Standard Operating Procedure (SOP)

Low Voltage AC Testing at a Substation

OBJECTIVE
To ensure the safety, reliability, and functionality of low voltage AC (LVAC) systems at substations through comprehensive testing procedures.

SCOPE
This SOP applies to all personnel involved in the testing of LVAC panels and associated equipment at substations.

PREREQUISITES

- **Qualified Personnel:** Only personnel who are qualified and authorized to perform electrical work should conduct the testing. This includes having the necessary training, certifications, and experience in electrical testing and safety procedures.
- **Safety Equipment:** Ensure all necessary safety equipment is available and in good condition. This includes:
    - Insulated gloves
    - Safety glasses
    - Arc flash protection if necessary
    - Grounding equipment
    - Lockout/tagout devices.
- **Job Risk Analysis (JRA):** Conduct a JRA prior to starting work to identify potential hazards and implement appropriate safety measures.
- **De-energization and Isolation:** Ensure that the equipment to be tested is de-energized, isolated, and locked out where possible. If work must be performed on energized equipment, strict safety protocols must be followed.
- **Testing Tools:** Have all necessary testing tools available, including:
    - 1000 V DC megohmmeter (Megger) for insulation resistance testing
    - Continuity tester with a signal
    - Primary injection test sets for circuit breaker testing
    - Voltage and phase sequence meters.
- **Documentation:** Ensure all documentation, including test procedures, safety protocols, and any site-specific requirements, are available and understood by the testing team.
- **Pre-Job Safety Meeting:** Conduct a pre-job safety meeting to discuss the job with all workers involved, plan the entire job in advance, and take every precaution.
- **Disconnect Ground Sensing Devices:** Disconnect both the ground sensing device and control cords before testing.
- **Isolate Equipment:** If cables are already connected, open the isolating devices before testing.

PROCEDURE

1. Preparation:

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1.1 Safety Precautions

- **Assess Risks:** Conduct a pre-job safety meeting to discuss the job with all workers involved. Plan the entire job in advance to take every precaution.
- **De-energize Equipment:** Ensure that the equipment is de-energized, isolated, and locked out where possible. If work must be performed on energized equipment, follow strict safety protocols.
- **Personal Protective Equipment (PPE):** Wear appropriate PPE including insulated gloves, safety glasses, and arc flash protection if necessary.

1.2 Equipment Setup

- **Disconnect Ground Sensing Devices:** Disconnect both the ground sensing device and control cords.
- **Isolate Equipment:** If cables are already connected, open the isolating devices before testing.

2. Testing Procedures:

2.1 Insulation Resistance Test

- **Test Voltage:** Use a 1000 V DC megohmmeter (Megger) for measuring insulation resistance (IR value) after one minute of electrification.
    - Connect each phase, together with the other two and neutral, to ground.
    - Measure IR value between auxiliary circuit and ground using a 500 V DC megohmmeter.
- **Record Results:** Document the IR values obtained.

2.2 Continuity and Functional Tests

- **Continuity Check:** Use a tester with a signal to check continuity. Ensure all connections are visually inspected.
- **Functional Tests:**
    - Check operation of all active digital inputs and output contacts or SCRs.
    - Verify internal relay logic functions used in the protection scheme.
    - Perform end-to-end tests for relays, including primary protective relay, backup protective relay, and anti-islanding scheme.

2.3 Voltage and Phase Sequence Check

- **Voltage Measurement:** Measure voltage at each bus bar to ensure correct voltage levels.
- **Phase Sequence:** Check the phase sequence to ensure correct phasing.

2.4 Circuit Breaker Testing

- **Primary Injection Testing:** Use primary injection test sets to inject current through the poles of the circuit breaker to verify operation as per the trip unit settings.
    - Ensure the test set is appropriate for the current and voltage requirements of the breaker.

3. Post-Testing:

3.1 Reconnection

- **Reconnect Cables:** After testing, reconnect all cables and ensure all connections are secure.
- **Close Circuit Breakers:** Close all outgoing circuit breakers as needed after testing.

3.2 Documentation

- **Record Results:** Document all test results, including IR values, continuity checks, functional tests, and any anomalies observed.
- **Inspection Report:** Prepare an individual inspection report detailing all tests performed, results, and any corrective actions taken.

3.3 Safety Verification

- **Verify Safety:** Ensure all safety measures are reinstated, including reconnecting ground sensing devices and control cords.
- **Check for Hazards:** Verify that no hazards remain from the testing process.

3.4 Final Checks

- **Operational Check:** Perform a final operational check to ensure all systems are functioning correctly post-testing.
- **Clean Up:** Clean the work area, remove all testing equipment, and ensure the substation is left in a safe and operational state.