Grounding & Bonding for Electrical Systems Functional Performance Test

Equipment ID	**[Equipment ID]**
Building	**{Building]**
Location	**[Room]**

System Description

Description:
Operational Assumptions:

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

Re-Test 1		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

Re-Test 2		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

Deferred/Seasonal Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

Test Participants

Organization	Required	Optional
General Contractor	☐	☐
Mechanical Contractor	☐	☐
Electrical Contractor	☐	☐
TAB Contractor	☐	☐
Controls Contractor	☐	☐
Owner's O&M Personnel	☐	☐

Test Equipment Required (to be provided by the Contractor)

Test Name	Equipment Description
Bolt Torque	Calibrated torque wrench
Contact Resistance	Four-probe Digital Low Resistance Ohmmeter (DLRO)
Voltage/Continuity	DVM
Fall of Potential	Fall-of-Potential Ground Resistance Tester

Functional Performance Test -- **(Verify all components are ready before energizing or operating the system.)**

The Commissioning Authority will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) Y= Checked and Passed
C = Corrected (Check (✓) when correction verified) N = Not Passed

ACTION	REQUIRED REACTION	Y (✓)	N (✓)	COMMENTS	R (✓)	C (✓)
PRE-TEST VISUAL MECHANICAL INSPECTION						
1. Verify equipment identification.	Equipment identification and plan location matches shop drawings and specifications.	☐	☐		☐	☐
	Field wiring terminations match record drawings.	☐	☐		☐	☐

ACTION	REQUIRED REACTION	Y (✓)	N (✓)	COMMENTS	R (✓)	C (✓)
Record issues				Issue Log Item:		
				Initial / Date		
2. Confirm that system is installed per contract documents with indicated connections to each unit of electrical equipment	Connections to equipment ground buses per drawings.	☐	☐		☐	☐
	Connections to equipment enclosures/cases per drawings.	☐	☐		☐	☐
	Connections to wire mesh fence per drawings.	☐	☐		☐	☐
	Gate grounding jumper installed per drawings.	☐	☐		☐	☐
	Connections to main cold water pipes per drawings and specs.	☐	☐		☐	☐
	Connections to dry type transformers per drawings and specs.	☐	☐		☐	☐
	Measured diameter of bare copper conductor corresponds to diameter of specified conductors.	☐	☐		☐	☐
	Conduits with grounding bushings and full-size bonding conductors.	☐	☐		☐	☐
	All busses mounted on standoff neoprene insulators.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
3. Observe condition of ground ring before backfill and/or cover applied.	No visible damage to cable.	☐	☐		☐	☐
	Cable depth a minimum of 3’0”.	☐	☐		☐	☐
	Ground rod configuration and depth as shown on drawings.	☐	☐		☐	☐
Record issues				Issue Log Item:		

ACTION	REQUIRED REACTION	Y (✓)	N (✓)	COMMENTS	R (✓)	C (✓)
				Initial / Date		
4. Observe main ground wall mounted grounding bar.	Dimensions as specified ____ long, 4" x ¼".	☐	☐		☐	☐
	Standoff distance 5" from wall as shown on drawings.	☐	☐		☐	☐
	Connections are welded or bolted as per the approved submittals and construction drawings.	☐	☐		☐	☐
Record issues				Issue Log Item: / Initial / Date		
5. Observe electrical closet ground buses	Buses: Copper, ¼" x 2" x10" minimum, length as shown on drawings.	☐	☐		☐	☐
	Buses mounted on standoff neoprene insulator - standoff distance 1" from wall as shown on drawings.	☐	☐		☐	☐
	Bus length to accommodate 100% spare.	☐	☐		☐	☐
	Connections are welded or bolted as per the approved submittals and construction drawings.	☐	☐		☐	☐
Record issues				Issue Log Item: / Initial / Date		
6. Observe telecom closet ground buses	Buses: Copper, ¼" x 2" x8" provided by each telecom backboard.	☐	☐		☐	☐
Record issues				Issue Log Item: / Initial / Date		

ACTION	REQUIRED REACTION	Y (✓)	N (✓)	COMMENTS	R (✓)	C (✓)
7. Inspect compression type and exothermically welded connections	Cables do not rotate with respect to each other or to steel column, etc. (All connections are solid).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
8. Inspect grounding connection at service entrance	Connection point is per (not beyond service disconnect) NEC 250-23.	☐	☐		☐	☐
	Neutral is solidly grounded at service disconnect, and at no point beyond.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
9. Verify equipment grounding conductor termination.	Grounding connections are made with non-reversible connections.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
10. Verify tightness of accessible bolted electrical connections with calibrated torque wrench.	Bolted torque should comply with NETA Table 100.12 unless manufacturer specified values are listed on the equipment.	☐	☐	Record data in Contact Integrity Table Bolt Torque	☐	☐
	If Contractor's Test Reports are received and used in lieu of 100% testing, perform random checks of tightness of bolted electrical connections. Randomly Test 10% of connections. If any are not tight, test 100%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

ACTION	REQUIRED REACTION	Y (✓)	N (✓)	COMMENTS	R (✓)	C (✓)
GROUNGING ELECTRICAL INTEGRITY						
11. Perform resistance test of <u>non-accessible</u> bolted electrical system connections using a Digital Low Resistance Ohmmeter (DLRO) and non-bolted electrical system connections using a DVM.	Resistance shall be less than 500 micro-ohms.	☐	☐	Note: For connections that are inaccessible or unable to be verified by torque (ex: welded connections), conduct a DLRO measurement of connection resistance across connection from closest accessible point on each side. Record Data in Contact Integrity Table – DLRO/DVM	☐	☐
	Compare connection resistance to values of similar connections. Values should be within 10% of each other.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
12. Verify the ground system is complete (connections to building steel, water main etc.) and tested prior to performing the final "system" fall of potential.		☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
13. Perform and evaluate a Fall-of-Potential test on the grounding system.	The curve should be "flat" between Y_1 and Y_2	☐	☐	The fall of potential test consists of plotting the ratio of V/I-R as a function of probe spacing. A value of impedance is obtained at Y, Y_1 and Y_2. This impedance is plotted as a function of distance, and	☐	☐
	The resistance value at distance Y is effective resistance of the electrode or system.	☐	☐		☐	☐
	Results are less than or equal to 10 ohms.	☐	☐		☐	☐

ACTION	REQUIRED REACTION	Y (✓)	N (✓)	COMMENTS	R (✓)	C (✓)
		☐	☐	the value in ohms at which this plotted curve appears to level out is taken as the impedance value of the ground under test. If the curve is not flat between Y_1 and Y_2 additional impedance measurements must be taken. Position the potential probe at several additional distances between the electrode and current probe Z. Record distances and plots the impedance to obtain the flat area of the curve. Attach a copy of the Fall-of-Potential contractor's test report on all individual ground rods. Record values in Fall of Potential Table.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

Test Equipment Used:

Test Name	Manufacturer	Model Number	Serial Number	Calibration (Date)

Connection Integrity

Conductor Description		Torque Verified		DLRO/DVM		Continuity Verified	Date
From (A)	To (B)	(A)	(B)	(A)	(B)		

Conductor Description		Torque Verified		DLRO/DVM		Continuity Verified	Date
From (A)	To (B)	(A)	(B)	(A)	(B)		

Fall of Potential

Electrode ID	Distance (Y_1)	Distance Y	Distance (Y_2)	Distance (Z)	Resistance	AT	RH	Date

AT=Ambient Temperature

RH = Relative Humidity

Final Sign-Off

Commissioning Agent	Printed Name	Initials	Date

CONTRACTOR	PRINTED NAME	INITIALS	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			
Owner's O&M Personnel			

TABLE 100.12.1
Bolt-Torque Values for Electrical Connections

US Standard Fasteners [a]
Heat-Treated Steel – Cadmium or Zinc Plated [b]

Grade	SAE 1&2	SAE 5	SAE 7	SAE 8
Head Marking				
Minimum Tensile (Strength) (lbf/in^2)	64K	105K	133K	150K
Bolt Diameter (Inches)	**Torque (Pound-Feet)**			
1/4	4	6	8	8
5/16	7	11	15	18
3/8	12	20	27	30
7/16	19	32	44	48
1/2	30	48	68	74
9/16	42	70	96	105
5/8	59	96	135	145
3/4	96	160	225	235
7/8	150	240	350	380
1.0	225	370	530	570

a. Consult manufacturer for equipment supplied with metric fasteners.

b. Table is based on national coarse thread pitch.