTURED BY RAYCHEM, 3M, OR AN APPROVED EQUAL AND MUST BE UL LISTED FOR WET LOCATIONS. SPLICES IN POLE BASES, HANDHOLES, MANHOLES, OR DIRECT BURIED WHERE MULTIPLE WIRES TERMINATE MUST BE MADE WITH AN APPROVED CAST RESIN SPLICE KIT OR POLARIS SUBMERSIBLE CONNECTORS AS APPROVED BY THE PROJECT ENGINEER.
- 2.8. EQUIPMENT GROUNDING CONDUCTORS -ALL METALLIC NON-CURRENT CARRYING PARTS OF ELECTRICAL EQUIPMENT MUST BE GROUNDING WITH EQUIPMENT GROUNDING CONDUCTORS. EQUIPMENT GROUNDING CONDUCTORS MUST ALWAYS BE GREEN INSULATED COPPER CONDUCTORS. THEY MUST BE SIZED IN ACCORDANCE WITH TABLE 250-122 "MINIMUM SIZE EQUIPMENT CONDUCTORS FOR GROUNDING RACEWAY AND EQUIPMENT" OF THE NEC, BUT NOT SMALLER THAN #12 AWG.
- 2.8.1. INSTALLATION OF EQUIPMENT GROUNDING CONDUCTORS -EACH OVER CURRENT DEVICE MUST HAVE ITS OWN EQUIPMENT GROUNDING CONDUCTOR. THE EQUIPMENT GROUNDING CONDUCTOR MUST BE INSTALLED IN THE SAME CONDUIT AS ITS RELATED OVER CURRENT DEVICE. POWER CONDUCTORS MUST BE CONNECTED TO THE GROUND BUS IN THE BRANCH OR DISTRIBUTION PANEL BOARD. METAL CONDUIT HOUSING THE EQUIPMENT GROUNDING CONDUCTOR MUST BE ELECTRICALLY CONTINUOUS, FORMING A PARALLEL PATH TO THE GROUNDING CONDUCTOR.
- 2.9. GROUNDING -THE GROUNDING SYSTEM FOR THE FACILITY MUST BE AS SHOWN ON THE DRAWINGS AND AS SPECIFIED HEREIN. GROUNDING MUST BE IN ACCORDANCE WITH NFPA 70, FAA-C-1217, AND FAA-STD-019. A EQUIPMENT GROUNDING SYSTEM TO PROPERLY SAFEGUARD EQUIPMENT AND PERSONNEL MUST SUPPLEMENT THE GROUNDING NEUTRAL OF THE SECONDARY DISTRIBUTION SYSTEM. A GREEN INSULATED GROUND WIRE MUST BE INSTALLED IN EACH CONDUIT USED FOR POWER CONDUCTORS TO LIGHT FIXTURE RECEPTACLES, AND ALL ELECTRICAL EQUIPMENT. ALL METALLIC NON-CURRENT CARRYING PARTS OF ELECTRICAL EQUIPMENT MUST BE GROUNDING WITH AN EQUIPMENT GROUNDING CONDUCTOR WHETHER OR NOT SHOWN ON THE DRAWINGS. WHEN SURFACE METAL RACEWAYS, WIREWAYS, OR CABLE RACK SYSTEMS ARE INSTALLED, A SEPARATE COPPER CONDUCTOR MUST BE INSTALLED ON THE RACEWAY AND MUST BE PROPERLY BONDED TO EACH SECTION. THE SIZE OF THIS WIRE MUST BE #6, UNLESS OTHERWISE INDICATED.

- 2.10.1. **GROUNDING ELECTRODE CONDUCTOR**-THE GROUNDING ELECTRODE CONDUCTOR MUST BE COPPER INSULATED GREEN AND SIZED AS SHOWN ON THE PROJECT DRAWINGS. THE CONDUCTORS AND INTERCONNECTING GROUNDING SYSTEMS MUST BE SIZED IN AS SHOWN ON THE PROJECT DRAWINGS. THE GROUNDING ELECTRODE CONDUCTOR MUST BOND ALL GROUNDING ELECTRODES PLUS THE NEUTRAL ON THE LINE SIDE OF THE SERVICE DISCONNECT. THIS CONDUCTOR MUST BE CONNECTED TO A NEUTRAL BUS INSIDE THE MAIN SERVICE DISCONNECT. THIS GROUND BUS MUST BE CONNECTED TO THE NEUTRAL BUS ONLY AT THIS LOCATION.
- 2.10.2. **GROUNDING ELECTRODES** -GROUND RODS MUST BE COPPER CLAD STEEL, 3/4-INCH DIAMETER, MINIMUM LENGTH 10 FEET. GROUND RODS MUST BE DRIVEN VERTICALLY FULL LENGTH INTO THE EARTH.
- 2.10.3. **GROUNDING CONNECTIONS**-ALL EQUIPMENT, ARMORED CABLE, GRS CONDUIT AND ALL OTHER EXPOSED, NON-CURRENT CARRYING METAL PARTS OF ELECTRICAL EQUIPMENT MUST BE GROUND BY AN EQUIPMENT GROUNDING CONDUCTOR SIZED IN ACCORDANCE WITH TABLE 250-95 OF THE NEC WHETHER OR NOT SHOWN ON THE PROJECT DRAWINGS. THIS CONDUCTOR MUST BE RUN IN THE SAME RACEWAY AS THE CIRCUIT CONDUCTORS. ALL CONNECTION POINTS MUST BE CLEANED OF PAINT, INSULATION AND OTHER NON-CONDUCTING MATERIALS BEFORE MAKING THE CONNECTION. ALL CONNECTIONS TO THE EQUIPMENT TO BE GROUNDED MUST BE MADE WITH A GROUND CONNECTOR SPECIFICALLY INTENDED FOR THAT PURPOSE. CONNECTING SCREWS OR MOUNTING BOLTS ARE NOT SUITABLE FOR USE AS GROUNDING CONNECTIONS. GROUNDING CONDUCTORS PASSING THROUGH CONDUITS MUST BE ATTACHED TO ALL GROUND BUSHINGS ON THE CONDUIT AND ON PULL OR JUNCTION BOXES. CONNECTIONS TO GROUND ELECTRODES AND ALL OTHER UNDERGROUND CONNECTIONS MUST BE EXOTHERMICALLY WELDED.
- 2.11. **SEPARATION OF POWER AND CONTROL CABLES**-ELECTRIC POWER CONDUCTORS MUST BE ROUTED SEPARATELY FROM ALL OTHER CONDUCTOR TYPES. THIS MAY BE ACCOMPLISHED BY ROUTING POWER CONDUCTORS AND OTHER CONDUCTORS IN SEPARATE RACEWAYS.
- 2.12. **EARTH ELECTRODE SYSTEM (GROUNDING COUNTERPOISE)**-THE EARTH ELECTRODE SYSTEM MUST BE INSTALLED AS SHOWN ON THE DRAWINGS. THE SYSTEM SHALL CONSIST OF GROUND RODS DRIVEN AS SHOWN ON THE CONSTRUCTION DRAWINGS. GROUND RODS MUST BE INTERCONNECTED WITH A #4/0 AWG BARE COPPER CONDUCTOR FORMING A CLOSED LOOP. THE #4/0 CONDUCTOR MUST BE BURIED A MINIMUM OF TWO FEET BELOW THE GROUND SURFACE AND THE TOP OF THE RODS MUST BE A MINIMUM OF ONE FOOT BELOW THE GROUND SURFACE. ALL UNDERGROUND METAL CONDUITS MUST BE CONNECTED TO THE EARTH ELECTRODE SYSTEM WITH A CABLE NO SMALLER THAN #2 AWG. ALL UNDERGROUND CONNECTIONS MUST BE MADE BY EXOTHERMIC WELDING PROCESS UNLESS OTHERWISE INDICATED.
- 2.12.1. **GROUND RODS**-GROUND RODS MUST BE DRIVEN FULL LENGTH INTO THE EARTH SO THAT THE TOP IS A MINIMUM OF 12 INCHES BELOW FINISHED GRADE. RODS MUST BE THREE-QUARTER INCH COPPER OR COPPER CLAD STEEL 10 FEET IN LENGTH UNLESS OTHERWISE INDICATED.
- 2.12.2. **OTHER HARDWARE** -INSTALL HARDWARE IN A NEAT MANNER, PARALLEL OR PERPENDICULAR OR PLUMB WHERE FASTENED TO SURFACES. FOR SURFACES USED WITH ADHESIVE TYPE HARDWARE, CLEAN THE SURFACES IN ACCORDANCE WITH THE ADHESIVE MANUFACTURER'S INSTRUCTIONS.
- 2.13. **RACEWAY INSTALLATIONS**
- 2.13.1. **GENERAL** -PANELBOARDS, SURGE ARRESTERS, DISCONNECT SWITCHES, ETC., MUST NOT BE USED AS RACEWAYS FOR CONDUITOR ROUTING OTHER THAN CONDUCTORS THAT ORIGINATE OR TERMINATE IN THESE ENCLOSURES. ISOLATED GROUND CONDUCTORS WILL BE ALLOWED TO TRAVERSE THESE ENCLOSURES. EACH RUN MUST BE COMPLETE BEFORE CONDUCTORS ARE PULLED INTO THE CONDUIT AND MUST BE SWABBED BEFORE CONDUCTORS ARE INSTALLED. ENDS OF CONDUIT SYSTEMS NOT TERMINATED IN BOXES OR CABINETS MUST BE CAPPED. CRUSHED OR DEFORMED RACEWAYS MUST NOT BE INSTALLED. ALL METALLIC CONDUIT ENCLOSING AC SERVICE LINES MUST BE TERMINATED USING CONDUCTIVE FITTINGS TO PANELBOARD, THE POWER METER, AND TO THE SERVICE. ALL BURIED METALLIC CONDUIT ENCLOSING SIGNAL, CONTROL, STATUS AND OTHER POWER LINES MUST BE TERMINATED USING CONDUCTIVE FITTINGS TO FACILITY JUNCTION BOXES, EQUIPMENT CABINETS, ENCLOSURES, OR OTHER GROUNDED METAL STRUCTURE.
- 2.13.2. **CONDUIT INSTALLATIONS** -THE WIRING METHOD MUST CONSIST OF INSULATED COPPER CONDUCTORS PULLED INTO RIGID METALLIC CONDUIT, ELECTRICAL METALLIC TUBING (EMT), RIGID NONMETALLIC CONDUIT (PVC OR POLYETHYLENE) OR FLEXIBLE METALLIC CONDUIT. CONDUIT SYSTEM MUST BE INSTALLED COMPLETE BEFORE CONDUCTORS ARE PULLED INTO THE CONDUIT. EACH RUN MUST BE CLEANED AND SWABBED BEFORE CONDUCTORS ARE INSTALLED. ALL CONDUIT TERMINATIONS MUST INCLUDE INSULATED BUSHINGS. UNLESS OTHERWISE NOTED ON THE DRAWINGS, CONDUIT INSTALLATIONS MUST RUN PARALLEL OR PERPENDICULAR TO THE BUILDING LINES IN A NEAT AND WORKMANLIKE MANNER. LOCATION OF EXPOSED CONDUIT RUNS WILL BE SUBJECT TO APPROVAL OF THE RESIDENT ENGINEER. CONDUIT MUST BE SUPPORTED AS PER NEC REQUIREMENTS. ALL UNUSED CONDUITS MUST HAVE A PULL STRING/WIRE INSTALLED WITH A MINIMUM TENSILE STRENGTH OF 200LBS. TEN INCHES MINIMUM SLACK MUST BE LEFT AT EACH END OF THE CONDUIT.
- 2.13.3. **FIELD BENDS** -FIELD BENDS MUST BE AVOIDED WHERE POSSIBLE. IF FIELD BENDS ARE USED THEY MUST BE APPROVED BY THE RESIDENT ENGINEER. ALL BENDS MUST BE MADE WITH STANDARD APPROVED JACKKNEYS AND CONDUIT BENDING DEVICES. BENDING DEVICES MUST BE USED TO ENSURE THAT NO DAMAGE IS DONE TO THE CONDUIT DURING THE BENDING PROCESS. ANY DAMAGE MUST BE REPAIRED TO A FACTORY EQUIVALENT LEVEL.
- 2.13.4. **FIELD CUTTING AND THREADING** -ALL FIELD CUT CONDUITS MUST BE SQUARE CUT AND THE ENDS CAREFULLY REAMED TO REMOVE ALL BURRS. CONDUIT THREADS MUST BE TAPERED SUCH THAT THEY PROVIDE CONTINUITY AND SOLIDLY GROUNDED CONNECTIONS. THE USE OF RUNNING THREADS IS NOT PERMITTED.
- 2.13.5. **HOLES AND SLEEVES**-THE CONTRACTOR MUST PROVIDE ALL HOLES AND SLEEVES NECESSARY TO INSTALL CONDUIT AND EQUIPMENT. ALL REQUIRED FLASHING, ESCUTCHEON, AND SLEEVES SHALL BE CONTRACTOR FURNISHED.
- 2.13.6. **FLEXIBLE STEEL CONDUIT, AND LIQUDTIGHT FLEXIBLE METAL CONDUIT**-FLEXIBLE STEEL CONDUIT MUST BE IN 6-FEET OR LESS NOMINAL LENGTHS FOR TERMINAL CONNECTIONS TO MOTORS OR MOTOR DRIVEN EQUIPMENT, AND MAY BE USED IN SHORT LENGTHS FOR OTHER APPLICATIONS AS PERMITTED BY THE NEC. LIQUDTIGHT FLEXIBLE METALLIC CONDUIT MAY BE USED OUTDOORS OR IN WET LOCATIONS. IF LIQUDTIGHT FLEXIBLE CONDUIT IS REQUIRED TO BE LONGER THAN SIX (6) FEET IN LENGTH, THE CONTRACTOR MUST OBTAIN APPROVAL FROM THE SITE REPRESENTATIVE.
- 2.13.7. **POLYVINYL CHLORIDE (PVC OR RIGID NONMETALLIC) CONDUIT**-MAKE ALL BENDS BY MEANS OF AN ELECTRICAL HEATING UNIT APPROVED BY THE CONDUIT MANUFACTURER WHERE STANDARD ELBOWS AND FITTINGS CANNOT BE USED. RIGID NONMETALLIC CONDUIT MAY BE USED FOR LIGHTENING PROTECTION SYSTEM CONDUCTORS AND TO PROTECT GROUNDING CONDUCTORS.
- 2.13.8. **SURFACE METAL RACEWAYS**-SURFACE METAL RACEWAYS MUST CONFORM TO FEDERAL SPECIFICATION W-C-582. SURFACE METAL RACEWAYS MUST BE INSTALLED ONLY IN EXPOSED, DRY LOCATIONS WHERE NOT SUBJECT TO PHYSICAL DAMAGE.
- 2.13.9. **WIREWAYS** -SQUARE DUCT MUST ONLY BE INSTALLED IN ACCESSIBLE LOCATIONS. COVERS MUST BE HINGED AND MUST ALSO HAVE SCREW FASTENERS. WIREWAYS INSTALLED IN WET OR DAMP LOCATIONS MUST BE RATED FOR THESE LOCATIONS.
- 2.13.12. **UNDERGROUND CONDUIT AND CABLE DEPTH REQUIREMENTS**-UNLESS OTHERWISE SPECIFIED, ALL UNDERGROUND CABLES, DUCTS AND CONDUITS MUST BE INSTALLED A MINIMUM OF 30" DEEP TO TOP OF CONDUIT.
- 2.14. **JUNCTION, OUTLET, AND PULL BOXES**
- 2.14.9. **SPECIAL CONSTRUCTION** -FURNISH JUNCTION BOXES AS SHOWN ON THE DRAWINGS FOR CABLE TO BE INSTALLED BY OTHERS.
- 2.14.10. **JUNCTION, PULL AND OUTLET BOXES**-A JUNCTION OR OUTLET BOX MUST BE PROVIDED AT EACH LOCATION INDICATED IN THE PLANS AND SPECIFICATION, OR WHERE NECESSARY FOR COMPLIANCE WITH THE NATIONAL ELECTRICAL CODE, OR FOR A NEAT, WORKMANLIKE INSTALLATION. ALL BOXES MUST BE OF SUFFICIENT SIZE AND SHAPE TO MEET CODE REQUIREMENTS.
- 2.15. **SUPPORTS AND FASTENERS** -SUPPORTING METHODS FOR ALL ELECTRICAL EQUIPMENT AND BRANCH CIRCUITRY MUST CONFORM TO THE BEST PRACTICE, UTILIZE ONLY APPROVED MATERIALS, AND SATISFY ALL REQUIREMENTS OF THE NATIONAL ELECTRICAL CODE. RACEWAYS MUST BE SECURELY SUPPORTED AND FASTENED IN PLACE AT INTERVALS OF NOT MORE THAN 10 FEET WITH PIPE STRAPS, WALL BRACKETS, HANGERS, OR CEILING TRAPEZE. RACEWAYS MUST ALSO BE SUPPORTED WITHIN 3 FEET (MAXIMUM) OF TERMINATION. FASTENING MUST BE BY TOGGLE BOLTS ON HOLLOW MASONRY UNITS; BY EXPANSION-BOLTS ON CONCRETE OR BRICK; BY MACHINE SCREWS, WELDED THREADED STUDS, OR SPRING TENSION CLAMPS ON STEEL WORK. MALE TYPE NYLON ANCHORS OR THREADED STUDS DRIVEN IN BY A POWER CHARACTER UNID WIDED WITH LOCK WASHERS AND NUTS MAY BE USED IN LIEU OF EXPANSION BOLTS OR MACHINE SCREWS. RACEWAYS OR PIPE STRAPS MUST NOT BE WELDED TO STEEL STRUCTURES. RACEWAYS MUST NOT BE SUPPORTED FROM SHEET METAL ROOF DECKS. DO NOT SUPPORT CONDUIT OR ELECTRICAL EQUIPMENT WITH WIRE. ALL METALLIC ELECTRICAL SUPPORT STRUCTURES MUST BE ELECTRICALLY CONTINUOUS AND MUST BE BONDED TO THE MULTIPPOINT GROUND SYSTEM OR THE EARTH ELECTRODE SYSTEM EITHER DIRECTLY OR INDIRECTLY.

- 2.16. CABLE INSTALLATION IN CONDUIT THE CONTRACTOR MUST TAKE ALL NECESSARY PRECAUTIONS TO INSURE AGAINST DAMAGING THE INSULATION AND CONDUCTOR DURING INSTALLATION IN CONDUIT. A NON-PETROLEUM BASED LUBRICANT APPROVED BY UNDERWRITERS' LABORATORIES MUST BE USED IF NECESSARY TO REDUCE TENSION DURING PULLING. THE CABLE MAY BE PULLED BY POWER WINCH OR BY HAND. UNDER NO CIRCUMSTANCES MAY THE CONTRACTOR USE CONSTRUCTION VEHICLES TO PULL CABLE. CABLE ENDS MUST BE SEALED WITH CABLE END SEALING CAPS OR A WATERPROOF TAPE. WHERE MORE THAN ONE CABLE IS INSTALLED IN A CONDUIT, ALL MUST BE PULLED AT THE SAME TIME. SPLICES MUST NOT BE PULLED INTO A CONDUIT. CONTROL CABLE MUST NOT BE INSTALLED IN THE SAME CONDUIT AS POWER CABLE.
- 2.16.1. DEDICATED NEUTRAL AND GROUNDING CONDUCTOR. SHARED/COMMON NEUTRALS MUST NOT BE PERMITTED. NEUTRAL CONDUCTOR SIZES MUST NOT BE LESS THAN THE RESPECTIVE FEEDER OR PHASE CONDUCTOR. FOR EACH CIRCUIT INSTALLED UNDER THIS CONTRACT, THE CONTRACTOR MUST INSTALL A DEDICATED NEUTRAL AND EQUIPMENT GROUNDING CONDUCTOR THROUGHOUT THE ENTIRE CIRCUIT. THE PHASE CONDUCTOR, THE NEUTRAL AND THE EQUIPMENT GROUNDING CONDUCTOR MUST BE PROPERLY IDENTIFIED AS A SET AT THE SOURCE PANEL, IN EVERY J-BOX WHERE A TERMINATION TAKES PLACE AND AT EACH ELECTRICAL DEVICE WHERE THE CIRCUIT TERMINATES.
- 2.17. CABLE TERMINATION-CABLE TERMINATIONS MUST CONFORM TO NEC ARTICLE 110-14. SPLICES MUST BE MADE ONLY AT OUTLETS, JUNCTION BOXES, OR IN ACCESSIBLE RACEWAYS. TERMINATIONS OF ALL CONTROL, POWER, AND COAXIAL CABLES MUST BE AS SPECIFIED. CARE MUST BE TAKEN NOT TO DAMAGE CONDUCTORS WHEN REMOVING INSULATION. COMPRESSION LUGS, PROPERLY INSULATED, SHOULD BE USED WHENEVER POSSIBLE. COMPRESSION SPLICES MUST BE TAPED WITH ELECTRICAL INSULATING TAPE IN A MANNER WHICH MAKES THEIR INSULATION EQUAL TO THE INSULATION ON THE CONDUCTORS. WIRE NUTS MAY BE USED TO SPLICE CONDUCTORS SIZED #10 AWG AND SMALLER. WIRE NUTS MUST BE TAPED FOR MECHANICAL SECURITY. COMPRESSION CONNECTORS MUST BE USED TO SPLICE CONDUCTORS #8 AWG AND LARGER. MULTIPLE CABLES MUST NOT BE TERMINATED IN LUGS LISTED FOR ONLY ONE CONDUCTOR. SPLICING IN PANELBOARDS IS NOT PERMITTED.
- 2.18. IDENTIFICATION
- 2.18.1. EQUIPMENT IDENTIFICATION -EACH OF THE FOLLOWING TYPES OF EQUIPMENT MUST BE IDENTIFIED WITH A NAME PLATE WHICH SHOWS: THE FUNCTIONAL NAME OF THE UNIT, VOLTAGE UTILIZED, SINGLE OR THREE PHASES AS APPLICABLE, THE PANEL AND CIRCUIT NUMBER POWERING THE EQUIPMENT, AND ANY OTHER PERTINENT INFORMATION. NAME PLATES MUST BE NON-FERROUS METAL OR RIGID PLASTIC, STAMPED, EMBOSSED, OR ENGRAVED WITH 3/8-INCH MINIMUM HEIGHT LETTERING AND NUMERALS. NAME PLATE BACKGROUND AND LETTERING MUST BE IN BLACK. THE PLATES MUST BE SECURED TO THE EQUIPMENT WITH A MINIMUM OF TWO SCREWS OR RIVETS. SWITCHES FOR LOCAL LIGHTING DO NOT NEED TO BE IDENTIFIED.
- PANEL BOARDS
 - DISCONNECT SWITCHES
 - LOAD BANK
 - AUTOMATIC TRANSFER SWITCH
 - JUNCTION BOXES
 - LOAD BANK CONTROLLER
 - BATTERY CHARGER
 - REMOTE STATUS ALARM PANEL
- ADDITIONAL EQUIPMENT MUST BE IDENTIFIED AS REQUIRED IN THE CONSTRUCTION DOCUMENTS.
- 2.18.2. CONDUCTOR IDENTIFICATION -IN ADDITION TO COLOR CODING, ALL FEEDER, LINE, PHASE, BRANCH, AND NEUTRAL CONDUCTORS MUST BE IDENTIFIED BY SHRINK EMBOSSED LABELS, MARKERS, OR EQUIVALENT MEANS AS APPROVED BY THE SITE REPRESENTATIVE. PANEL AND CIRCUIT NUMBERS MUST BE IDENTIFIED. CONDUCTOR IDENTIFICATION MUST BE PROVIDED AT ALL TERMINATIONS, AND IN ALL JUNCTION BOXES THROUGH WHICH THESE CONDUCTORS PASS.

CAUTION - SELECTIVELY COORDINATED
THIS EQUIPMENT MUST BE REPLACED WITH
IDENTICAL PROTECTIVE DEVICE TO
MAINTAIN SELECTIVE COORDINATION

- 2.19. COLOR CODING OF POWER CONDUCTORS-ALL WIRING, INCLUDING FEEDERS, MUST BE COLOR CODED AS SPECIFIED HEREIN. THE COLOR-CODING MUST BE CONTINUOUS THROUGHOUT THE FACILITY ON EACH PHASE CONDUCTOR TO ITS POINT OF UTILIZATION SO THAT THE CONDUCTOR PHASE CONNECTION IS READILY IDENTIFIABLE. ALL FEEDER AND BRANCH CIRCUITS, INCLUDING NEUTRAL CONDUCTORS, MUST BE IDENTIFIED AT BOTH ENDS OF THE CONDUCTOR WITH PANEL AND CIRCUIT NUMBER INDICATED. NEUTRAL CONDUCTORS MUST BE CONTINUOUS. FOR CONDUCTORS NO. 4 AWG AND LARGER, WHERE COLOR-CODING IS NOT AVAILABLE, COLOR-CODED TAPE, HALF LAPPED FOR A MINIMUM LENGTH OF 12 INCHES MUST BE USED WITH A MAXIMUM SPACING OF 3 FEET. IN NO CASE, HOWEVER, MUST GREEN INSULATED CONDUCTORS BE RE-IDENTIFIED FOR PURPOSES OTHER THAN GROUNDING, NOR MUST WHITE OR NEUTRAL GRAY CONDUCTORS BE RE-IDENTIFIED AS OTHER THAN GROUND (NEUTRAL) CONDUCTORS. WHERE CONDUCTORS ARE COLOR CODED IN THIS MANNER, THEY MUST BE COLOR CODED IN ALL JUNCTION BOXES AND PULLBOXES, ACCESSIBLE RACEWAYS, PANELBOARDS, OUTLETS, AND SWITCHES, AS WELL AS AT ALL TERMINATIONS. COLOR CODING FOR CONDUCTORS IN CONTROL CABLES MUST BE IN ACCORDANCE WITH NEMA STANDARD WC-5. DC POWER CONDUCTORS MUST BE COLOR CODED AS FOLLOWS: POSITIVE CONDUCTOR, RED. NEGATIVE CONDUCTOR, BLACK. A/C POWER CONDUCTORS MUST BE COLOR CODED AS FOLLOWS:

PHASE CONDUCTORS - PHASE CONDUCTORS MUST BE COLOR CODED AS FOLLOWS

COLOR CODING OF CONDUCTORS			
	120/240V 1-PH, 3-WIRE	(240) 3 208Y/120V 3-PH OR 4-WIRE	480Y/277V 3-PH 4-WIRE
PHASE A	BLACK	BLACK	YELLOW
PHASE B	RED	RED	BROWN
PHASE C		BLUE	ORANGE
NEUTRAL	WHITE	WHITE	GREY/WHITE
GROUND	GREEN	GREEN	GREEN

REV	APPROVED DATE	DESCRIPTION				JCN	REDLINE DATE	APV
DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION								
ATO - TECHNICAL OPERATIONS						WESTERN SERVICE AREA		
<div>PAPI</div> <div>SPECIFICATIONS & REQUIREMENTS</div> <div>PART 2 OF 3</div>								
LIHUE			LIHUE AIRPORT					
REVIEWED BY	SUBMITTED BY <i>[Signature]</i> PROJECT ENGINEER, AJW-2W14B							
	DO NOT SIGN DO NOT SIGN DO NOT SIGN DO NOT SIGN DO NOT SIGN DO NOT SIGN DO NOT SIGN DO NOT SIGN							
	DESIGNED ADM				ISSUED BY			
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	CHECKED				PLATFORM MANAGER, AJW-2W14B			
					DATE 01/06/2023		JCN	1798073
					DRAWING NO LIH-D-PAPI21-G004		REV	

G. ELECTRICAL MATERIALS AND METHODS (CONT.)

- 2.20.

PAINTING AND FINISHING-WHERE FACTORY FINISHES ARE PROVIDED ON EQUIPMENT AND NO ADDITIONAL FIELD PAINTING IS SPECIFIED, ALL MARRED OR DAMAGED SURFACES MUST BE TOUCHED UP OR REFINISHED SO AS TO LEAVE A SMOOTH, UNIFORM FINISH AT THE TIME OF FINAL INSPECTION AS DIRECTED BY THE SITE REPRESENTATIVE. PAINTS AND FINISHES MUST BE REMOVED TO BARE METAL WHERE BONDING CONNECTIONS ARE REQUIRED.
- 2.21.

REPAIR OF EXISTING WORK-ELECTRICAL WORK MUST BE CAREFULLY LAID OUT IN ADVANCE. WHERE CUTTING, CHANNELING, CHASING, OR DRILLING OF FLOORS, WALL PARTITIONS, CEILINGS, OR OTHER SURFACES IS NECESSARY FOR THE PROPER INSTALLATION, SUPPORT, OR ANCHORAGE OF THE CONDUIT, RACEWAYS, OR OTHER ELECTRICAL WORK, IT MUST BE CAREFULLY DONE. DAMAGE TO THE BUILDING, PIPING, OR EQUIPMENT MUST BE REPAIRED BY SKILLED MECHANICS OF THE TRADES INVOLVED AT NO ADDITIONAL COST.
- 2.22.

SURGE ARRESTOR-ARRESTER MUST BE COMPATIBLE WITH THE SERVICE VOLTAGE, AND MUST BE WIRED TO AVOID LOOPS, SHARP BENDS AND KINKS, AND TO MINIMIZE THE LENGTH OF THE CONDUCTOR AND NUMBER OF BENDS. ARRESTER ENCLOSURE MUST BE MOUNTED WITHIN 4" OR LESS OF THE SERVICE DISCONNECT ENCLOSURE AND MUST BE CLOSE NIPPLE DIRECTLY TO THE SERVICE DISCONNECT. CONDUCTOR LENGTH MUST NOT EXCEED 12" UNLESS APPROVED BY THE RESIDENT ENGINEER. CONDUCTORS SHALL BE AS LARGE AS THE TERMINALS ON THE OVERCURRENT DEVICE AND THE ARRESTOR CAN ACCEPT. THERE MUST BE NO INTERCONNECTION BETWEEN NEUTRAL AND GROUND WITHIN THE ARRESTER.
- 2.23.

DEMOLITION REPAIR-WALL SECTIONS EXPOSED BY DEMOLITION OF EQUIPMENT UNDER THIS CONTRACT MUST BE REPAIRED/REFINISHED TO MATCH EXISTING. ALL PENETRATIONS AND MOUNTING HOLES MUST BE SEALED WEATHER-TIGHT AND REFINISHED TO MATCH SURROUNDING SURFACE. ALL REPAIRS MUST BE MADE TO THE SATISFACTION OF THE RESIDENT ENGINEER.
- 2.24.

MECHANICAL EQUIPMENT-CONTRACTOR MUST PROVIDE ALL CONDUITS, J-BOXES, CABLE, LUGS, TERMINATIONS, DISCONNECTS, PROTECTIVE DEVICES, ETC. AS REQUIRED TO COMPLETE POWER AND CONTROL SERVICE TO ALL MECHANICAL EQUIPMENT INSTALLED/AFFECTED BY THIS CONTRACT. THE CONTRACTOR MUST COORDINATE ALL WORK BETWEEN MECHANICAL AND ELECTRICAL SUB-CONTRACTORS TO COMPLETE FUEL AND VENTILATION SYSTEMS EVEN IF NOT SPECIFICALLY IDENTIFIED WITHIN THE DRAWINGS. INSTALLATION NOT SPECIFICALLY COVERED IN THE CONSTRUCTION DOCUMENTS MUST BE PERFORMED PER THE MANUFACTURER'S RECOMMENDATIONS. MECHANICAL SYSTEMS MUST BE TESTED AND MEET REQUIREMENTS OUTLINED IN MECHANICAL DRAWINGS AND SPECIFICATIONS.
3.

TESTING
- 3.1.

GENERAL -ALL TESTS MUST BE PERFORMED IN THE PRESENCE OF THE RESIDENT ENGINEER. THE CONTRACTOR MUST KEEP RECORDS OF ALL TESTS PERFORMED. THE CONTRACTOR MUST PREPARE A REPORT OF ALL MEASUREMENTS AND SUBMIT THEM TO THE RESIDENT ENGINEER.
- 3.2.

INSULATION RESISTANCE TESTS -ALL GOVERNMENT AND CONTRACTOR FURNISHED CONDUCTORS MUST BE TESTED PRIOR TO INSTALLATION. ALL FEEDERS, BRANCH CIRCUITS, AND COORDINATE COMMUNICATION CABLE MUST HAVE THE INSULATION TESTED AFTER INSTALLATION AND BEFORE ANY SPLICES OR TERMINATIONS ARE MADE TO EQUIPMENT. ALL CONDUCTORS MUST TEST FREE FROM SHORT CIRCUITS AND GROUNDS, AND THE MINIMUM INSULATION RESISTANCE PHASE-TO-PHASE AND PHASE-TO-GROUND SHALL BE 50 MEGAOHMS MEASURED WITH A 500-VOLT DC INSULATION RESISTANCE TESTER (AS PER FAA-C-1217). CABLES RATED FOR MORE THAN 600V SHALL BE TESTED AT THEIR RATED DC INSULATED VOLTAGE. MOTORS AND TRANSFORMERS MUST BE TESTED FOR GROUNDS OR SHORT CIRCUITS BEFORE INSTALLATION. PRIOR TO FINAL INSPECTION, THE CONTRACTOR MUST SUBMIT A TEST REPORT INCLUDING THE CIRCUIT BEING TESTED, THE TEST RESULTS, THE PERSON PERFORMING THE TEST, AND THE DATE OF THE TEST.
- 3.2.1.

EXISTING AND GOVERNMENT FURNISHED CONDUCTORS -GOVERNMENT FURNISHED CONDUCTORS MUST BE TESTED PRIOR TO INSTALLATION. ANY CONDUCTOR FOUND TO BE DEFECTIVE AFTER PLACEMENT MUST BE REPLACED AT NO ADDITIONAL EXPENSE TO THE GOVERNMENT. EXISTING CONDUCTORS MUST BE TESTED PRIOR USE IN NEW SYSTEMS. IF EXISTING CONDUCTORS ARE FOUND TO HAVE A INSULATION RESISTANCE OF UNDER 10 MEGAOHMS IMMEDIATELY REPORT THIS FINDING TO THE RESIDENT ENGINEER.
- 3.2.2.

FAILURE OF CABLE UNDER TEST -CABLE, INCLUDING SPLICES, WHICH FAIL TEST REQUIREMENTS MUST BE REPAIRED OR REPLACED, AND RETESTED. CABLE MUST NOT BE PUT INTO SERVICE UNTIL IT HAS PASSED ALL TEST REQUIREMENTS.
- 3.3.

CONTINUITY TESTS-ALL CABLES, INCLUDING INDIVIDUAL CONDUCTORS OF A MULTI-CONDUCTOR CABLE, MUST BE CONTINUITY TESTED PRIOR TO CONNECTION. PRIOR TO FINAL INSPECTION, THE CONTRACTOR MUST SUBMIT A TEST REPORT INCLUDING THE CABLE BEING TESTED, THE TEST RESULTS, THE PERSON PERFORMING THE TEST, AND THE DATE OF THE TEST. TEST REPORTS MUST INCLUDE CIRCUIT #, PHASE, TIME AND DATE OF TEST, EQUIPMENT SERVED, TEST RESULTS, AND SIGNATURE OF THE PERSON CONDUCTING THE TEST.
- 3.4.

NEUTRAL ISOLATION TEST -AFTER INSTALLATION OF ALL BRANCH CIRCUITS THE NEUTRAL IN THE SERVICE ENTRANCE SWITCH MUST BE TESTED FOR ISOLATION FROM GROUND WITH AN OHMMETER SET ON ITS RX1 SCALE. ANY CONTACT BETWEEN THE NEUTRAL AND GROUND (OTHER THAN AT THE SERVICE ENTRANCE SWITCH) IS A POSSIBLE CAUSE OF NOISE IN ELECTRONIC EQUIPMENT AND MUST BE CORRECTED.
- 3.5.

EARTH RESISTANCE TEST-USING THE FALL OF POTENTIAL METHOD, THE CONTRACTOR MUST MEASURE THE RESISTANCE TO EARTH OF EACH INDIVIDUAL GROUND ROD PRIOR TO INTERCONNECTION WITH THE 4/0 LOOP CONDUCTOR. THE RESULTS OF THESE TESTS MUST BE SUBMITTED TO THE RESIDENT ENGINEER FOR REVIEW. AFTER APPROVAL BY THE SITE REPRESENTATIVE, THE GROUND RODS MUST BE INTERCONNECTED AND THE RESISTANCE TO EARTH OF THE NEW GROUND SYSTEM MUST BE TESTED WITH THE RESULTS SUBMITTED IMMEDIATELY TO THE RESIDENT ENGINEER FOR APPROVAL. THE CONTRACTOR MAY ELECT TO TEST THE COMPLETED SYSTEM ONLY. IF THE CONTRACTOR ELECTS TO TEST ONLY THE COMPLETED SYSTEM, AND IT DOES NOT MEET THE REQUIREMENTS LISTED HEREIN, THE CONTRACTOR WILL EXPOSE THE ENTIRETY OF THE SYSTEM AND RETEST EACH GROUND ROD AND EXOTHERMIC WELD. POOR WELD CONNECTIONS SHALL BE REMOVED AND REPLACED. THIS WILL BE DONE AT THE CONTRACTOR'S EXPENSE. THE FAA REQUIRES A EARTH RESISTANCE OF 10 OHMS OR LESS FOR THE COMPLETED EARTH ELECTRODE SYSTEM. TESTS MUST NOT BE CONDUCTED WITHIN 48 HOURS OF A RAINFALL OR IN FROZEN SOIL. PRIOR TO FINAL INSPECTION, THE CONTRACTOR MUST SUBMIT A TEST REPORT INCLUDING THE PREVIOUS 72-HOUR WEATHER CONDITIONS, CIRCUIT BEING TESTED, THE TEST RESULTS, THE PERSON PERFORMING THE TEST, AND THE DATE OF THE TEST.
- 3.6.

OPERATING TEST-AFTER THE WIRING SYSTEM INSTALLATION IS COMPLETED THE CONTRACTOR MUST CONDUCT AN OPERATING TEST FOR APPROVAL. THE EQUIPMENT MUST BE DEMONSTRATED TO OPERATE IN ACCORDANCE WITH THE REQUIREMENTS OF THIS SPECIFICATION, EQUIPMENT MANUFACTURERS SPECIFICATIONS, AND THE CONTRACT DRAWINGS. THE TEST MUST BE PERFORMED IN THE PRESENCE OF THE RESIDENT ENGINEER OR AN AUTHORIZED REPRESENTATIVE. THE CONTRACTOR MUST FURNISH ALL INSTRUMENTS AND PERSONNEL REQUIRED FOR THE TESTS.
- 3.7.

SHIELD TEST-CONTINUITY OF SHIELDING MUST BE VERIFIED USING A LOOP RESISTANCE TEST. AN UNGROUNDED SHIELD TO GROUND RESISTANCE TEST MUST BE DONE TO VERIFY THAT THE SHIELD IS NOT GROUNDED EXCEPT AT ONE END. READINGS MUST BE RECORDED AND GIVEN, IN WRITING, TO THE RESIDENT ENGINEER.
- 3.8.

LOAD BALANCING-BEFORE ENERGIZING ANY NEW ELECTRICAL 3-PHASE EQUIPMENT, WHICH HAS BEEN INSTALLED UNDER THIS CONTRACT, THE CONTRACTOR MUST MAKE CERTAIN THAT THE PHASE ROTATION IS POSITIVE. LOAD BALANCING REQUIRES THAT NO SINGLE PHASE LOAD MUST EXCEED A 20% DIFFERENCE BETWEEN READINGS IN ANY TWO PHASES. THE CONTRACTOR MUST TAKE PHASE ANGLE AND LOAD MEASUREMENTS ON THE SERVICE DISCONNECT AND EACH DISTRIBUTION PANEL AND REPORT THE RESULTS TO THE RESIDENT ENGINEER IN WRITING. THESE READINGS MUST BE TAKEN WITH ALL LOADS ENERGIZED. THE CONTRACTOR MUST REDISTRIBUTE SINGLE-PHASE LOADS WHERE THERE IS GREATER THAN A 20% DIFFERENCE BETWEEN READINGS IN ANY TWO PHASES AT THE APPROVAL OF THE RESIDENT ENGINEER AND THE FAA. THE CONTRACTOR IS REQUIRED TO DOCUMENT CURRENT READINGS TAKEN BEFORE AND AFTER INSTALLATION, AND ANY PHASE LOADED ABOVE 80% OF THE RATING OF ITS OVERCURRENT PROTECTIVE DEVICE.

H. TUNNELING, BORING, & JACKING

1. PRODUCTS

- 1.1.

PIPE-PIPE DIAMETER SHALL BE AS INDICATED ON THE CONSTRUCTION DRAWINGS. UNLESS OTHERWISE INDICATED USE HIGH DENSITY POLYETHYLENE PIPE (HDPE) WITH AN SDR OF 9. THE SDR OF A CONDUIT IS DEFINED AS THE RATIO OF THE AVERAGE CONDUIT DIAMETER DIVIDED BY THE MINIMUM WALL THICKNESS.
- 1.2.

DRILLING FLUIDS-DISPOSAL OF FLUIDS IS THE RESPONSIBILITY OF THE CONTRACTOR. DISPOSE OF FLUIDS IN A MANNER THAT IS IN COMPLIANCE WITH ALL PERMITS AND APPLICABLE FEDERAL, STATE, AND LOCAL REGULATIONS. USE A HIGH QUALITY BENTONITE DRILLING FLUID TO ENSURE HOLE STABILITY, CUTTINGS TRANSPORT, BIT AND ELECTRONICS COOLING, AND HOLE LUBRICATION TO REDUCE DRAG ON THE DRILL PIPE AND THE PRODUCT PIPE. USE ONLY FLUID WITH A COMPOSITION WHICH COMPLIES WITH ALL FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS. MIX THE BENTONITE DRILLING FLUID WITH POTABLE WATER (OF PROPER PH) TO ENSURE NO CONTAMINATION IS INTRODUCED INTO THE SOIL DURING THE DRILLING, REAMING, OR PIPE INSTALLATION PROCESS. THE CONTRACTOR IS RESPONSIBLE FOR ANY REQUIRED PH ADJUSTMENTS. DISPOSAL OF THE DRILLING FLUIDS IS THE RESPONSIBILITY OF THE CONTRACTOR. CONDUIT DISPOSAL IN COMPLIANCE WITH ALL RELATIVE ENVIRONMENTAL REGULATIONS, RIGHT-OF-WAY AND WORK SPACE AGREEMENTS, AND PERMIT REQUIREMENTS. COLLECT DRILLING FLUID RETURNS IN THE ENTRANCE PIT, EXIT PIT, OR SPOILS RECOVERY PIT. IMMEDIATELY CLEAN UP ANY DRILLING FLUID SPILLS OR OVERFLOWS FROM THESE PITS. DRILLING FLUIDS MAY NOT BE DISPOSED ON THE AIRPORT WITHOUT THE APPROVAL OF THE AIRPORT MANAGER.

2. EXECUTION

- 2.1.

DRILL ENTRANCE & EXIT PITS-DRILL ENTRANCE AND EXIT PITS ARE REQUIRED. MAINTAIN AT MINIMUM SIZE TO ALLOW ONLY THE MINIMUM AMOUNT OF DRILLING FLUID STORAGE PRIOR TO TRANSFER TO MUD RECYCLING OR PROCESSING SYSTEM OR REMOVAL FROM THE SITE. DO NOT ALLOW DRILLING MUD TO FLOW FREELY ON THE SITE OR AROUND THE ENTRANCE OR EXIT PITS. REMOVE SPILLED MUD AND RESTORE GROUND TO ORIGINAL CONDITION. PROVIDE SHORE PITS IN COMPLIANCE WITH OSHA STANDARDS, 29 CFR 1926.652. WHEN DRILLING NEAR WETLANDS OR WATER COURSES, PROVIDE SECONDARY CONTAINMENT TO PREVENT DRILLING FLUIDS FROM ENTERING THE WETLANDS, AND SECURE WRITTEN APPROVAL OF SECONDARY CONTAINMENT PLAN FROM THE PROJECT ENGINEER.
- 2.2.

DRILL ENTRANCE & EXIT ANGLE-ENSURE ENTRANCE AND EXIT ANGLES AND ELEVATION PROFILE MAINTAINS ADEQUATE COVER TO REDUCE RISK OF DRILLING FLUID BREAKOUTS AND GROUND EXIT OCCURS AS SPECIFIED HEREIN. ENSURE THAT ENTRANCE AND EXIT ANGLES GENERATE PULLBACK FORCES THAT DO NOT EXCEED 5 PERCENT STRAIN ON THE POLYETHYLENE PIPE.
- 2.3.

PILOT HOLE-THE TYPE AND SIZE OF THE PILOT STRING CUTTING HEAD AND THE DIAMETER OF THE DRILL PIPE IS AT THE CONTRACTOR'S DISCRETION. DRILL THE PILOT HOLE ALONG THE PATH SHOWN ON THE PLAN AND PROFILE DRAWINGS. PILOT HOLE TOLERANCES ARE AS FOLLOWS:

2.3.1.

VERTICAL TOLERANCE: PROVIDE MINIMUM COVER BELOW CHANNEL BOTTOM AS SPECIFIED ON THE PLANS. PILOT HOLE MAY GO DEEPER IF NECESSARY TO PREVENT BREAKOUT.

2.3.2.

HORIZONTAL TOLERANCE: PLUS/MINUS 60-INCHES FROM THE CENTERLINE OF THE PRODUCT PIPE.

2.3.3.

CURVE RADIUS: NO CURVE IS ACCEPTABLE WITH A RADIUS LESS THAN 1,000-FEET.

2.3.4.

ENTRY POINT LOCATION: MAKE PILOT HOLE ENTRY POINT WITHIN PLUS/MINUS 60-INCHES OF THE LOCATION SHOWN ON THE DRAWINGS OR AS DIRECTED BY THE RESIDENT ENGINEER IN THE FIELD. ENSURE THAT ENTRY POINT LOCATION DOES NOT CONFLICT WITH RSA OR TSA BOUNDARIES.

2.3.5.

EXIT POINT LOCATION: MAKE THE EXIT POINT LOCATION WITHIN PLUS/MINUS 60-INCHES OF THE LOCATION SHOWN ON THE DRAWINGS OR AS DIRECTED BY THE CONTRACTING OFFICER IN THE FIELD. ENSURE THAT EXIT POINT LOCATION DOES NOT CONFLICT WITH THE RSA OR TSA BOUNDARIES.

2.3.6.

MANDATORY PIPELINE COVER REQUIREMENTS ARE AS SHOWN ON THE DRAWINGS OR AS SPECIFIED.
- 2.4.

GUIDANCE SYSTEM-UNLESS OTHERWISE INDICATED, WALKOVER GUIDANCE SYSTEMS ARE ACCEPTABLE FOR THIS PROJECT. IF ADDITIONAL PRECISION IS DEEMED NECESSARY, DUE TO UTILITY CROSSINGS DISCOVERED IN THE FIELD, THE RESIDENT ENGINEER MAY REQUIRE, AT HIS DISCRETION, THE USE OF A GRID SYSTEM. IF REQUIRED A MAGNETIC SURVEY TOOL LOCATOR INSTALLED BEHIND THE PILOT STRING CUTTING HEAD AND AN ELECTRIC GRID (TRU-TRACKER) SYSTEM SHALL BE USED FOR GUIDANCE.
- 2.5.

REAMING-CONDUCT REAMING OPERATIONS AT THE CONTRACTOR'S DISCRETION. DETERMINE THE TYPE OF BACK REAMER TO BE UTILIZED BY THE TYPE OF SUBSURFACE SOIL CONDITIONS THAT ARE ENCOUNTERED DURING THE PILOT HOLE DRILLING OPERATION. THE REAMER TYPE IS AT THE CONTRACTOR'S DISCRETION.
- 2.6.

PULL BACK-FULLY ASSEMBLE THE ENTIRE PIPELINE TO BE INSTALLED VIA DIRECTIONAL DRILL PRIOR TO COMMENCEMENT OF PULL BACK OPERATIONS. SUPPORT THE PIPELINE DURING PULLBACK OPERATIONS IN A MANNER TO ENABLE IT TO MOVE FREELY AND PREVENT DAMAGE. INSTALL THE PIPELINE IN ONE CONTINUOUS PULL. IN GENERAL SPLICES IN THE CONDUIT ARE NOT ALLOWED. THE CONTRACTOR MUST OBTAIN WRITTEN AUTHORIZATION FROM THE PROJECT ENGINEER TO USE ANY SPLICES. MINIMIZE TORSION STRESS BY USING A SWIVEL TO CONNECT THE PULL SECTION TO THE REAMING ASSEMBLY. MAXIMUM ALLOWABLE TENSILE FORCE IMPOSED ON THE PULL SECTION IS NOT TO EXCEED 90 PERCENT OF THE PIPE MANUFACTURER'S SAFE PULL (OR TENSILE) STRENGTH. IF THE PULL SECTION IS MADE UP OF MULTIPLE PIPE SIZE OR MATERIALS, THE LOWEST SAFE PULL STRENGTH VALUE GOVERNS AND THE MAXIMUM ALLOWABLE TENSILE FORCE IS NOT TO EXCEED 90 PERCENT OF THIS VALUE. MINIMIZE EXTERNAL PRESSURE DURING INSTALLATION OF THE PULLBACK SECTION IN THE REAMED HOLE. REPLACE DAMAGED PIPE RESULTING FROM EXTERNAL PRESSURE AT NO COST. BUOYANCY MODIFICATION IS AT THE DISCRETION OF THE CONTRACTOR.
- 2.7.

CONDUIT SPLICES AND TRANSITIONS-WHEN PLACING HDPE CONDUIT UNDERGROUND THROUGH A BORE, USE ONE CONTINUOUS LENGTH OF FLEXIBLE HDPE CONDUIT. IN INSTANCES WHERE A CONTINUOUS RUN OF CONDUIT IS NOT POSSIBLE, INDIVIDUAL SECTIONS SHALL BE JOINED USING HEAT-WELDED (FUSED) CONNECTIONS. AFTER EMERGING FROM A BORE, THE HDPE WILL TYPICALLY TERMINATE IN A MANHOLE AT BOTH ENDS, TO JOIN LENGTHS OF CONDUIT TOGETHER AFTER EMERGENCE FROM A BORE, FOLLOW THESE PROCEDURES:

2.7.1.

IF THE EMERGING HDPE CONDUIT IS TO BE JOINED TO PVC CONDUIT, THE HDPE CONDUIT SECTION SHALL BE RUN INTO THE BELL END OF THE PVC CONDUIT AND CEMENTED USING A SPECIAL TWO-PART BONDING AGENT SUCH AS *BONDUIIT CONDUIT ADHESIVE* WITH MINIMUM CONNECTION STRENGTH AS SHOWN IN TABLE 1. ADHESIVES TYPICALLY USED FOR CONNECTING PVC SEGMENTS ARE NOT OF SUFFICIENT STRENGTH FOR HDPE-TO- PVC TRANSITIONS AND SHALL NOT BE USED. ALTERNATIVELY, THE HDPE CONDUIT MAY BE CONNECTED TO A PVC COUPLING ON THE END OF A LENGTH OF PVC CONDUIT. IF THE CONNECTION IS NOT OCCURRING IN A VAULT IT SHALL ALSO BE COMPLETELY ENCASED IN A MINIMUM OF 3 INCHES OF CONCRETE.

2.7.2.

CONNECTIONS BETWEEN SECTIONS OF HDPE CONDUIT SHALL BE JOINED BY HEAT-WELDED CONNECTIONS ONLY. MECHANICAL CONNECTIONS ARE NOT ALLOWED. THE CONNECTION SHALL BE OF STRENGTH EQUAL TO OR GREATER THAN THAT OF THE ORIGINAL PIPE. ACCEPTABLE JOINING TECHNIQUES ARE BUTT, SADDLE, AND SOCKET FUSION. ELECTOFUSION IS ALSO ACCEPTABLE. THE CONTRACTOR SHALL SELECT THE METHOD OF FUSION FROM THE AFOREMENTIONED LIST, AND SUBMIT TO THE PROJECT ENGINEER DOCUMENTATION DEMONSTRATING THE STRENGTH OF THE CONNECTION.
- | TABLE 1: ADHESIVE MINIMUM PULLOUT-FORCE REQUIREMENTS FOR BONDING HDPE TO PVC CONDUIT MATERIALS. | | | |
|---|-----------------|---------------|--|
| CONDUIT DIAMETER | COUPLING LENGTH | PULLOUT FORCE | |
| 1 INCH | 2 ½ INCH | 760 LBS | |
| 1 ½ INCH | 2 ½ INCH | 1,140 LBS | |
| 2 INCH | 2 ½ INCH | 1,520 LBS | |
| 4 INCH | 3 ¾ INCH | 4,560 LBS | |
- 2.8.

FIELD QUALITY CONTROL -MAINTAIN DRILLING LOGS THAT ACCURATELY PROVIDE DRILL BIT LOCATION (BOTH HORIZONTALLY AND VERTICALLY) AT LEAST EVERY 1 FOOT ALONG THE DRILL PATH. IN ADDITION, KEEP LOGS THAT RECORD, AS A MINIMUM THE FOLLOWING, EVERY 15 MINUTES THROUGHOUT EACH DRILL PASS, BACK REAM PASS, OR PIPE INSTALLATION PASS:

2.8.1.

DRILLING FLUID PRESSURE

2.8.2.

DRILLING FLUID FLOW RATE

2.8.3.

DRILL THRUST PRESSURE

2.8.4.

DRILL PULLBACK PRESSURE

2.8.5.

DRILL HEAD TORQUE

MAKE ALL INSTRUMENTATION, READINGS, AND LOGS AVAILABLE TO THE RESIDENT ENGINEER AT ALL TIMES DURING OPERATION AND PROVIDE A COPY TO THE PROJECT ENGINEER AFTER INSTALLATION IS COMPLETE.
- 2.9.

MINIMUM DEPTHS-UNLESS OTHERWISE INDICATE THE MINIMUM DEPTHS FOR DIRECTION BORES SHALL BE AS FOLLOWS. UNDER NO CIRCUMSTANCES SHALL THE BORE PROCEED THROUGH A PAVEMENT SECTION (INCLUDING SUBBASE). MINIMUM DEPTHS APPLY AT THE EDGE OF PAVEMENT/STRUCTURE UNDER WHICH THE BORE IS OCCURRING. MAXIMUM ALLOWABLE ANGLE OF CONDUIT AT ANY POINT IS 10%. USE ENTRANCE/EXIT PITS AND/OR INCREASED SETBACKS TO ACHIEVE MINIMUM DEPTHS AT ALLOWABLE BORE ANGLES.

2.9.1.

CITY/COUNTY ROADS: 3'-0 BGS UNLESS SHALLOWER DEPTHS ARE ALLOWED BY THE OWNER.

2.9.2.

HIGHWAYS/TREEWAYS: 5'-0" BGS UNLESS SHALLOWER DEPTHS ARE ALLOWED BY THE OWNER.

2.9.3.

RAILROADS: 6'-0" BGS UNLESS SHALLOWER DEPTHS ARE ALLOWED BY THE OWNER.

2.9.4.

RIVERS/WATERWAYS: 10'-0" BELOW BOTTOM OF CHANNEL

2.9.5.

APRONS: 8'-0" BGS

2.9.6.

TAXIWAYS: 8'-0" BGS

2.9.7.

RUNWAYS: 10'-0" BGS

2.10.

CLOSEOUT ACTIVITIES-IMMEDIATELY CLEAN "BLOW HOLES" OR "BREAKOUTS" OF DRILLING FLUID TO THE SURFACE AND RETURN THE SURFACE AREA TO ITS ORIGINAL CONDITION. DISPOSE OF ALL DRILLING FLUIDS, SOILS, AND SEPARATED MATERIALS IN COMPLIANCE WITH FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS. SUBMIT AN ELECTRONIC COPY OF THE BORING RECORD TO THE PROJECT ENGINEER WITHIN FIVE DAYS AFTER COMPLETING THE PULL BACK. INCLUDE IN THE RECORD A PLAN, PROFILE, AND ALL INFORMATION RECORDED DURING THE PROGRESS OF THE WORK. CLEARLY TIE THE RECORD DRAWINGS TO THE PROJECT'S SURVEY CONTROL. MAINTAIN AND SUBMIT UPON COMPLETION SIGNED COMPLETE WORK LOGS OF GUIDED DIRECTIONAL DRILL OPERATIONS.
- I. STEEL HELICAL PIERS
1. GENERAL
- 1.1.

DESIGN-UNLESS OTHERWISE INDICATED ON THE CONSTRUCTION DRAWINGS, STEEL HELICAL PIERS SHALL BE DESIGNED AND INSTALLED TO A MINIMUM TORQUE OF 4000 FT.-LBS. INSTALLATION TORQUES BELOW THIS VALUE REQUIRE APPROVAL OF THE PROJECT ENGINEER.

1.2.

INSTALLER QUALIFICATIONS-INSTALLATION SHALL BE DONE BY AN A.B. CHANCE AUTHORIZED INSTALLATION CONTRACTOR. PROOF OF CURRENT CERTIFICATION WITH THE A.B. CHANCE COMPANY SHALL BE SUBMITTED TO THE FAA PROJECT ENGINEER PRIOR TO STARTING INSTALLATION.

1.3.

MANUFACTURING-STEEL HELICAL PIERS AS SPECIFIED SHALL BE MANUFACTURED BY A FACILITY WHOSE QUALITY CONTROL SYSTEMS COMPLY WITH ISO (INTERNATIONAL ORGANIZATION OF STANDARD) 9001 REQUIREMENTS. CERTIFICATES OF REGISTRATION DENOTING ISO STANDARDS NUMBER SHALL BE PRESENTED UPON REQUEST TO THE FAA PROJECT ENGINEER.

2.

PRODUCTS

2.1.

LISTING-THE STEEL HELICAL PIER SYSTEM SHALL BE ICBO LISTED. INSTALLING CONTRACTOR SHALL FURNISH EVIDENCE TO THE FAA PROJECT ENGINEER BY MEANS OF THE ICBO EVALUATION REPORT NUMBER ER-5110.

2.2.

PIER SHAFTS-

2.2.1.

THE 1 ½ INCH ROUND CORNERED SQUARE (RCS) SOLID STEEL SHAFTS SHALL CONFORM TO THE GENERAL REQUIREMENTS OF ASTM A29 AND THE FOLLOWING DESCRIPTIONS:

2.2.1.1.

HIGH STRENGTH LOW ALLOY (HSLA), LOW TO MEDIUM CARBON STEEL GRADE (SIMILAR TO ASTM 1530) WITH IMPROVED STRENGTH DUE TO FINE GRAIN SIZE AND STRUCTURE HAVING A TORSIONAL STRENGTH RATING OF 7,000 FT-LBS.

2.2.2.

THE 1 ¼ INCH ROUND CORNERED SQUARE (RCS) SOLID STEEL SHAFTS SHALL CONFORM TO THE GENERAL REQUIREMENTS OF ASTM A29 AND THE FOLLOWING DESCRIPTION:

2.2.2.1.

HIGH STRENGTH LOW ALLOY (HSLA), LOW TO MEDIUM CARBON STEEL GRADE (SIMILAR TO ASTM 1530) WITH IMPROVED STRENGTH DUE TO FINE GRAIN SIZE AND STRUCTURE HAVING A TORSIONAL STRENGTH RATING OF 10,000 FT-LBS.

2.3.

HELICES-CARBON STEEL SHEET, STRIP, OR PLATE FORMED ON MATCHING METAL DIES TO TRUE HELICAL SHAPE AND SHALL CONFORM THE FOLLOWING ASTM SPECIFICATIONS:

2.3.1.

5,500 FT.-LBS. 1 ½ INCH PIERS: ASTM A607, A570, OR A572 80.

2.3.2.

7,000 FT.-LBS. 1 ½ INCH PIERS: ASTM A607, A570, OR A572 80.

2.3.3.

10,000 FT.-LBS. 1 ½ INCH PIERS: ASTM A715 GRADE 80.

2.4.

BOLTS-THE SIZES AND TYPES OF BOLTS USED TO CONNECT THE HELICAL PIER EXTENSIONS TO LEAD SECTIONS OR ANOTHER EXTENSION SHALL CONFORM TO THE FOLLOWING ASTM SPECIFICATIONS:

2.4.1.

1 ½ INCH PIERS: ¾ INCH DIAMETER BOLT PER ASTM A320 GRADE L7.

2.4.2.

1 ¾ INCH PIERS: 7/8 INCH DIAMETER BOLT PER ASTM A193 GRADE B7.

2.5.

COUPLINGS-COUPLINGS WILL BE FORMED AS AN INTEGRAL PART OF (RCS) SHAFT EXTENSION MATERIAL THROUGH A FORGING PROCESS.

2.6.

FINISH-ALL MATERIAL SHALL HAVE A CLASS B-1 HOT DIPPED GALVANIZED COATING COMPLYING WITH ASTM A153.

3. EXECUTION

3.1. INSTALLATION EQUIPMENT-

3.1.1.

SHALL BE ROTARY TYPE MOTOR WITH EQUAL FORWARD AND REVERSE TORQUE CAPABILITIES. THIS EQUIPMENT SHALL BE CAPABLE OF CONTINUAL ADJUSTMENT OF THE TORQUE DRIVE UNITS' REVOLUTIONS PER MINUTE (RPM'S) DURING INSTALLATION. PERCUSSION DRILLING EQUIPMENT WILL NOT BE ALLOWED.

3.1.2.

SHALL BE CAPABLE OF APPLYING INSTALLATION TORQUE EQUAL TO THE TORQUE REQUIRED TO MEET THE PIER LOADS.

3.1.3.

EQUIPMENT SHALL BE CAPABLE OF APPLYING DOWN PRESSURE AND TORQUE SIMULTANEOUSLY.

3.2.

TORQUE MONITORING DEVICE-THE TORQUE BEING APPLIED BY THE INSTALLATION UNITS SHALL BE MONITORED THROUGHOUT THE INSTALLATION BY THE INSTALLER. THE TORQUE MONITORING DEVICE SHALL EITHER BE A PART OF THE INSTALLING UNIT OR AN INDEPENDENT DEVICE IN-LINE WITH THE INSTALLING UNIT. CALIBRATION FOR EITHER UNIT SHALL BE AVAILABLE FOR REVIEW BY THE FAA.

3.3. INSTALLATION PROCEDURES-

3.3.1.

ADVANCING SECTIONS-

3.3.1.1.

ENGAGE AND ADVANCE THE HELICAL PIER SECTIONS IN A SMOOTH, CONTINUOUS MANNER WITH THE RATE OF PIER ROTATION IN THE RANGE OF 5 TO 20 RPM.

3.3.1.2.

APPLY SUFFICIENT DOWN PRESSURE TO UNIFORMLY ADVANCE THE HELICAL SECTIONS TO APPROXIMATELY 3-INCHES PER REVOLUTION. THE RATE OF ROTATION AND MAGNITUDE OF DOWN PRESSURE MUST BE ADJUSTED FOR DIFFERENT SOIL CONDITIONS AND DEPTHS IN ORDER TO MAINTAIN THE PENETRATION RATE.

3.3.1.3.

IF THE HELICAL SECTION CEASES TO ADVANCE, REFUSAL WILL HAVE BEEN REACHED AND THE INSTALLATION SHALL BE TERMINATED.

3.3.2.

TERMINATION CRITERIA-

3.3.2.1.

THE TORQUE AS MEASURED DURING THE INSTALLATION SHALL NOT EXCEED THE TORSIONAL STRENGTH RATING OF THE STEEL HELICAL LEAD AND EXTENSION SECTIONS.

3.3.2.2.

THE MINIMUM DEPTH CRITERIA INDICATED ON THE DRAWINGS MUST BE SATISFIED PRIOR TO TERMINATING THE STEEL HELICAL PIER.

3.3.2.3.

THE TOP HELIX IS TO BE LOCATED NOT LESS THAN FIVE (5) FEET BELOW THE BOTTOM GRADE. THE PROJECT DRAWINGS MAY INDICATE A GREATER DEPTH.

3.3.2.4.

IF THE TORSIONAL STRENGTH RATING OF THE PIER AND/OR INSTALLING UNIT HAS BEEN REACHED PRIOR TO SATISFYING THE MINIMUM DEPTH REQUIRED, THE INSTALLING CONTRACTOR SHALL HAVE THE FOLLOWING OPTIONS:

3.3.2.4.1.

TERMINATE THE INSTALLATION AT THE DEPTH OBTAINED WITH THE APPROVAL OF THE FAA PROJECT ENGINEER OR

3.3.2.4.2.

REMOVE THE EXISTING PIER AND INSTALL A PIER WITH SMALLER AND/OR FEWER HELICES. THIS REVISED PIER SHALL BE TERMINATED AT LEAST THREE (3) FEET BEYOND TERMINATING DEPTH OF THE ORIGINAL PIER.

3.3.2.5.

IN THE EVENT THE MINIMUM INSTALLATION TORQUE IS NOT ACHIEVED AT MINIMUM DEPTH, THE CONTRACTOR SHALL INSTALL THE FOUNDATION DEEPER USING ADDITIONAL PLAIN EXTENSION SECTIONS.

3.3.2.6.

THE AVERAGE TORQUE FOR THE LAST THREE FEET OF PENETRATION SHALL BE USED AS A BASIS OF COMPARISON WITH THE MINIMUM RECOMMENDED INSTALLATION TORQUE. THE AVERAGE TORQUE IS THE AVERAGE OF THE LAST THREE READINGS RECORDED AT ONE FOOT INTERVALS. THIS AVERAGE TORQUE IN INTENDED SOLELY AS AN INDICATION OF THE PIER'S ULTIMATE COMPRESSION CAPACITY.

3.3.3.

INSTALLATION RECORD-
THE INSTALLER SHALL KEEP A WRITTEN INSTALLATION RECORD FOR EACH HELICAL PIER. THIS RECORD SHALL INCLUDE THE FOLLOWING INFORMATION:

3.3.3.1.

PROJECT NAME AND LOCATION

3.3.3.2.

NAME OF AUTHORIZED AND CERTIFIED DEALER AND INSTALLER.

3.3.3.3.

NAME OF INSTALLER'S FOREMAN OR REPRESENTATIVE WITNESSING THE INSTALLATION.

3.3.3.4.

DATE OF INSTALLATION.

3.3.3.5.

LOCATION OF HELICAL PIER.

3.3.3.6.

DESCRIPTION OF LEAD SECTION INCLUDING NUMBER AND DIAMETER OF HELICES AND EXTENSIONS USED.

3.3.3.7.

OVERALL DEPTH OF INSTALLATION FROM A KNOWN REFERENCE POINT.

3.3.3.8.

INSTALLATION TORQUE AT TERMINATION OF PIER.

REV	APPROVED DATE	DESCRIPTION	JCN	REDLINE DATE	APVD
DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION ATO - TECHNICAL OPERATIONS WESTERN SERVICE AREA					
PAPI SPECIFICATIONS & REQUIREMENTS PART 3 OF 3					
LIHUE			LIHUE AIRPORT		
HI			HI		
REVIEWED BY	SUBMITTED BY	DESIGNED	ISSUED BY	DATE	JCN
	ALISTIN MAXWELL	ADM	ADM	01/06/2023	1798073
			ENGINEERING SERVICES	DRAWING NO	REV
			NAVAIDS	LIH-D-PAP121-G005	

SPRLESS
STAINES
SHAWNES

EDW:lin-64-ga002-1-003.dwg

ISSUED FOR: BID

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