

# SCOPE OF WORK

## INTEGRATED SWITCHGEAR ACCEPTANCE TESTING 24X7

### SERVICE SUMMARY

Feature	Detail
On-site Service	One site trip within the 48 contiguous states after the system has been installed and cabling terminated. Visit to be scheduled at the customer's convenience (excluding national holidays).
Warranty Extension	Service extends standard 18 month material and labor warranty on Vertiv branded switchgear to 24 months.
Service Professional	Performed by NETA certified technician.

### SERVICE PERFORMED

#### Customer Responsibilities

1. Visit must be scheduled 10 business days in advance of need by contacting the Vertiv Customer Response Center at 1-800-543-2378 or by contacting the region office.
2. Customer shall provide convenient access to the equipment covered by the Scope of Work, and shall provide any special lifting or racking devices needed prior to start of any work by Vertiv Services.
3. Customer shall provide utility power, as needed, to facilitate electrical testing of the equipment described in the Scope of Work prior to start of any work by Vertiv Services.
4. Customer shall provide an updated electrical short circuit coordination study.

#### Deliverables

Upon request, Vertiv Services can provide handwritten data sheets to customer at the end of each shift. Final reports will be supplied in electronic media within thirty days (30) days of completion.

#### Purpose

To provide evidence that mission critical switchgear equipment has integrity and ability to effectively support 100% of rated load in normal operation and to provide overload and short-circuit protection per design documents.

#### PROCEDURES:

##### *Switchgear and Switchboard Assemblies*

Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical, electrical and mechanical condition including evidence of moisture or corona.
3. Inspect anchorage, alignment, grounding, and required area clearances.
4. Verify the unit is clean.
5. Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study
6. Verify that current and voltage transformer ratios correspond to drawings.
7. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
  - Attempt closure on locked-open devices. Attempt to open locked-closed devices.
  - Make key exchange with devices operated in off-normal positions.
8. Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
9. Inspect insulators for evidence of physical damage or contaminated surfaces.
10. Verify correct barrier and shutter installation and operation.
11. Exercise all active components.

12. Inspect mechanical indicating devices for correct operation.
13. Verify that filters are in place and vents are clear.
14. Perform visual and mechanical inspection of instrument transformers.
15. Inspect control power transformers.
  - Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
  - Verify that primary and secondary fuse or circuit breaker ratings match drawings.
  - Verify correct functioning of drawout disconnecting and grounding contacts and interlocks

#### Electrical Tests

1. Perform resistance measurements through bolted electrical connections with a low-resistance ohmmeter, if applicable, in accordance with ANSI/NETA ATS-2009 Section 7.1.1.
2. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer data, use NETA Table 100.1.
3. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it shall be in accordance with ANSI/NETA ATS-2009 Table 100.2. The test voltage shall be applied for one minute.
4. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration shall be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
5. Perform ground-resistance tests in accordance with ANSI/NETA ATS-2009 Section 7.13.
6. Perform system function tests in accordance with ANSI/NETA ATS-2009 Section 8.
7. Verify operation of cubicle switchgear/switchboard space heaters and their controller if applicable.
8. Perform phasing checks on double-ended or dual-source switchgear to insure correct bus phasing from each source.

#### Test Values

1. Test Values - Visual and Mechanical
  - Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value. ANSI/NETA ATS-2009 (7.1.1.7.1)-
2. Test Values - Electrical
  - Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - Insulation-resistance values of bus insulation shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use ANSI/NETA ATS-2009 Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated. Dielectric withstand voltage tests shall not proceed until insulation-resistance levels are raised above minimum values.
  - If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
  - Minimum insulation-resistance values of control wiring shall not be less than two megohms.
  - Results of ground-resistance tests shall be in accordance with ANSI/NETA ATS-2009 Section 7.13.
  - Results of system function tests shall be in accordance with ANSI/NETA ATS-2009 Section 8.
  - Heaters shall be operational.
  - Phasing checks shall prove the switchgear or switchboard phasing is correct and in accordance with the system design.

#### **Circuit Breakers, Air, Insulated-Case/Molded-Case**

##### Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.

3. Inspect anchorage and alignment.
4. Verify the unit is clean.
5. Operate the circuit breaker to insure smooth operation.
6. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
7. Perform adjustments for final protective device settings in accordance with the coordination study if provided by end user.

#### Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with ANSI/NETA ATS-2009 Section 7.6.1.1.1.
2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use ANSI/NETA ATS-2009 Table 100.1.
3. Perform a contact/pole-resistance test.
4. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration shall be one minute. Do not overvoltage solid state devices.
5. Test functions of the trip unit by means of primary injection.
6. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
7. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators.
8. Verify operation of charging mechanism.

#### Test Values

1. Test Values - Visual and Mechanical
  - Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - Settings shall comply with coordination study recommendations.
2. Test Values - Electrical
  - Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use ANSI/NETA ATS-2009 Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated.
  - Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
  - Insulation-resistance values of control wiring shall not be less than two megohms.
  - Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in ANSI/NETA ATS-2009 Table 100.7. (Circuit breakers exceeding specified trip time shall be tagged defective.)
  - Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band. (Circuit breakers exceeding specified trip time shall be tagged defective.)
  - Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band. (Circuit breakers exceeding specified trip time shall be tagged defective.)

- Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, refer to Table 100.8. (Circuit breakers exceeding specified trip time shall be tagged defective.)
- Pickup values and trip characteristics shall be within manufacturer's published tolerances. (Circuit breakers exceeding specified trip time shall be tagged defective.)
- Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data. In the absence of the manufacturer's published data, refer to ANSI/NETA ATS-2009 Table 100.20.
- Breaker open, close, trip, trip-free, antipump, and auxiliary features shall function as designed.
- The charging mechanism shall operate in accordance with manufacturer's published data.

#### Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Verify the unit is clean.

#### Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with ANSI/NETA ATS-2009 Section 7.11.1.
2. Verify all instrument multipliers.
3. Verify that current transformer and voltage transformer secondary circuits are intact.

#### Test Values

1. 1 Test Values - Electrical
  - Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - Instrument multipliers shall be in accordance with system design specifications.
  - Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.

### **Grounding Systems**

#### Visual and Mechanical Inspection

1. Verify ground system is in compliance with drawings, specifications, and NFPA 70 National Electrical Code Article 250.
2. Inspect physical and mechanical condition.
3. Inspect anchorage.

#### Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with ANSI/NETA ATS-2009 section 7.13.1.
2. Perform fall-of-potential or alternative test in accordance with ANSI/IEEE 81 on the main grounding electrode or system. The client is responsible for providing access to the earth to perform this test.
3. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points.

#### Test Values

1. Test Values - Visual and Mechanical
  - Grounding system electrical and mechanical connections shall be free of corrosion.
2. Test Values - Electrical
  - Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

- The resistance between the main grounding electrode and ground shall be no greater than five ohms for large commercial or industrial systems and 1.0 ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference ANSI/IEEE Standard 142)
- Investigate point-to-point resistance values that exceed 0.5 ohm

## ASSUMPTIONS AND CLARIFICATIONS

Service will be priced and performed on a minimum of four (4) breakers.

Covers Integrated Switchgear components excluding Static Switch.

Does not include monitoring or switchgear automation set-up.

Expenses incurred due to delays that are beyond the control of Vertiv Services may be billed at cost.

## CUSTOMER RESPONSIBILITIES

In order to provide timely, accurate and thorough execution of the services described herein, Vertiv requests the following:

- Point of Contact: Provide an authorized point of contact(s), specific for the scope of work, for scheduling and coordination purposes.
- Scheduling: Make dates available for scheduling service. All visits must be requested 10 business days in advance of need by contacting the Vertiv Services Customer Resolution Center at 1-800-543-2378.
- Site Access: Prior to time of scheduled work, provide site access including any customer required escort, security clearance, safety training and badging for Vertiv service personnel.
- Equipment Access: Convenient access to the equipment covered by the Scope of Work. Prior to scheduled time of work, notify Vertiv service personnel of any special requirements for equipment access including lifts, ladders, etc.
- Shutdown: Service may require shutdown of load to ensure electrical connection integrity.
- Notification: If for any reason the work cannot be performed during scheduled time, notify Vertiv service personnel 24-hours prior to scheduled event.

## TERMS AND CONDITIONS

Subject to all Terms & Conditions as noted in the Vertiv Services Terms & Conditions or the terms of a Master Agreement between the parties, if any, shall apply.