



Panelboards

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)	Explanation:			
<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> Partial Test w/Corrective Actions <input type="checkbox"/> Complete Test w/Corrective Actions <input type="checkbox"/> Other				

Re-Test 1		Start Date	End Date	Initials
Results (Check one)	Explanation:			
<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> Partial Test w/Corrective Actions <input type="checkbox"/> Complete Test w/Corrective Actions <input type="checkbox"/> Other				

Re-Test 2		Start Date	End Date	Initials
Results (Check one)	Explanation:			
<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> Partial Test w/Corrective Actions <input type="checkbox"/> Complete Test w/Corrective Actions <input type="checkbox"/> Other				



Deferred/Seasonal Test	Start Date	End Date	Initials
Results (Check one) <input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> Partial Test w/Corrective Actions <input type="checkbox"/> Complete Test w/Corrective Actions <input type="checkbox"/> Other	Explanation:		

Test Equipment Required (to be provided by the Contractor)

Test Name	Equipment Description
Bolt Torque	Calibrated torque wrench
Voltage/Continuity	DVM
Insulation Resistance	Battery or line-powered (Hand-crank not acceptable).
Variable Voltage Source	3-Phase variable voltage source

Test Participants

Organization	Required	Optional
General Contractor	<input type="checkbox"/>	<input type="checkbox"/>
Mechanical Contractor	<input type="checkbox"/>	<input type="checkbox"/>
Electrical Contractor	<input type="checkbox"/>	<input type="checkbox"/>
TAB Contractor	<input type="checkbox"/>	<input type="checkbox"/>
Controls Contractor	<input type="checkbox"/>	<input type="checkbox"/>
U.S. Army Corps of Engineers	<input type="checkbox"/>	<input type="checkbox"/>

**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 (J) retest required)

Y = Checked and Passed

C = Corrected (Check (J) when correction verified)

N = Not Passed

ACTION	REQUIRED REACTION	Y (J)	N (J)	COMMENTS	R (J)	C (J)
PRE-TEST VISUAL MECHANICAL INSPECTION						
1. Safe conditions (protective gear in- place, available & procedures observed)		<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Record issues				Issue Log Item:		
				Initial	Date	
2. Verify panelboard installations	Completed panelboard schedules.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Appropriate anchorage.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Required area clearances. 3 ft in front and 30 in wide.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	No physical damage.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Breaker casing does not have cracks.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Correct alignment.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Feeder color-coding is: 480/277 V System as follows: Phase A: Brown Phase B: Orange Phase C: Yellow Neutral: Gray Ground: Green	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Record issues				Issue Log Item:		
				Initial	Date	
3. Inspect panelboard doors, panels, and	Free of Corrosion, dents, scratches, fit.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>



ACTION	REQUIRED REACTION	Y (J)	N (J)	COMMENTS	R (J)	C (J)
sections	No missing hardware.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	No missing screws.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	No open unused knockouts.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Record issues				Issue Log Item:		
				Initial	Date	
4. Verify panelboard configuration and nameplate data matches shop drawings, one-line diagram and specification	Volts: 480/277V.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Bus Amps: ____A.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	3ph, 4W.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Frequency: 60hZ.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Enclosure: NEMA 1.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Main Breaker Max. Rating. ____ Amp.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Isolated Equipment Ground Bus if applicable.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Panelboard arrangement - # of circuits.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Neutral bus size (100%).	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Extra Gutter space as applicable.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Shunt trip as indicated.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
TVSS as indicated.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		



ACTION		REQUIRED REACTION		Y (J)	N (J)	COMMENTS	R (J)	C (J)
Record issues						Issue Log Item:		
						Initial	Date	
5. Verify panelboard equipment grounding	Solid neutral mounted in main circuit breaker compartment with main lugs, is insulated.	<input type="checkbox"/>	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>
	Neutral is not bonded to ground.	<input type="checkbox"/>	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>
	Frame and enclosure connected to ground bus.	<input type="checkbox"/>	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>
	Breaker and feeder equipment grounding conductors/conduit are connected to ground bus.	<input type="checkbox"/>	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>
Record issues						Issue Log Item:		
						Initial	Date	
6. Operate each circuit breaker (5) times to ensure smooth operation	Breaker opens and closes in a smooth motion without binding.	<input type="checkbox"/>	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>
Record issues						Issue Log Item:		
						Initial	Date	
ELECTRICAL INTEGRITY								
7. Perform an insulation resistance test at 1000VDC, phase-to-phase and phase to ground, in accordance with NETA Table 100.1	Minimum insulation resistance shall be 100 Megohms.	<input type="checkbox"/>	<input type="checkbox"/>	Record results in Insulation Resistance Table. Perform the test on each bus section. Test for one minute in accordance with NETA Table 100.1.			<input type="checkbox"/>	<input type="checkbox"/>
	Results temperature corrected in accordance with NETA Table 100.14.	<input type="checkbox"/>	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>
Record issues						Issue Log Item:		
						Initial	Date	



ACTION	REQUIRED REACTION	Y (J)	N (J)	COMMENTS	R (J)	C (J)
8. Perform an insulation resistance test at 1000VDC on main breaker, phase-to-phase and phase to ground, connected to the bus in the CLOSED position, in accordance with NETA Table 100.1. Perform insulation resistance test (pole to pole) on main breaker with breaker in the open position	Minimum insulation resistance shall be 100 Megohms.	<input type="checkbox"/>	<input type="checkbox"/>	Record results in Insulation Resistance Table. Perform the test on each bus section. Test for one minute in accordance with NETA Table 100.1. Test Name: Insulation Resistance Reference Equip. Table	<input type="checkbox"/>	<input type="checkbox"/>
Record issues				Issue Log Item:		
				Initial	Date	
9. At the conclusion of testing, inspect interior hardware and electrical terminations	All hardware in place and properly torqued.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
	Compartments clear of tools and hardware.	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Record issues				Issue Log Item:		
				Initial	Date	
FUNCTIONAL TRIP TESTS						
10. Test the Long Time Delay (seconds) and Long Time Pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection	Long delay current pick up and time delay per coordination study.	<input type="checkbox"/>	<input type="checkbox"/>	Record results in Data Table. Test Name: Primary Current Inject. Reference Equip. Table	<input type="checkbox"/>	<input type="checkbox"/>
Record issues				Issue Log Item:		
				Initial	Date	



ACTION	REQUIRED REACTION	Y (J)	N (J)	COMMENTS	R (J)	C (J)
11. Test the Short Time Delay (seconds) and Short Time Pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection	Short delay current pick up and time delay per coordination study.	<input type="checkbox"/>	<input type="checkbox"/>	Record results in the Circuit Breaker Current Injection Table. Test Name: Primary Current Inject. Reference Equip. Table	<input type="checkbox"/>	<input type="checkbox"/>
Record issues				Issue Log Item:		
				Initial	Date	
12. Test the Instantaneous Time Delay (seconds) and Instantaneous Time Pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection	Instantaneous pick up per coordination study.	<input type="checkbox"/>	<input type="checkbox"/>	Record results in the Circuit Breaker Current Injection Table. Test Name: Primary Current Inject. Reference Equip. Table	<input type="checkbox"/>	<input type="checkbox"/>
Record issues				Issue Log Item:		
				Initial	Date	
13. Test the Ground Fault Time Delay (seconds) and Ground Fault Time Pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection.	Ground fault pick up per coordination study.	<input type="checkbox"/>	<input type="checkbox"/>	Record results in the Circuit Breaker Current Injection Table. Test Name: Primary Current Inject. Reference Equip. Table	<input type="checkbox"/>	<input type="checkbox"/>
Record issues				Issue Log Item:		
				Initial	Date	



ACTION	REQUIRED REACTION	Y (J)	N (J)	COMMENTS	R (J)	C (J)
14. After testing is performed on the panelboard, verify tightness of main connections.	Primary feeder cable connections properly torqued and marked.	<input type="checkbox"/>	<input type="checkbox"/>	Record results in the Termination Torque Table. Bolted torque should comply with NETA Table 100.12 unless manufacturer specified values are listed on the equipment. Test Name: Bolt Torque Reference Equip. Table	<input type="checkbox"/>	<input type="checkbox"/>
Record issues				Issue Log Item:		
				Initial	Date	

**Test Equipment Used:**

Test Name	Manufacturer	Model Number	Serial Number	Calibration (Date)

Data Tables

Temperature: _____

Relative Humidity: _____

Insulation Resistance (1000 VDC)

Circuit Breaker (Closed)	A-B	B-C	C-A	A-G	B-G	C-G	N
1 Minute (Meg Ohms)							
Circuit Breaker (open)	A-A	B-B	C-C				
1 Minute (Meg Ohms)							

Current Injection

Function	Actual Set.	Test Setting	Test Point	Nominal Val.	A	B	C	Trip Setting (Sec.)
LTD								
LDPU								
STD								
SDPU								
INSTPU								
GFD								
GFPU								



Termination Torque (Newton Meters or Foot Pounds)

Bolt/Lug	A	B	C	N	G
Primary Feeder					
Feeder Lugs					

SAMPLE



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)			
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Table 100.1
Insulation Resistance Test Values
Electrical Apparatus and Systems

Nominal Rating of Equipment in Volts	Minimum Test Voltage, DC	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
1,000	1,000	100
2,500	1,000	500
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
34,500 and above	15,000	100,000

See Table 100.14 for temperature correction.

In the absence of consensus standards dealing with insulation-resistance tests, the Standards Review Council suggests the above representative values.

Test results are dependent on the temperature of the insulating material and the humidity of the surrounding environment at the time of the test.

Insulation-resistance test data may be used to establish a trending pattern. Deviations from the baseline information permit evaluation of the insulation.

**Table 100.12**

US Standard
Bolt Torques for Bus Connection
Heat-Treated Steel . Cadmium or Zinc Plated

Grade	SAE 1&2	SAE 5	SAE 7	SAE 8
Head Markings				
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter in Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

Reference: International Electrical Testing Association (NETA) ATS-1999, Table 100.12, page 202.

Table 100.12 (Cont.)

Bolt Torques for Bus Connections
Silicon Bronze Fasteners¹
Torque (Foot Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

Reference: International Electrical Testing Association (NETA) ATS-1999, Table 100.12, page 203.



Table 100.12 (Cont.)
Bolt Torques for Bus Connections
Aluminum Alloy Fasteners²
Torque (Foot Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	8.0
3/8	20	11.2
1/2	40	20.0
5/8	55	32.0
3/4	70	48.0

Reference: International Electrical Testing Association (NETA) ATS-1999, Table 100.12, page 203.

Table 100.12 (Cont.)
Bolt Torques for Bus Connections
Stainless Steel Fasteners³
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

Reference: International Electrical Testing Association (NETA) ATS-1999, Table 100.12, page 204.



Table 100.14

Insulation Resistance
Correction Factors
$$R_{90} = R_{at} \times F_{90} \times F_{temp}$$

Temperature		Multiplier	
t	a	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulators
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

Reference: International Electrical Testing Association (NETA) ATS-1999, Table 100.14, page 206.