

PURPOSE AND SCOPE

1. THIS DRAWING PROVIDES DESIGN PARAMETERS, APPLICATION AND ORDERING INFORMATION FOR GROUNDING OF EQUIPMENT, STRUCTURES, ETC. IN ELECTRICAL STATIONS INCLUDING TRANSMISSION AND DISTRIBUTION SUBSTATIONS AND SWITCHING STATIONS
2. GROUNDING OF NON-CURRENT CARRYING METALLIC PARTS AND STRUCTURES TO LIMIT POTENTIAL GRADIENTS DURING GROUND FAULT CONDITIONS FOR PROTECTION OF PERSONNEL IN THE AREA AND MAINTAIN EQUIPMENT INTERGRITY AND RELIABILITY.
3. GROUNDING OF NEUTRALS TO STABILIZE CIRCUIT POTENTIALS WITH RESPECT TO EARTH AND PROVIDE MEANS FOR CIRCUIT RELAYING TO CLEAR GROUND FAULTS.
4. GROUNDING FOR LIGHTNING AND SWITCHING SURGE PROTECTION.

GROUND GRID SPECIFICATIONS

5. THE GROUND GRID SHALL BE BURIED 1'-6" MINIMUM BELOW UNFINISHED GRADE IN THE AREA WITHIN THE SUBSTATION SECURITY FENCE AND TERMINATED NOT LESS THAN 8 FT FROM THE FENCE. THE FENCE SHALL BE GROUNDED SEPARATELY FROM THE GRID UNLESS OTHERWISE NOTED ON THE APPROPRIATE PROJECT DRAWING. FOR FENCE GROUNDING, SEE ES 020607.
6. NEW STATION OR MAJOR STATION ADDITIONS WILL BE SPECIFICALLY ANALYZED TO DETERMINE THE APPROPRIATE GRID RESISTANCE AND GRID SPACING TO ASSURE PERSONNEL SAFETY.
7. THE GRID PERIMETER SHOULD ENCLOSE ALL ABOVE SURFACE GROUNDED METAL OBJECTS WITH AT LEAST 3 FT (6 FT PREFERRED) OUTSIDE CLEARANCE SPACING. SEE APPLICATION "S", THIS DRAWING, FOR REQUIREMENTS FOR HIGH VOLTAGE TOWERS AND POLES INSIDE STATION FENCE.
8. PERIMETER GROUND RODS ARE TO BE SPACED AT 20-30 FT APART AND AT THE CORNERS OR AS DETERMINED BY GROUNDING ANALYSIS. INTERIOR GROUND RODS SPACED 50 FT APART AND AT SPECIAL LOCATIONS.
9. 250 KCMIL MHD COPPER IS THE MINIMUM CONDUCTOR USED FOR GROUND GRIDS AND FOR CONNECTING STRUCTURES SUPPORTING HIGH VOLTAGE BUS AND EQUIPMENT TO THE GRID. USE 500 KCMIL MHD COPPER CABLE FOR FAULT DUTY EXCEEDING 35KA.
10. NO BOLTED CONNECTION IS TO BE USED ABOVE OR BELOW GROUND OR FOR TERMINATING GRID CONDUCTORS. USE APPROVED EXOTHERMIC OR APPROVED COMPRESSION CONNECTORS.

NOTES

1. FOR MATERIAL USED FOR FENCE GROUNDING, SEE ES 020607.
2. SOFT DRAWN COPPER MAY BE SUBSTITUTED FOR MHD BY EPC CONTRACTORS WITH ENGINEERING PERMISSION
3. THE AMPACITY OF 30% CONDUCTIVITY COPPERWELD 7*8 AND 19*8 CABLES ARE 10KA AND 25KA RESPECTIVELY. IF THESE CONDUCTORS ARE FOUND, THE MAXIMUM SUBSTATION FAULT DUTY SHOULD BE VERIFIED TO BE LESS THAN THESE VALUES OTHERWISE, THEY SHOULD BE REPLACED.
4. GROUND RODS ARE STEEL WITH A COPPER CLADDING. USE THE PROPER TOOLS FOR DRIVING THE GROUND ROD. IT IS IMPORTANT THAT THE COPPER CLADDING NOT BE DAMAGED TO THE EXTENT THAT THE STEEL IS EXPOSED AS THIS WILL LEAD TO CORROSION AND EVENTUAL FAILURE OF THE GROUND ROD.

REFERENCES:

GROUNDING DESIGN STANDARD DRAWING MASTER LIST	_____	DRAWING NO.	ES 067911
COPPER AND ALUMINUM POWER CONNECTORS	_____		ES 046267
ARRANGEMENT OF VOLTAGE TRANSFORMER (VT) AND COUPLING CAPACITOR VOLTAGE TRANSFORMER (CCVT).	_____		EDS 058104

7	4-16-15	CHANGED SHEETS 1, 3, 13, 15	STD	SXZO				GOD
6	9-22-14	ADDED MATERIAL CODE FOR LYNCONYTE SHEET 10	STD	SXZO				GOD
8	4-5-2021	MODIFIED SHEETS 4 & 15 AND ABSORBED BULLITEN TD-3322M-B071	STD	OEC	OCT4	OCT4	OCT4	OCT4
1	12-17-01	ISSUED FOR CONSTRUCTION	STD	RIM/MLJ		MPL		GD

REV	DATE	DESCRIPTION	JOB NO	DSG/DWN	CHKD	SUPV	APVD
REVISION 1		ENGINEERING STANDARD GROUNDING REQUIREMENTS FOR OUTDOOR ELECTRICAL SUBSTATIONS SUBSTATION ENGINEERING PACIFIC GAS AND ELECTRIC COMPANY SAN FRANCISCO, CALIFORNIA	B/M DWG LIST SUPSDS 055962 SUPSD BY SHEET NO 10F 17 SHEETS				
DSC	R MILLENA		DRAWING NUMBER REV 067910 8				
DWN	R MILLENA						
CHKD							
SUPV	M LY						
APVD							
APVD							
DATE	12-17-01						

CAD USER: RQBS DATE: 05-06-20
 VECTOR: 067910.EDS
 RASTER: NONE

APPLICATIONS:

(A). STRUCTURES:

EACH ABOVE SURFACE GROUND METAL STRUCTURE THAT SUPPORTS ENERGIZED BUS SHOULD HAVE A MINIMUM OF ONE CONNECTION TO THE GRID. MORE CONNECTIONS TO THE GRID ARE NEEDED IF:

- (1) THE STRUCTURE BASE AREA DIMENSION IS GREATER THAN 5 FT SQUARE OR SUPPORT ACTIVE DEVICES: (SWITCHES, BREAKER, ETC.), THEN TWO GROUND COPPER CONNECTIONS SHALL BE MADE ON DIAGONALLY OPPOSITE CORNERS.
- (2) STRUCTURE HAS FOUR OR MORE SEPARATE LEGS, SPACED 10FT OR MORE APART THEN EACH LEG OF STRUCTURE MUST BE CONNECTED TO THE GROUND GRID.

(B). AIR SWITCHES, CIRCUIT SWITCHERS:

PROVIDE CONTINUOUS VISIBLE BONDING CONNECTION FROM OPERATING ROD(S) TO OPERATING PLATFORM. USE 250 KCMIL COPPER CABLE FOR BONDING. (SEE FIG 3 THROUGH FIG 7, THIS DRAWING).

(C). POWER TRANSFORMERS:

FOR 3-PHASE TRANSFORMER NEUTRALS (H0, X0), USE ONE GROUND CONNECTION PER BUSHING. FOR 4-WIRE SYSTEMS NEUTRAL, SEE APPLICATION "E". FOR SINGLE AND 3-PHASE TRANSFORMER CASE GROUNDS, USE TWO GROUND CONNECTIONS PER TRANSFORMER PLACED ON DIAGONALLY OPPOSITE CORNERS FOR TANK GROUNDING.

(D). NEUTRAL BUS FOR SINGLE PHASE EQUIPMENT:

NEUTRALS FOR BANKS OF SINGLE-PHASE TRANSFORMERS OR REGULATORS SHALL BE MADE UP SEPARATELY FROM THE GROUND GRID - ON A NEUTRAL BUS MOUNTED ON INSULATORS - AND CONNECTED TO THE GRID ON ONE END WITH TWO GROUND CABLES. IN A MULTI-BANK INSTALLATION, NO MORE THAN TWO BANKS SHALL BE CONNECTED TO SAME NEUTRAL BUS AND THE CONNECTION TO THE GROUND GRID SHALL BE MADE AT A MID-POINT BETWEEN THE BANKS. ALL NEUTRAL BUSHINGS SHALL BE CONNECTED TO THE NEUTRAL BUS UNLESS OTHERWISE SPECIFIED ON ARRANGEMENT DRAWINGS, AND THE APPROPRIATE NOTE SO SPECIFIES.

(E). FOUR WIRE DISTRIBUTION:

USE TWO 250 KCMIL COPPER CABLES FROM TRANSFORMER LOW VOLTAGE NEUTRAL (X0) TO GROUND GRID (SEE FIG 19, THIS DRAWING) AND FROM FEEDER TERMINATION STRUCTURE TO GROUND GRID (SEE FIG 17, THIS DRAWING). THE TWO CABLES SHALL BE ROUTED IN SEPARATE TRENCHES TO DIFFERENT POINTS ON THE GROUND GRID.

(F). POWER CIRCUIT BREAKER (PCB'S), HIGH VOLTAGE CIRCUIT BREAKERS (HVCB'S)

TWO GROUND CONNECTIONS FOR SKID MOUNTED PCB'S OR PER TANK FOR NON-SKID MOUNTED BREAKERS. FRAME MOUNTED BREAKERS SHALL HAVE TWO GROUND CONNECTIONS TO STATION GRID. THE TWO CABLES SHALL BE PLACED ON DIAGONALLY OPPOSITE CORNERS. ONE #1/0 COPPER CONNECTION TO TERMINAL LUG OF HVCB STRUCTURE AND MAKE CONNECTIONS TO THE THRU BOLT OF THE GROUND BUS ON THE BOTTOM OF THE CABINET. SEE FIG.11 THIS DRAWING. FOR BONDING OF BUSHING POTENTIAL DEVICES, SEE FIG. 29.

(G). REGULATORS:

THREE-PHASE REGULATORS SAME REQUIREMENTS AS OUTLINED IN APPLICATION "C", EXCEPT FOR 3-PHASE STEP REGULATORS OPERATING AT VOLTAGES 23KV AND BELOW, WILL BE OPERATED WITH THE NEUTRAL UNGROUNDED. FOR SINGLE-PHASE REGULATORS, SEE APPLICATION "D" AND "E". FOR SINGLE PHASE REGULATOR CASE GROUND, SEE APPLICATION "C".

(H). CARRIER COUPLING CAPACITORS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS (CCVT):

TWO GROUND CONNECTIONS TO COMBINATION GROUND TERMINAL AND CASE GROUND. (SEE FIG 23 AND FIG 24, THIS DRAWING). REFER TO EDS 058104 FOR ADDITIONAL GROUNDING INFORMATION.

(I). POTENTIAL DEVICES/ VOLTAGE TRANSFORMERS:

ONE GROUND CONNECTION TO COMBINATION GROUND TERMINAL AND CASE GROUND. FOR OTHER VOLTAGE TRANSFORMER GROUNDING, (SEE FIG 25 AND FIG 26, THIS DRAWING). REFER TO EDS 058104 FOR ADDITIONAL GROUNDING INFORMATION.

(J). POWER CAPACITORS, SHUNT CAPACITOR BANKS AND AIR CORE REACTORS:

AIR CORE REACTORS AND CAPACITOR HOUSING OR SUPPORTING STEEL RACKS SHALL HAVE TWO GROUND CONNECTIONS TO THE GRID, (SEE FIG 10, FIG 16 AND FIG 22, THIS DRAWING).

PENINSULA GROUNDING SYSTEM IS REQUIRED FOR TRANSMISSION SHUNT CAPACITOR BANKS. FOR PENINSULA GROUNDING, THE GROUND CONDUCTORS ARE ELECTRICALLY CONNECTED TO THE MAIN STATION GROUND GRID AT ONLY ONE POINT AND TOTALLY ISOLATED FROM ALL FENCES, FENCE GROUNDS AND THE STATION GROUND GRID EXCEPT AT ONE POINT OF INTERCONNECTION. USE TWO (2) 500 KCMIL COPPER CABLES FOR 60KV THROUGH 230KV AND THREE (3) 500 KCMIL COPPER CABLES FOR 500KV SYSTEMS TO INTERCONNECT TO THE STATION GRID AND EXTEND THE CONDUCTORS INTO THE CAPACITOR GROUND GRID AREA. (SEE FIG 2, THIS DRAWING). EACH CAPACITOR STEP IS INDIVIDUALLY FENCED. THIS GUARD FENCE SHOULD BE SEPARATED FROM THE MAIN GROUNDING GRID AND ALL OTHER EQUIPMENT BY AT LEAST 10 FEET, AND MAY JOIN ADJACENT CAPACITOR GUARD FENCE OF ANOTHER STEP IN THE SAME CAPACITOR BANK GROUP. CAPACITOR GUARD FENCE SHALL NOT BE CONNECTED TO THE CAPACITOR GROUND GRID EXCEPT TO IT'S OWN GROUND RODS. CABLE PASSING UNDER CAPACITOR GUARD FENCE SHALL BE ISOLATED FROM FENCE BY PLACING CABLE IN 20 FEET LONG, 2" PVC PLASTIC CONDUIT. (SEE FIG 2, THIS DRAWING).

(K). STEEL CONDUITS, JUNCTION BOXES, CABLE TRAYS AND RECEPTACLES (OUTDOOR):

MUST BE BONDED TO STRUCTURE GROUND WITH ONE #4 AWG COPPER CABLE.

(L). LOW VOLTAGE POTENTIAL TRANSFORMERS, STATION SERVICE TRANSFORMERS, DISTRIBUTION PANELS AND EQUIPMENT INDOORS:

ONE #4 AWG COPPER CABLE CONNECTION TO STRUCTURE GROUND. THE SIZE OF THE CABLE WOULD HAVE TO INCREASE IF THE FAULT DUTY AT THE DEVICE EXCEEDS ITS RATING. FOR STATION SERVICE TRANSFORMERS NORMALLY SUPPLIED FROM TRANSMISSION TRANSFORMER BANK TERTIARY, THE MINIMUM GROUND CABLE IS 250 KCMIL CU

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(M). METER AND RELAY CABINETS (SCADA) ETC:

ONE #1/0 COPPER CABLE CONNECTION TO MAIN GROUND GRID AND VIA THRU BOLT AND 1-HOLE TERMINAL CONNECTORS MAKE CONNECTIONS TO THE SIDE OF THE CABINET AND THE GROUND BUS INSIDE THE CABINET.

(N). CONTROL BUILDING AND BATTERY ROOM:

USE TWO 250 KCMIL COPPER CABLES FROM THE OPPOSITE CORNERS OF THE BUILDING TO THE MAIN SWITCHBOARD COPPER GROUND BUS BAR AND TIE TO SURROUNDING GROUND GRID. (SEE FIG 1, THIS DRAWING). ALL BUILDING STRUCTURES SHOULD BE LOCATED AT A MINIMUM OF 11FT AWAY FROM STATION FENCE. FOR METALLIC BUILDING, (SEE APPLICATION "U", THIS DRAWING). FOR BATTERY ROOM GROUNDING REQUIREMENTS, REFER TO EDS 4018144, "TYPICAL INSTALLATIONS OF BATTERIES AND RACKS".

(O). LIGHTING STANDARDS:

ALL LIGHTING STANDARDS SHOULD BE LOCATED INSIDE THE GROUND GRID PERIMETER . USE ONE #1/0 COPPER CABLE CONNECTION TO GROUND GRID. FOR ADDITIONAL INFORMATION, REFER TO EDS 459076, "LIGHTING FIXTURE ASSEMBLY & MOUNTING DETAILS".

(P). FENCE GROUNDING:

REFER TO ES 020607 - "METHOD OF GROUNDING FENCES".

(Q). PULL BOXES:

IT IS NOT NECESSARY TO GROUND CABLE SUPPORTS OR COVER PLATE SUPPORTS IN PULL BOXES. REFER TO FIGURE 30 - DISTRIBUTION UNDERGROUND PRIMARY ENCLOSURE WITH METALLIC COVER.

(R). LIGHTNING OR SURGE ARRESTERS:

ARRESTERS MOUNTED ON TRANSFORMERS SHALL BE GROUNDED WITH ONE GROUND CONNECTION DIRECTLY TO GROUND ROD NEAR THE TRANSFORMERS AND THEN CONTINUING THE CABLE TO GROUND GRID. (SEE FIG 20, THIS DRAWING). FOR FREE STANDING ARRESTERS, (SEE FIG 21, THIS DRAWING). MAKE GROUND CONNECTIONS DIRECT TO THE GRID WITH THE LEAST AMOUNT OF SHARP BENDS.

(S). HIGH VOLTAGE TOWERS AND POLES INSIDE STATION FENCE:

- I) IF INSIDE PERIMETER GROUND, TIE TO GROUND GRID, (SEE APPLICATION A).
- II) IF OUTSIDE PERIMETER GROUND, TOWER MUST BE LOCATED 8 FT AWAY FROM THE GRID AND 8 FT AWAY FROM THE FENCE AND GROUND PER TRANSMISSION LINE STANDARDS.
- III) IF OUTSIDE PERIMETER GROUND AND 8 FT CLEARANCE CANNOT BE MAINTAINED, CONTACT ENGINEERING FOR SPECIFIC GROUND GRID DESIGN.
- IV) GUYS SHALL BE LOCATED INSIDE THE FENCE. DO NOT GROUND ANCHOR GUYS. MINIMUM DISTANCE FROM GROUND WIRE TO GUY BOLT OR GUY WIRE IS 6". INSTALL TWO INSULATOR BOBS IN THE GUY WIRE 8' MINIMUM ABOVE GROUND AND 8' MINIMUM FROM POLE.

(T). SYNCHRONOUS CONDENSERS, SERIES CAPACITORS AND STATIC VAR COMPENSATION EQUIPMENT:

THESE EQUIPMENT WILL HAVE THEIR OWN INDIVIDUAL DESIGNED GROUNDING STANDARDS BASED UPON THE MANUFACTURERS' RECOMMENDATIONS.

(U). METALLIC BUILDINGS LOCATED OUTSIDE THE MAIN GROUND PERIMETER (NOT APPLICABLE TO CONTROL BUILDING AND BATTERY ROOM):

INSTALL 250 KCMIL COPPER GROUND RING AROUND THE OUTSIDE OF THE BUILDING AND BOND TO THE BUILDING METAL STUDS AT OPPOSITE CORNERS WITH 250 KCMIL COPPER CABLE. THE GROUND RING SHOULD BE LOCATED 3 FT AWAY FROM THE BUILDING. (SEE FIG 1, DETAIL -A, THIS DRAWING).

(V). GROUND WELL:

USE AS A MEANS TO LOWER OVERALL RESISTANCE (TO REMOTE EARTH) OF A GROUND GRID SYSTEM WHEN IT IS DIFFICULT TO LOWER THE RESISTANCE BY EXPANDING THE GRID ALONG A HORIZONTAL PLANE AS INDICATED BY SPECIFIC GROUNDING ANALYSIS RECOMMENDATIONS. SEE FIGURE 28 THIS DRAWING.

(W). EXISTING GROUND GRID CONNECTIONS:

CONNECTIONS FROM EXISTING GROUND GRID TO NEW GROUND GRID CONDUCTORS SHOULD BE MADE WITH "HEAVY DUTY" EXOTHERMIC MOLDS OR APPROVED COMPRESSION CONNECTORS AS SHOWN ON SHEETS 12-14.

(X). HANDRAILS:

METALLIC HANDRAILS, INCLUDING HANDRAILS ON STAIRWAY TO MPAC BUILDINGS, LOCATED INSIDE THE SUBSTATION GRID PERIMETER MUST BE GROUNDED. CONNECT EVERY OTHER HANDRAIL POST WITH ONE #1/0 COPPER CABLE TO THE MAIN GROUND GRID. (SEE FIG 1, DETAIL - B, THIS DRAWING)

(Y). FIRE ALARM CONTROL PANEL AND FIRE SUPPRESSION SYSTEM:

MUST BE BONDED TO SWITCHBOARD COPPER GROUND BUS OR 250 KCMIL COPPER CABLE WITHIN THE CABLE TRAY IN THE BUILDING WITH ONE #4 AWG COPPER CABLE

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(Z). REQUIREMENTS DUE TO ATMOSPHERIC CONDITIONS APPLICABLE TO THE GEYSERS POWER PLANTS ONLY

4.1 THE EQUIPMENT BEING SPECIFIED WILL BE INSTALLED IN AN ATMOSPHERE THAT IS HIGHLY CORROSIVE TO COPPER AND COPPER BEARING ALLOYS AND IN LESSER DEGREE TO SILVER. ALUMINUM IS NOT AFFECTED BY THIS CONDITION. THIS CORROSION IS CAUSED BY THE HIGH HYDROGEN SULFIDE (H₂S) CONTENT IN THE AIR, COPPER WIRE, CABLE, BUS CONDUCTORS, FUSES, FUSE BLOCKS, KNIFE SWITCHES, AND TERMINAL LUGS SHALL BE TINNED. COPPER AND COPPER ALLOY PARTS SHALL BE TINNED OR COVERED WITH A PERMANENT PROTECTIVE COATING THAT IS EFFECTIVE AGAINST HYDROGEN SULFIDE. EXPOSED SILVER-COATED SURFACES SHALL BE COVERED WITH A PERMANENT PROTECTIVE COATING THAT IS EFFECTIVE AGAINST HYDROGEN SULFIDE. THIS COATING SHALL NOT AFFECT THE ELECTRICAL FUNCTIONS OF THE ITEMS PROTECTED.

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	SHEET 4 OF SHEETS	067910	8
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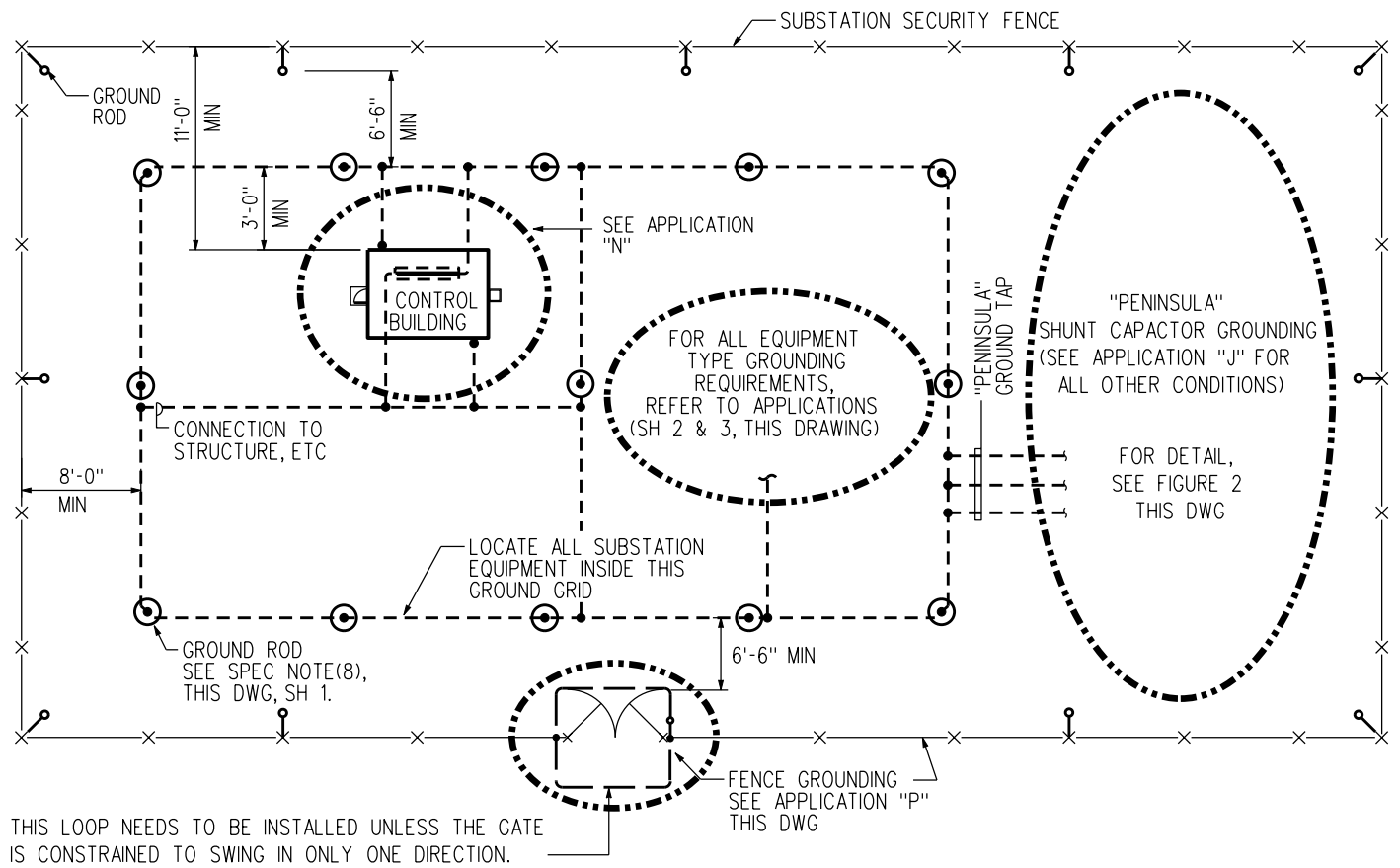
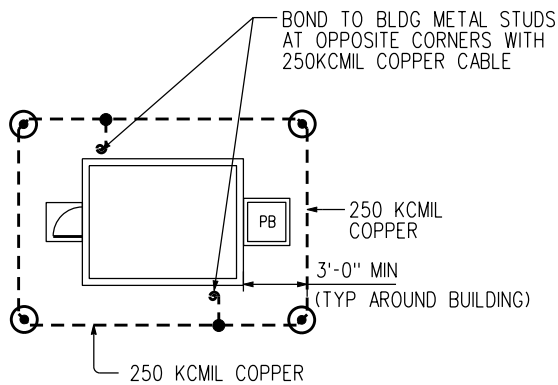


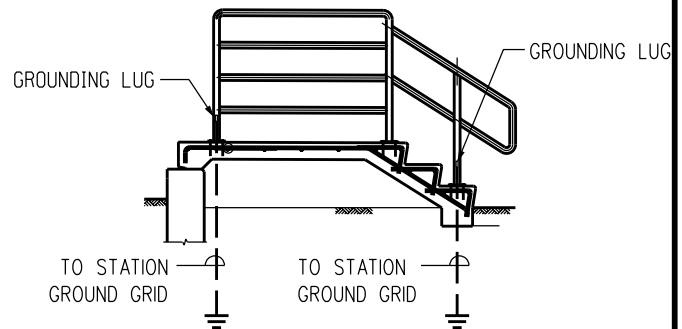
FIGURE 1

TYPICAL ARRANGEMENT OF GROUND GRID
(SEE GROUND GRID SPECIFICATIONS, THIS DRAWING)



DETAIL-A

TYPICAL GROUNDING FOR METALLIC BUILDING
OUTSIDE OF THE GRID



DETAIL-B

TYPICAL GROUNDING FOR METALLIC HANDRAILS

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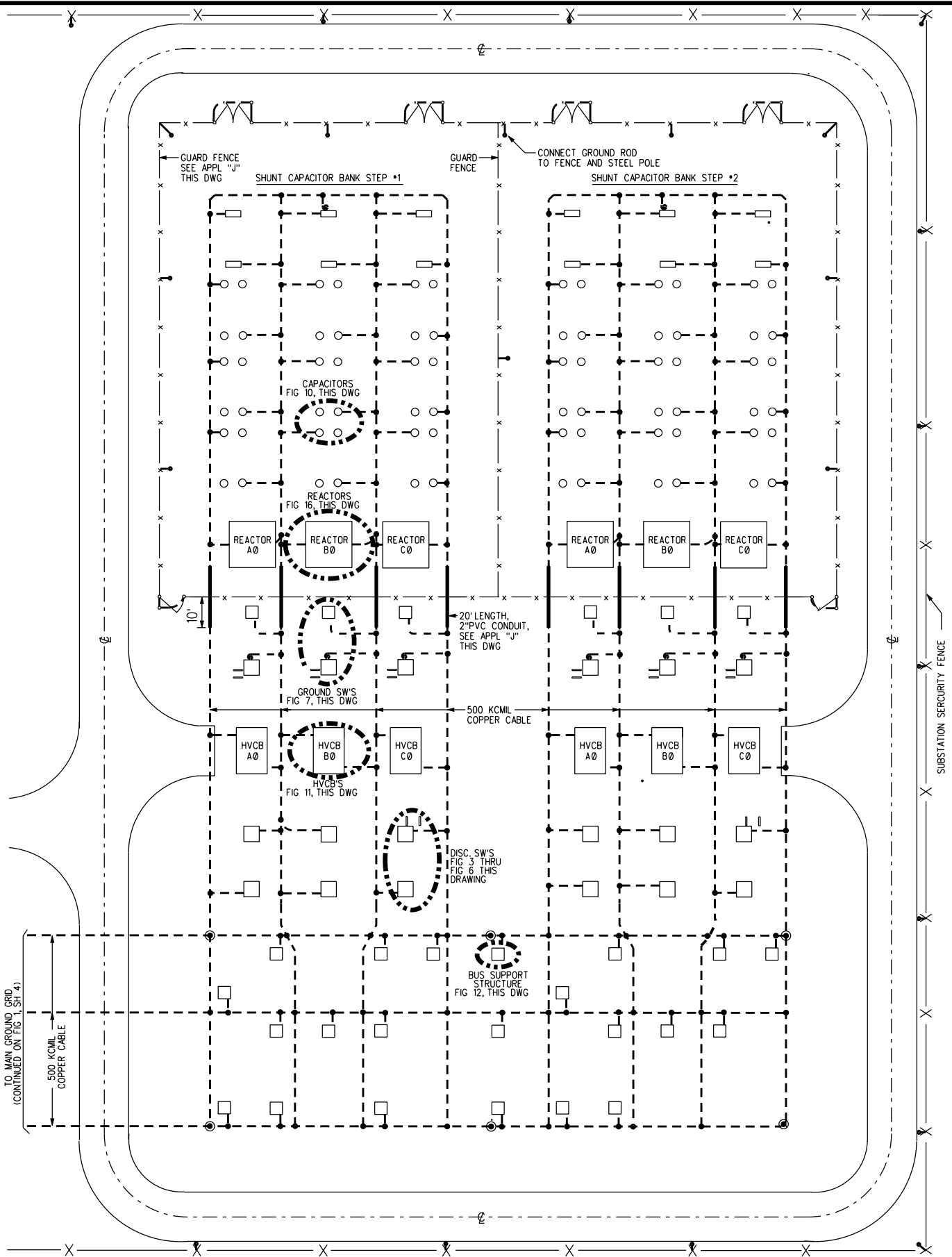


FIGURE 2

TYPICAL GROUNDING ARRANGEMENT FOR 2 STEPS 500KV, SHUNT CAPACITOR BANKS
(SEE APPLICATION "J" FOR ALL OTHER CONDITIONS)

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		MICROFILM	

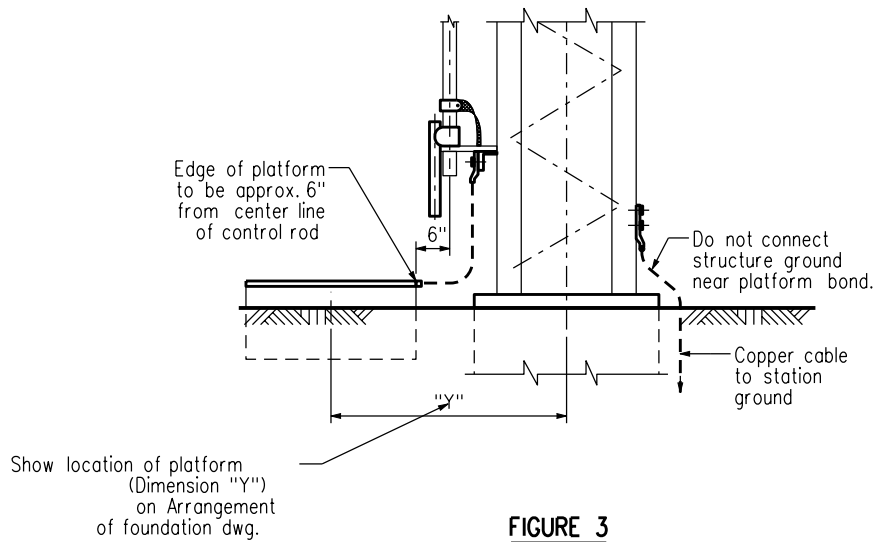


FIGURE 3
GROUNDING FOR TYPICAL
STEEL STRUCTURE INSTALLATION

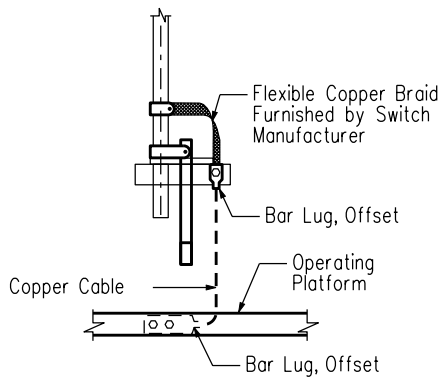


FIGURE 4
GROUNDING & BONDING ARRANGEMENT
FOR ONE SWITCH

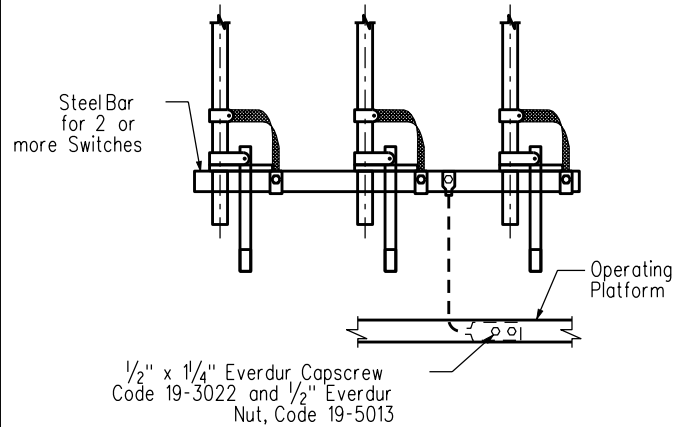


FIGURE 5
GROUNDING & BONDING ARRANGEMENT
FOR TWO OR MORE SWITCHES

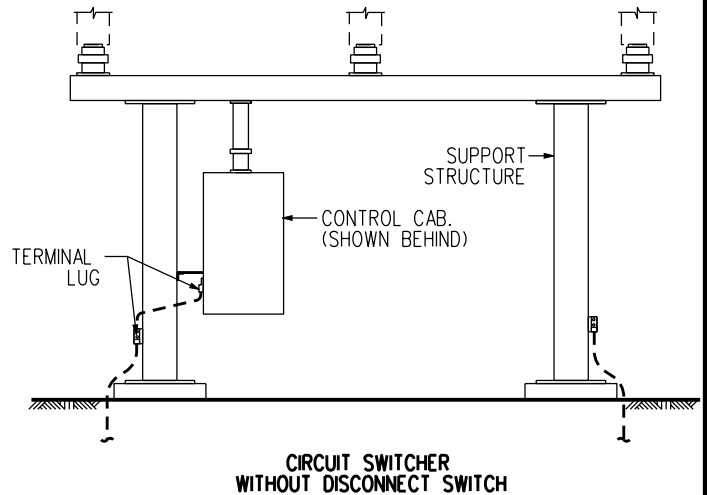
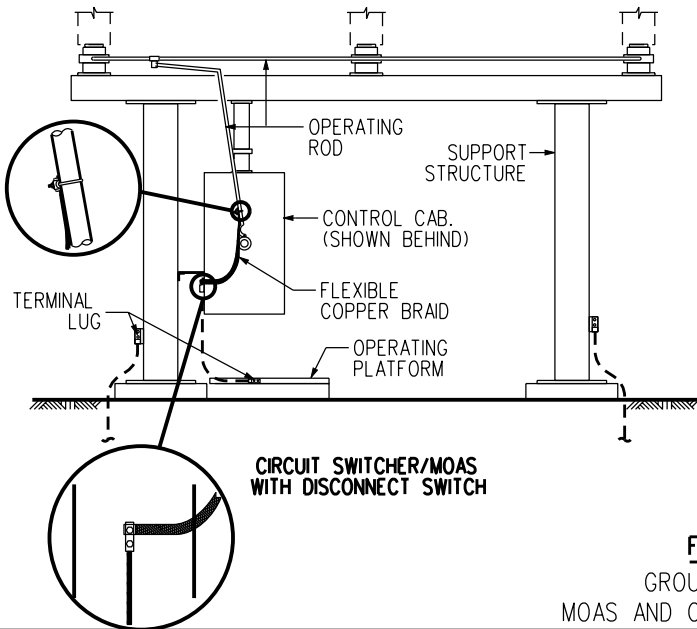


FIGURE 6
GROUNDING FOR
MOAS AND CIRCUIT SWITCHERS

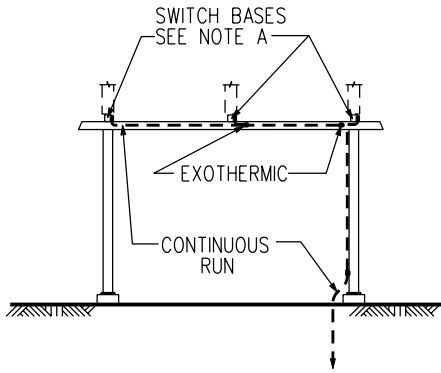
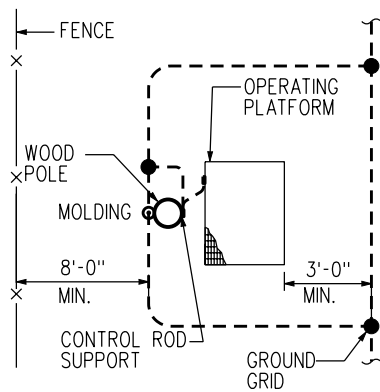


FIGURE 7

GROUNDING OF GROUND SWITCHES

NOTES

(A) CONNECTION TO SW BASES AND STRUCTURE LISTED ON APPROPRIATE BILL OF MATERIALS.

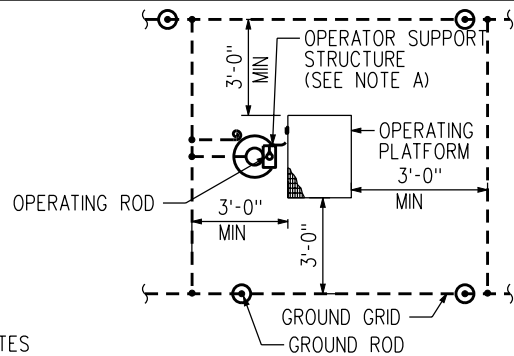


NOTES

SEE APPLICATION "S"-IV, SUBSTATION APPLICATION ONLY.

FIGURE 8

GROUNDING AIR SWITCH WITH FIBERGLASS CONTROL ROD ON WOOD POLE



NOTES

(A) GROUND PAD ON OPERATOR SUPPORT STRUCTURE SHALL BE LOCATED AS SHOWN
 (B) FOR BONDING OF PLATFORM, (SEE FIG 5, THIS DRAWING)
 (C) IF GROUND SW IS USED, RUN ONE GROUND CONDUCTOR FROM GRID TO SW BASE, (SEE FIG 7, THIS DRAWING)

FIGURE 9

GROUNDING OF OPERATOR SUPPORT STRUCTURE

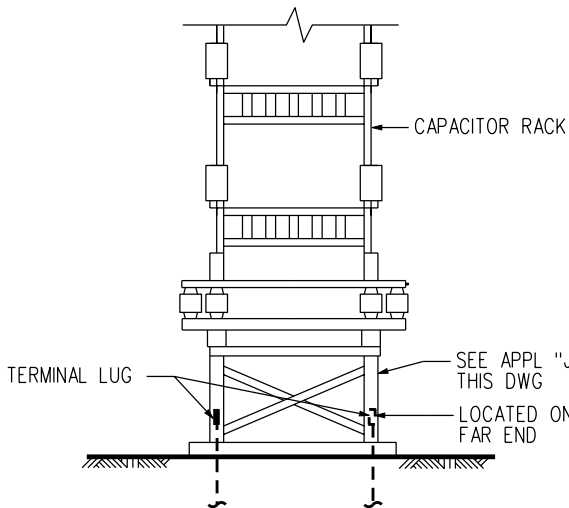


FIGURE 10

GROUNDING FOR SHUNT CAPACITOR BANKS

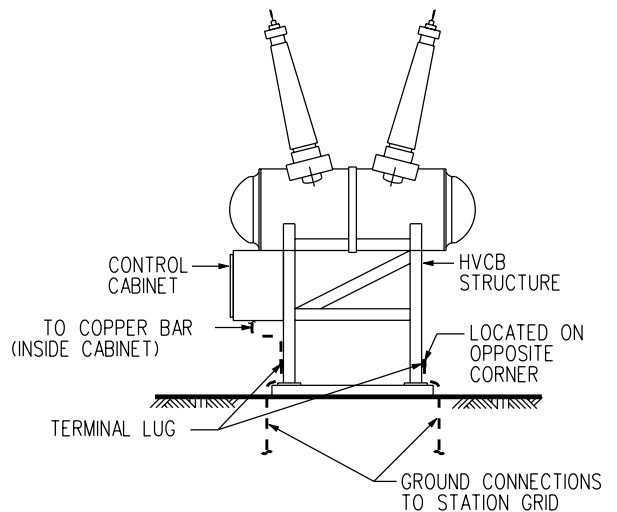


FIGURE 11

GROUNDING OF HIGH VOLTAGE CIRCUIT BREAKERS

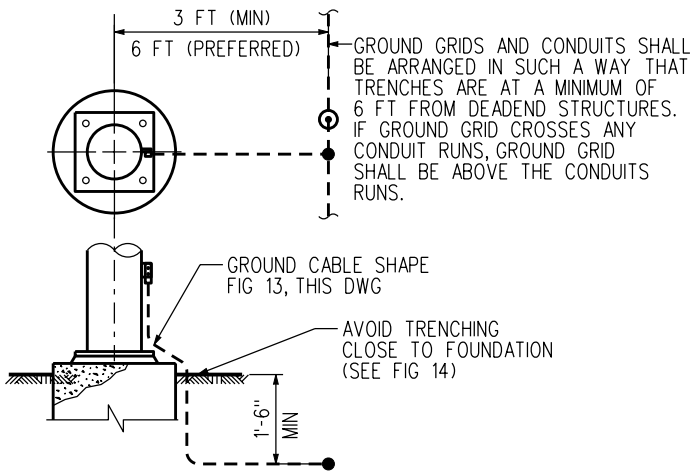


FIGURE 12

GROUNDING DEADEND (TENSION) STRUCTURE.

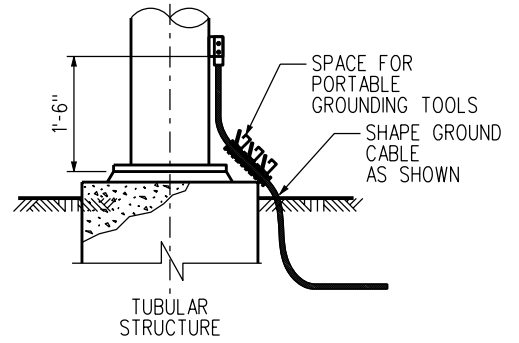


FIGURE 13

PROVISION FOR ATTACHING PORTABLE GROUND TOOLS

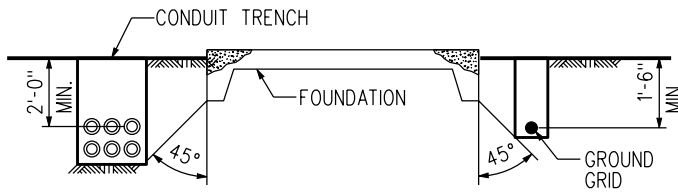
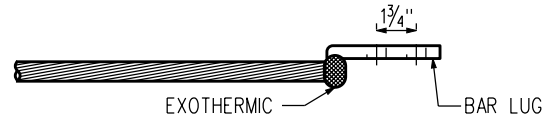


FIGURE 14

FOUNDATION CLEARANCES (MINIMUM DISTANCE OF TRENCH PARALLEL WITH FOUNDATION FOR TRANSFORMERS, HVCB'S, ETC.)



PREFERRED TERMINATION FOR COPPER CABLE ABOVE GROUND AS SHOWN. USE ALLOY HARDWARE ("EVERDUR" OR "DURIUM" TYPE) FOR ALL CONNECTIONS TO STRUCTURES AND EQUIPMENT.

FIGURE 15

TYPICAL DETAIL OF AN EXOTHERMIC CONNECTION

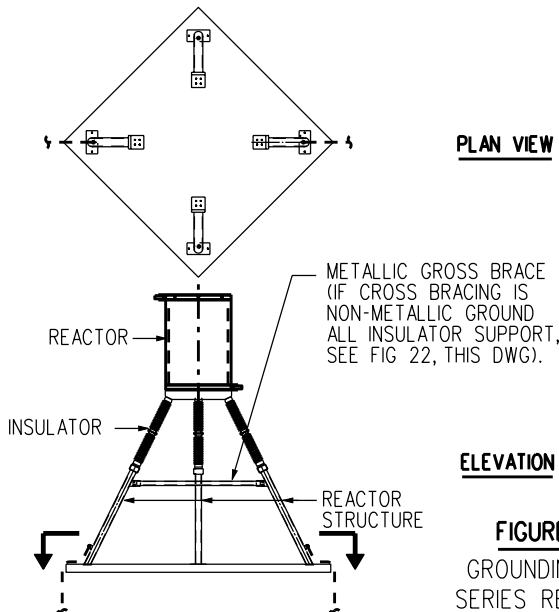


FIGURE 16

GROUNDING FOR SERIES REACTORS

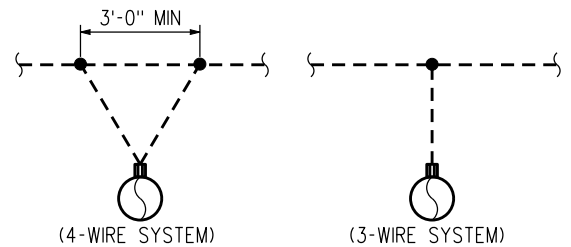


FIGURE 17

STRUCTURE FOR UNDERGROUND FEEDER TERMINATION OR NEUTRAL CURRENT LIMITING REACTOR

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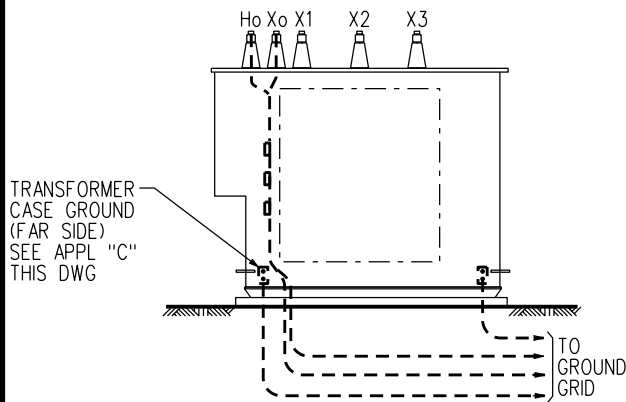


FIGURE 18
GROUNDING OF TRANSFORMER
(3-WIRE SYSTEM)

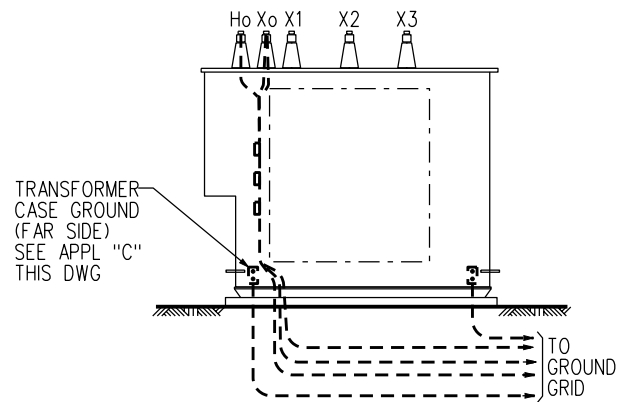


FIGURE 19
GROUNDING OF TRANSFORMER
(4-WIRE SYSTEM)

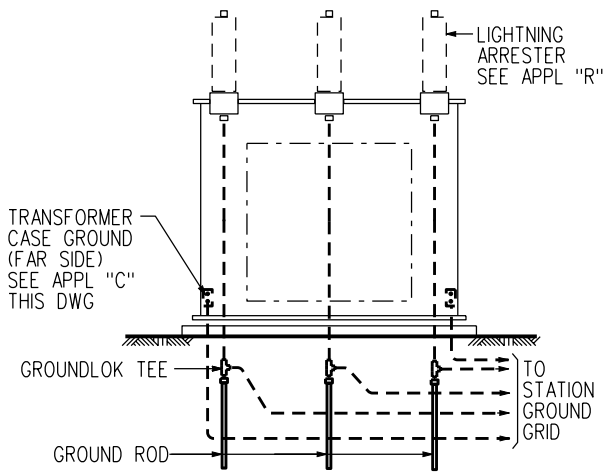


FIGURE 20
TRANSFORMER WITH LIGHTNING ARRESTER

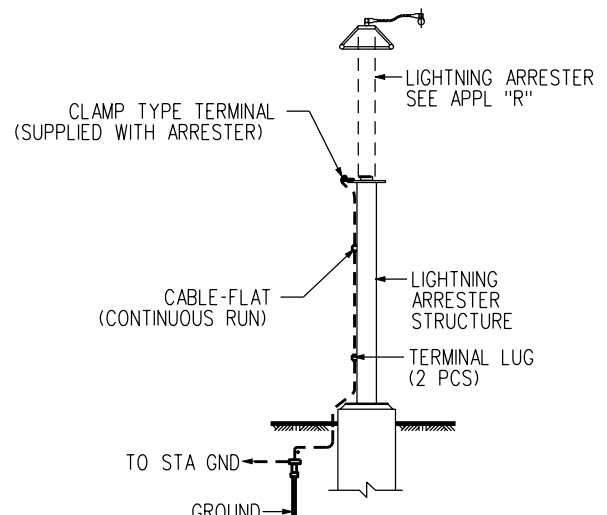


FIGURE 21
GROUNDING FOR FREE STANDING
LIGHTNING ARRESTERS

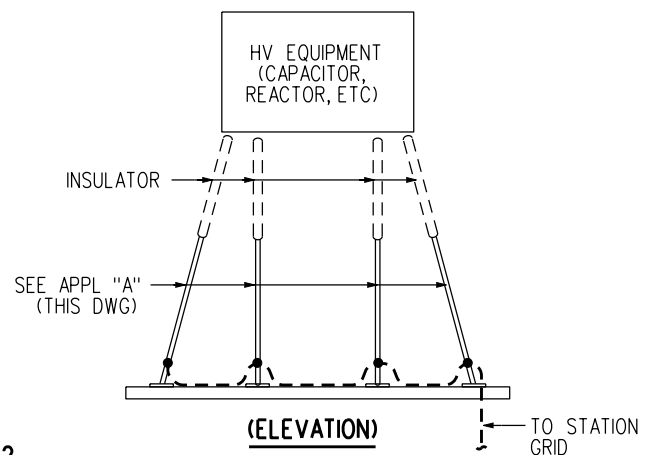
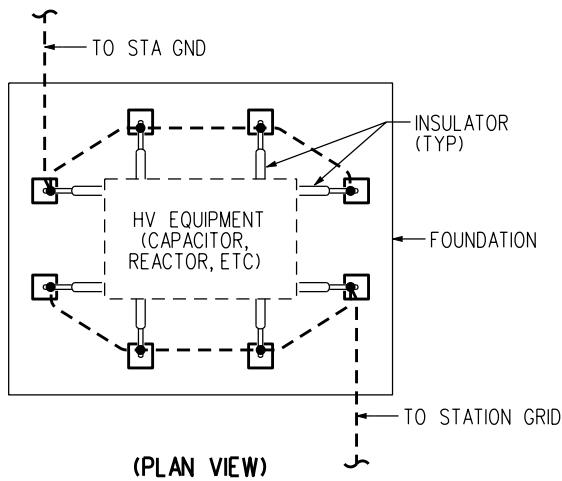


FIGURE 22
GROUNDING FOR STRUCTURES
WITH MULTIPLE INSULATOR BASES
WITH NO CROSS METALLIC BRACING SUPPORT

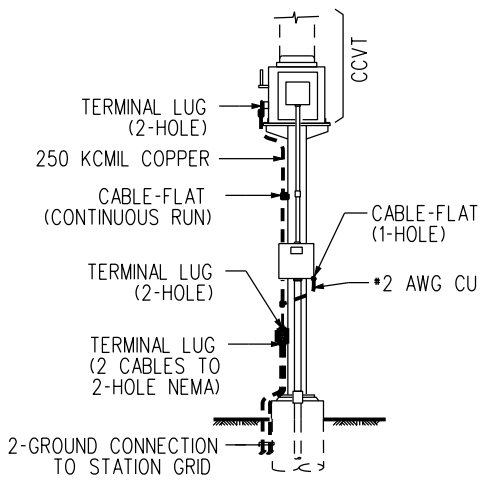


FIGURE 23

GROUNDING FOR 1-UNIT CCVT ON ONE STRUCTURE

NOTE:
REFER TO APPL "H"
FOR MORE INFORMATION

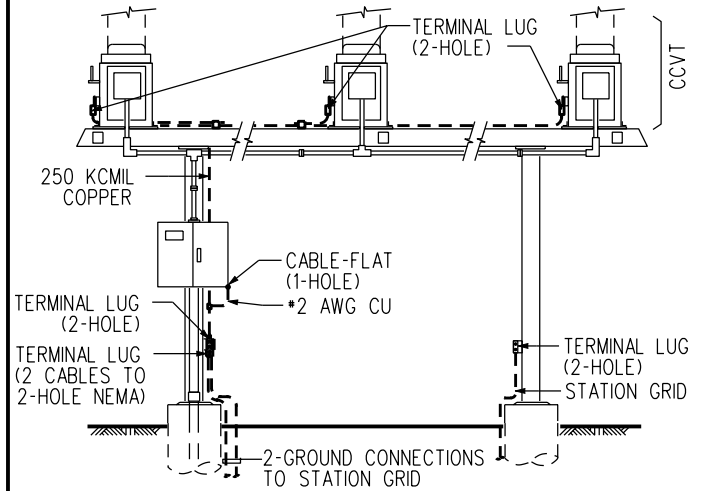


FIGURE 24

GROUNDING FOR 3-UNIT CCVT'S ON ONE STRUCTURE

NOTE:
REFER TO APPL "H"
FOR MORE INFORMATION

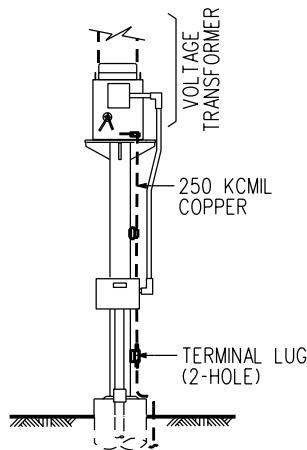


FIGURE 25

GROUNDING FOR 1-UNIT
VOLTAGE TRANSFORMER ON ONE STRUCTURE

NOTE:
REFER TO APPL "I"
FOR MORE INFORMATION

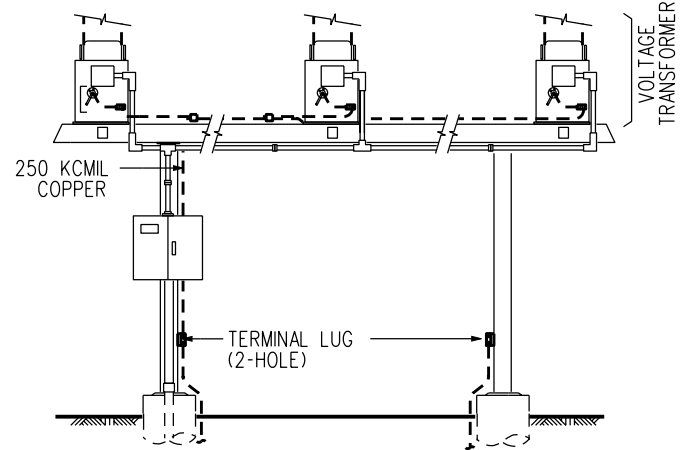


FIGURE 26

GROUNDING FOR 3-UNIT
VOLTAGE TRANSFORMERS ON ONE STRUCTURE

NOTE:
REFER TO APPL "I"
FOR MORE INFORMATION

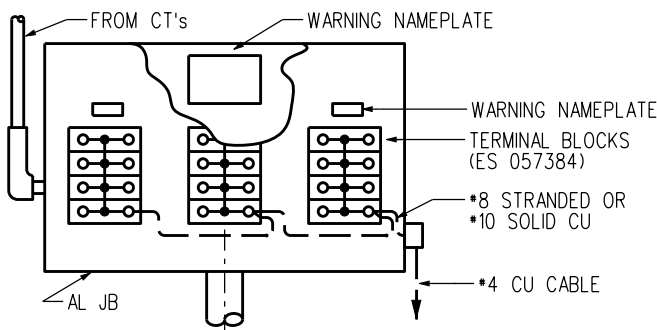


FIGURE 27

GROUNDING REQUIREMENTS FOR TERMINATING
SECONDARIES OF CURRENT TRANSFORMERS
(JUNCTION BOX APPLICATION SINGLE RATIO CT TERMINAL BLOCK SHOWN)

NOTE:
1. ALL CURRENT TRANSFORMERS INSTALLED ON SUBSTATION BUSES OR ADDED TO CIRCUIT BREAKERS, POWER TRANSFORMERS, ECT. SHALL HAVE ALL SECONDARY WINDINGS SHORT CIRCUITED AND GROUNDING WHEN NOT IN USE.
2. CONNECT THE *8 OR *10 GROUND WIRE FOR UNLOADED CT'S AND REMOVE THE GROUND WIRE FOR LOADED CT'S.

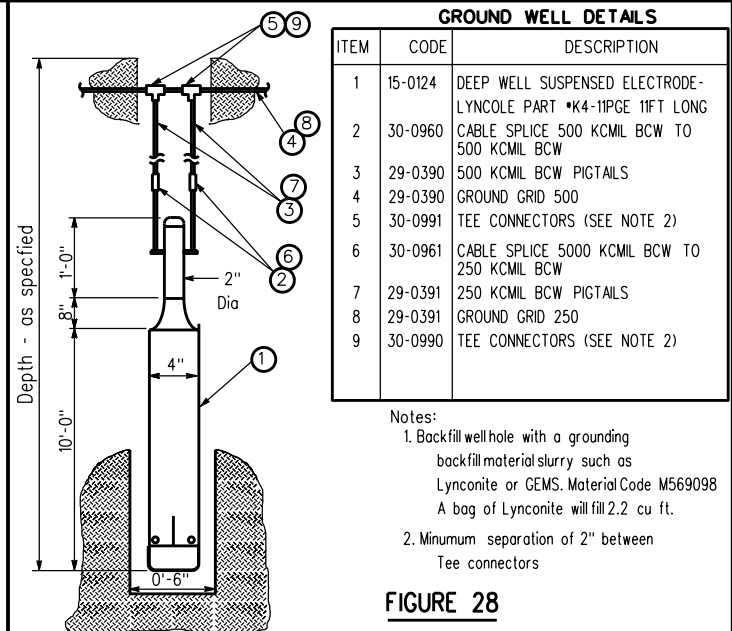


FIGURE 28

ENGINEERING STANDARD

GROUNDING REQUIREMENTS FOR OUTDOOR
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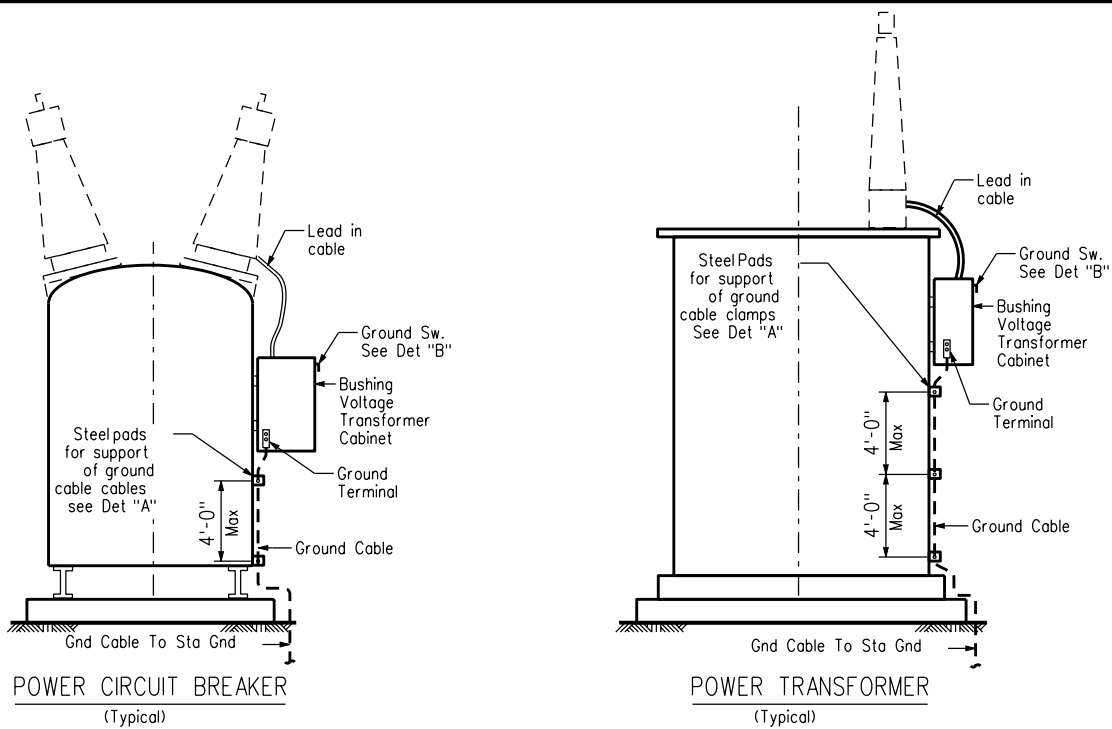
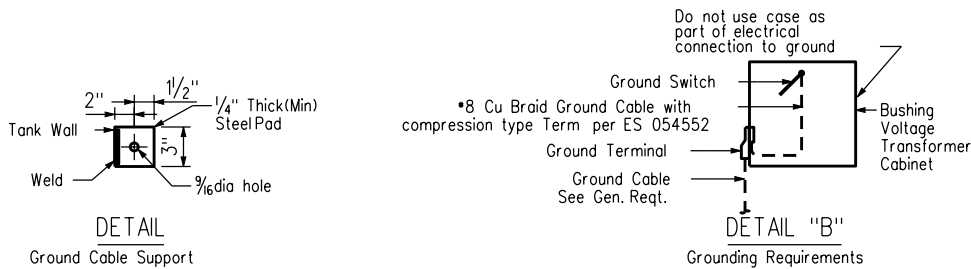


FIGURE 29

(Grounding for Bushing Voltage Transformer)



GENERAL REQUIREMENTS

Each Power Circuit Breaker or Power Transformer having a bushing Voltage Transformer on the tank shall have the Voltage Transformer provided with a separate ground lead, independent of the Breaker Frame or Transformer Case grounding leads.

Multiple voltage Transformers on one unit can have their grounding leads bussed together in convenient runs, i.e., for a breaker with 6 voltage transformers, the 3 on each side can be bussed to a separate single tie into the ground bus and possibly follow the inter voltage Transformer conduit run.

The ground cable shall be supported as shown on this dwg. The grounded end of the ground switch of the Voltage Transformer shall be electrically connected to the ground terminal on the cabinet. (See Detail "B"). When adding Voltage Transformers to existing installation, provide an independent ground lead from the Voltage Transformer or group of Voltage Transformers and connect to the nearest exposed station ground cables.

This sheet supersedes EDS 102825 "Requirements For Grounding Bushing Voltage Transformer" .

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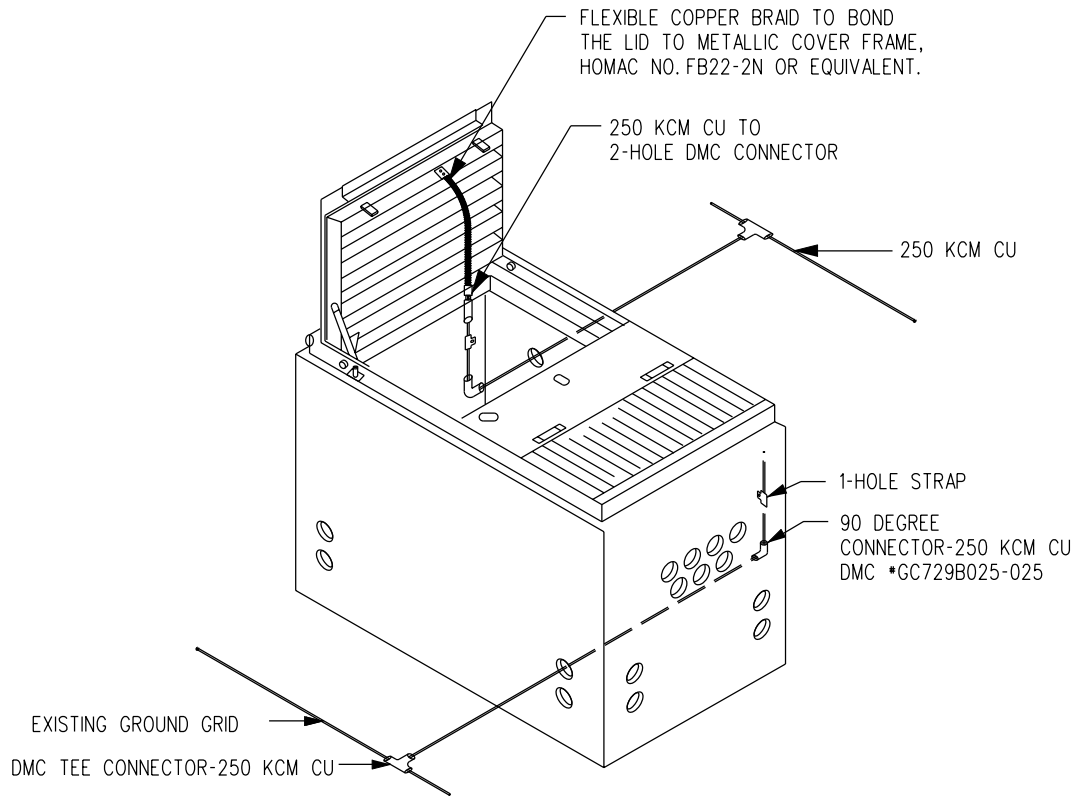


FIGURE 30
DISTRIBUTION UNDERGROUND PRIMARY ENCLOSURES WITH METALLIC COVER

TYPICAL MATERIALS TO BE USED: (TO BE LISTED ON ARRANGEMENT OF GROUNDING BILL OF MATERIALS)

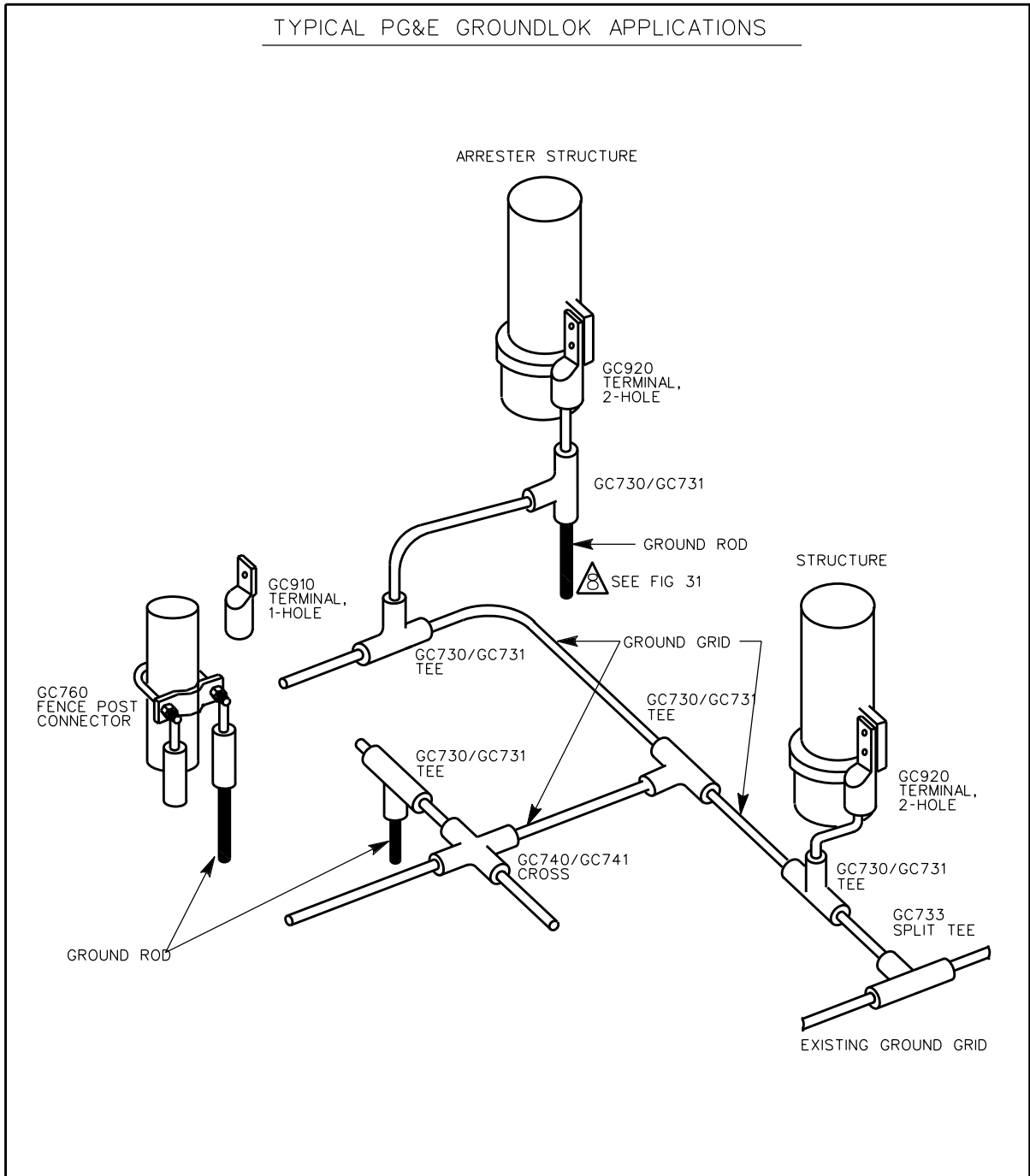
CODE	DESCRIPTION	REMARKS
29-0394	CABLE ELECTRICAL BARE COPPER 4 AWG MEDIUM HARD DRAWN 7 STRAND .129 LBS/FT 600 LBS PER REEL.	(SEE APPLICATIONS, THIS DRAWING)
29-0392	CABLE ELECTRICAL BARE COPPER 1/0 AWG MEDIUM HARD DRAWN 7 STRAND .326 LB/FT 600 LBS PER REEL .	(SEE LIGHTING, EDS 459076)
29-0391	CABLE ELECTRICAL BARE COPPER 250 KCM MEDIUM HARD DRAWN 19 STRAND, 0.574" DIA, 0.772 LB/FT.	(SEE APPLICATIONS, THIS DRAWING)
29-0390	CABLE ELECTRICAL BARE COPPER 500 KCM 37 STRAND, 0.813" DIA, 1.544 LB/FT, MEDIUM HARD DRAWN	(SEE APPLICATIONS, THIS DRAWING)
30-3542	TERMINAL LUG STRAIGHT *250-*500 KCM COPPER CADWELD * B-122-EG, 1/4" x 1/2", FOR 250 - 500 KCM COPPER CABLE TO 2-HOLE NEMA FLAT	▲ FOR CABLE-TO-FLAT, CALDWELD STD. DUTY MOLD, TYPE GL., FOR 250 KCMIL USE CAT. NO. GLC-EG2V, & CARTRIDGE NO. 115 (SEE FIG 15, THIS DRAWING)
30-0349	TERMINAL LUG OFFSET BAR *250-*500 KCM COPPER CADWELD * B-101-EG-OL TYPE LA, 1/4" x 1/2" FOR 250 - 500 KCM COPPER CABLE TO 1-HOLE FLAT	
01-0098	ROD GROUND, 3/4" x 12', (10 MIL MIN COPPER JACKET)	UG-1 DOCUMENT NO. 013109, SEE NOTE 4 SHEET 1
30-3226	CONNECTOR GROUND, *2/0AWG-*250KCM, CABLE-FLAT 1-BOLT *2/0 SOLID AWG TO *250 KCM COPPER.	EXTERNAL NEUTRAL BUS APPLICATION FOR CABLE SUPPORT TO STRUCTURE ONLY
15-0124	GROUND WELL SUSPENDED ELECTRODE, LYNCOLE PART *K4-11-PGE	(SEE APPLICATIONS, THIS DRAWING)

FOR COMPRESSION CONNECTORS SEE SHEETS 13, 14, & 15 OF THIS DRAWING.

▲ ALL GROUND MATERIAL EXCEPT EXOTHERMIC MOLDS AND CHARGES (CARTRIDGES) WHICH ARE FURNISHED BY THE CONSTRUCTORS TO BE LISTED ON RESPECTIVE BILL OF MATERIAL FOR VARIOUS ARRANGEMENT DRAWINGS.

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TYPICAL PG&E GROUNDLOK APPLICATIONS



SEE SHEETS 15 & 16 FOR MATERIALS AND CODE NUMBERS

COMPRESION TYPE GROUNDLOK CONNECTORS FOR GROUND GRID

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PG&E CO.

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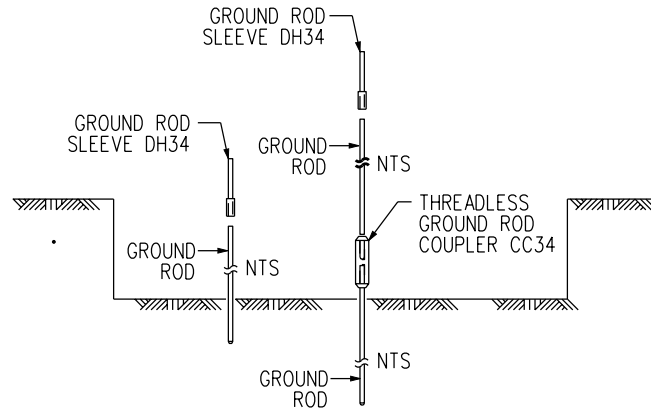


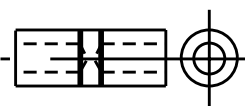
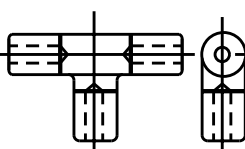
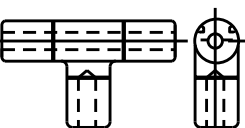
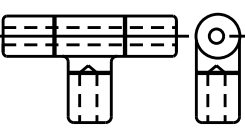
FIGURE 31
NTS

NOTES

1. USE OF GROUND SLEEVE AND COUPLER TO BE USED ON A CASE BY CASE BASIS DETERMINED BY FIELD PERSONNEL.
2. ANOTHER 3/4 INCH GROUND SLEEVE TYPES MAY BE USED AS LONG AS THE RIGHT TOOLS ARE USED WITH IT.

TYPICAL MATERIAL TO BE USED:

<u>CODE</u>	<u>DESCRIPTION</u>	<u>REMARKS</u>
XX-XXXX	GROUND ROD SLEEVE ERITECH CAT* DH34	
XX-XXXX	THREADLESS GROUND ROD COUPLER ERITECH CAT* CC34	

TYPE OF CONNECTOR	TYPE NO.	CODE	DIM. "A"	PAD TYPE			TUBE OR CABLE	MANUFACTURE AND TYPE OR SERIES	
				HOLES	SIZE	THICK		DEUTSCH POWER CONNECTORS	
								CONNECTOR CAT *	HEAD ASSEMBLY CAT *
 SPLICE		30-0959					250 KCMIL CU TO 250 KCMIL CU	GC720B025-025	DLT45CLHA03975
		30-0960					500 KCMIL CU TO 500 KCMIL CU	GC720B050-050	DLT45CLHA05565
		30-0961					500 KCMIL CU TO 250 KCMIL CU	GC720B050-025	DLT45CLHA05565
		30-0962					250 KCMIL CU TO 1/0 KCMIL CU	GC720B025-001	DLT45CLHA03975
		30-0963					250 KCMIL CU TO *4 AWG CU*	GC720B025-04G	DLT45CLHA03975
		30-0964					500 KCMIL CU TO 500 KCMIL CU**	GC720B050-053	DLT45CLHA03975/5565
		30-0965					5/8 COPPERCLAD ROD TO *4 CU*	GC720B562-004	DLT45CLHA03975
		30-0966					5/8 COPPERCLAD ROD TO 1/0 CU*	GC720B562-001	DLT45CLHA03975
		30-1014					250 KCMIL CU TO 19*8 COPPERWELD	GC720B030-025	DLT45CLHA03975
		30-1020					250 KCMIL CU TO 3/4 COPPERCLAD ROD	GC720B025-682	DLT45CLHA03975
 BLIND TEE		30-0967					250 KCMIL CU TO 250 KCMIL CU	GC730B025-025	DLT45CLHA03975
		30-0968					250 KCMIL CU TO 5/8 COPPERCLAD CU	GC730B025-562	DLT45CLHA03975
		30-0969					250 KCMIL CU TO 3/4 COPPERCLAD CU	GC730B025-682	DLT45CLHA03975
		30-0970					500 KCMIL CU TO 500 KCMIL CU	GC730B050-050	DLT45CLHA05565
		30-0971					500 KCMIL CU TO 250 KCMIL CU	GC730B050-025	DLT45CLHA05565
		30-0972					500 KCMIL CU TO 3/4 COPPERCLAD CU	GC730B050-040	DLT45CLHA05565
		30-0973					500 KCMIL CU TO 500 KCMIL CU**	GC730B050-053	DLT45CLHA03975/5565
		30-0974					250 KCMIL CU TO 1/0 AWG CU	GC730B025-001	DLT45CLHA03975
		30-0975					250 KCMIL CU TO *4 AWG CU*	GC730B025-04G	DLT45CLHA03975
		30-0976					500 KCMIL CU TO 1/0 KCMIL CU	GC730B050-001	DLT45CLHA05565
		30-0977					500 KCMIL CU TO *4 AWG CU*	GC730B050-04G	DLT45CLHA05565
		30-0978					1/0 CU TO 5/8 COPPERCLAD ROD	GC730B001-562	DLT45CLHA03975
		30-1018					250 KCMIL CU TO 19*8 COPPERWELD	GC730B030-025	DLT45CLHA03975
		30-1019					250 KCMIL CU TO 7*8 COPPERWELD	GC730B001-025	DLT45CLHA03975
	 SPLIT TEE		30-0990					250 KCMIL CU TO 250 KCMIL CU	GC733B025-025
		30-0991					500 KCMIL CU TO 500 KCMIL CU	GC733B050-050	DLT45CLHA05565
		30-0992					500 KCMIL CU TO 250 KCMIL CU	GC733B050-025	DLT45CLHA05565
		30-1013					250 KCMIL CU TO 19*8 COPPERWELD	GC733B030-025	DLT45CLHA03975
		30-1015					250 KCMIL CU TO 7*8 COPPERWELD	GC733B001-025	DLT45CLHA03975
 THRU HOLE TEE		30-0979					250 KCMIL CU TO 250 KCMIL CU	GC731B025-025	DLT45CLHA03975
		30-0980					250 KCMIL CU TO 5/8 COPPERCLAD CU	GC731B025-562	DLT45CLHA03975
		30-0981					250 KCMIL CU TO 3/4 COPPERCLAD CU	GC731B025-682	DLT45CLHA03975
		30-0992					500 KCMIL CU TO 500 KCMIL CU	GC731B050-050	DLT45CLHA05565
		30-0983					500 KCMIL CU TO 250 KCMIL CU	GC731B050-025	DLT45CLHA05565
		30-0984					500 KCMIL CU TO 3/4 COPPERCLAD CU	GC731B050-040	DLT45CLHA05565
		30-0985					250 KCMIL CU TO 1/0 KCMIL CU	GC731B025-001	DLT45CLHA03975
		30-0986					250 KCMIL CU TO *4 AWG CU*	GC731B025-04G	DLT45CLHA03975
		30-0987					500 KCMIL CU TO 1/0 AWG CU	GC731B050-001	DLT45CLHA05565
		30-0988					500 KCMIL CU TO *4 AWG CU*	GC731B050-04G	DLT45CLHA05565
		30-0989					1/0 CU TO 5/8 COPPERCLAD ROD	GC731B001-562	DLT45CLHA03975
		30-1004					250 KCMIL CU TO *2 AWG CU*	GC731B025-02G	DLT45CLHA03975
		30-1012					250 KCMIL CU TO 19*8 COPPERWELD	GC731B030-025	DLT45CLHA03975
		30-1021					250 KCMIL CU TO 7*8 COPPERWELD	GC731B001-025	DLT45CLHA03975

NOTES:

- * SOLID OR STRANDED
- ** 49 STRAND ROPE LAY

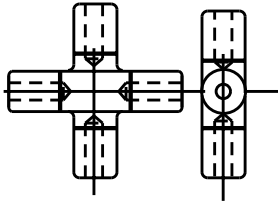
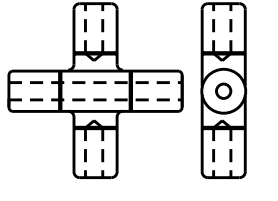
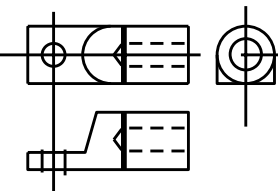
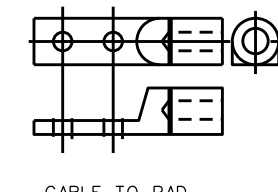
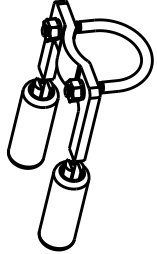
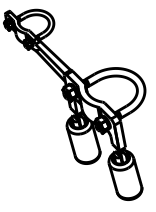
COMPRESSION TYPE GROUNDLOK CONNECTORS FOR GROUND GRID

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TYPE OF CONNECTOR	TYPE NO.	CODE	DIM. "A"	PAD TYPE			TUBE OR CABLE	MANUFACTURE AND TYPE OR SERIES	
				HOLES	SIZE	THICK		DEUTSCH POWER CONNECTORS	
								CONNECTOR CAT *	HEAD ASSEMBLY CAT *
 BLIND CROSS		30-0949					250 KCML CU TO 250 KCML CU	GC740B025-025	DLT45CLHA03975
		30-0950					500 KCML CU TO 500 KCML CU	GC740B050-050	DLT45CLHA05565
		30-0951					500 KCML CU TO 250 KCML CU	GC740B050-025	DLT45CLHA05565
 THRU HOLE CROSS		30-0952					250 KCML CU TO 250 KCML CU	GC741B025-025	DLT45CLHA03975
		30-0953					500 KCML CU TO 500 KCML CU	GC741B050-050	DLT45CLHA05565
		30-0954					500 KCML CU TO 250 KCML CU	GC741B050-025	DLT45CLHA05565
 CABLE TO PAD		30-0955					1/0 AWG CU TO 1 HOLE NEMA PAD	GC910B001T	DLT45CLHA03975
		30-1016					4 AWG CU TO 1 HOLE NEMA PAD	GC910BL04GT	DLT45CLHA03975
		30-1346					250 KCML CU TO 1 HOLE NEMA PAD	GC910B025T	DLT45CLHA03975
		30-1347					500 KCML CU TO 1 HOLE NEMA PAD	GC910B050T	DLT45CLHA03975
		30-1422					4 awg CU TO 1 HOLE NEMA PAD	GC910BL02GT	DLT45CLHA03975
 CABLE TO PAD		30-0956					250 KCML CU TO 2 HOLE NEMA PAD	GC920B025T	DLT45CLHA03975
		30-0957					500 KCML CU TO 2 HOLE NEMA PAD	GC920B050T	DLT45CLHA05565
		30-0958					500 KCML CU TO 2 HOLE NEMA PAD**	GC920B053T	DLT45CLHA03975/5565
		30-1423					2 AWG TO 2 HOLE NEMA PAD	GC920BL02GT	DLT45CLHA03975
		30-1424					4 AWG TO 2 HOLE NEMA PAD	GC920BL04GT	DLT45CLHA03975
 FENCE POST CONNECTOR		30-0993					2 1/2" FENCE POST TO 1/0 CU COND	GC760B-002-001	DLT45CLHA03975
		30-0994					2 1/2" FENCE POST TO *4 AWG CU*	GC760B-04G	DLT45CLHA03975
		30-1336					2" FENCE POST TO 1/0 CU*	GC760B32-002-002T	DLT45CLHA03975
		30-1337					3" FENCE POST TO 1/0 CU*	GC760B48-002-002T	DLT45CLHA03975
		30-1338					3 1/2" FENCE POST TO 1/0 CU*	GC760B56-002-002T	DLT45CLHA03975
		30-1339					4" FENCE POST TO 1/0 CU*	GC760B64-002-002T	DLT45CLHA03975
		30-1520					6" FENCE POST TO 1/0 CU*	GC760B96-002-002T	DLT45CLHA03975
		30-1521					8" FENCE POST TO 1/0 CU*	GC760B128-002-002T	DLT45CLHA03975
 SWING GATE TO FENCE POST CONNECTOR		30-1244					1 1/2" GATE TO 3" FENCE POST TO 1/0 CU*	GC762B2-48-002T	DLT45CLHA03975
		30-1245					1 1/2" GATE TO 2 1/2" FENCE POST TO 1/0 CU*	GC762B24-40-002T	DLT45CLHA03975
		30-1246					1 1/2" GATE TO 3 1/2" FENCE POST TO 1/0 CU*	GC762B24-56-002T	DLT45CLHA03975
		30-1247					1 1/2" GATE TO 4" FENCE POST TO 1/0 CU*	GC762B24-64-002T	DLT45CLHA03975
		30-1502					1 1/2" GATE TO 6" FENCE POST TO 1/0 OR 2/0 CU*	GC762B24-96-002DT	DLT45CLHA03975
		30-1503					1 1/2" GATE TO 8" FENCE POST TO 1/0 OR 2/0 CU*	GC762B24-128-002DT	DLT45CLHA03975

NOTES:

COMPRESSION TYPE GROUNDLOK CONNECTORS

- * SOLID OR STRANDED
- ** 49 STRAND ROPE LAY

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