

SECTION 26 01 26_MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

SEVEN – AL-HAMRA ENTERTAINMENT COMPLEX (EXIT 10)

RIYADH, KINGDOM OF SAUDI ARABIA

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including general and supplementary conditions and Division 01 Specifications sections, apply to this section.
- B. Read this section in conjunction with other related sections, the design drawings, contract conditions and MEPF General Requirements and Scope of Works.

1.2 SUMMARY

- A. This section includes:
 - 1. Methods and conditions for testing of electrical systems as defined in Division 26.
 - 2. Related accessories.

1.3 REFERENCE STANDARDS

- A. In addition to the requirements indicated on the Design Drawings, or specified in Division 01 General Requirements, the Particular Specifications and the MEPF Scope of Works, the Work shall be in accordance with the following standards, codes and relevant statutory requirements.
 - 1. National Fire Protection Association (NFPA) Standards
 - 2. British Standards Institution (BSI) Group, including but not limited to,
 - a. BS 7671 Requirements for Electrical Installations - IET Wiring Regulations.
 - b. BS 5266-1 Emergency lighting. Code of practice for the emergency escape lighting of premises. To be read in conjunction with BS EN 1838 and BS EN 50172.
 - c. BS 5839-1 Fire detection and fire alarm systems for buildings. Code of practice for system design, installation, commissioning and maintenance of systems in non-domestic premises.
 - d. BS EN 81 Safety rules for the construction and installation of lifts.
 - e. International Electrical Testing Association, NETA Standards.
 - f. National Electrical Manufacturers Association, NEMA Standards.
 - g. International Electrotechnical Commission, IEC Standards.
 - h. Institution of Engineering and Technology (UK), IET Standards.
 - 3. British Approvals Service for Electric Cables (BASEC).
 - 4. Underwriters' Laboratories (UL) Standards.
 - 5. The Industry Committee for Emergency Lighting (ICEL) Standards,
 - 6. International Code Council (ICC) Standards
 - 7. International Building Code (IBC).
 - 8. International Organization for Standardization (ISO) Standards.
 - 9. Underwriters' Laboratories, UL Standards,
 - 10. International Electrotechnical Commission (IEC) Standards, including but not limited to,
 - 11. National Electrical Manufacturers Association (NEMA) Standards.

1.4 REFERENCE STANDARDS – LOCAL AUTHOIRTIES WITH JURSDICTION

- A. In addition to the requirements indicated on the Design Drawings, or specified in Division 01 General Requirements, the Particular Specifications and the MEPF Scope of Works, the Work shall be in accordance with the relevant statutory authority requirements published by the local
1. The Saudi Electricity Company, SECO.
 2. The Saudi Building Code.
 3. The Saudi Arabian Distribution Code.
 4. Standards issued by the Saudi Arabian Standards Organization, SASO.
 5. Applicable Municipality Civil Defense

1.5 SUBMITTALS

- A. Comply with the requirements of Division 01 General Requirements, Divisions 26, 27 & 28 and MEPF Scope of Works.
- B. Post Contract Submittals
1. Comply with requirements of MEPF Scope of Works.
 2. Shop Drawings.
 3. Product Data on materials and components for use.
 4. Supplementary Product Literature: Include a statement from the manufacturer for the design life of the system.
 5. List of tests included.
 6. Certified test data.
 7. Outline technical specifications reflecting proposed materials and systems.
 8. A list of proposed suppliers and sub-contractors intended to be used.
 9. Preliminary Method Statement
 10. Preliminary Quality Plan
 11. Summary of deviations from the Specifications.
 12. Provide report certification by a licensed Electrical Engineer.
- C. Combine submittals of this Section with Sections listed under Related Sections and documentation to ensure the “design intent” of the system / assembly is understood and can be reviewed together.
1. Secure report and test documents together using index tabs and a 3 ring binder.

1.6 CLOSEOUT SUBMITTALS

- A. Comply with the requirements of Division 01 General Requirements, Divisions 26, 27 & 28 and MEPF Scope of Works.
1. Warranties.
 2. Operation and Maintenance (O&M) Manuals:
 - a. Comply with requirements of MEPF Scope of Works
 - b. Include component list with manufacturer's reference numbers, descriptions of materials and procedures for repairing and cleaning of finishes and cleaning frequency.

- B. Provide the following certified test report information, including but not limited to:
 - 1. Summary of job.
 - 2. Description of equipment tested.
 - 3. Description of test procedure.
 - 4. List of test equipment and calibration date.
 - 5. Test results.
 - 6. Conclusions and recommendations.
 - 7. Appendix, including all field test reports.
- C. Provide brief field report after completion of any test prior to leaving the site.
- D. Provide report certification by a licensed electrical Engineer.
- E. Secure report and test documents together using index tabs and a 3 ring binder.
- F. Report may be typed or printed. List the equipment tested, describe any deficiencies found and recommended corrections. Leave report copies with the Engineer.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications
 - 1. Provide testing firm qualifications to the acceptance of the Engineer. As a minimum, the testing firm is required to be:
 - a. A company that is a financially independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers and installers of equipment or systems evaluated by the testing firm.
 - b. A Member of the International Electrical Testing Association, specializing in the testing of equipment or apparatus specified in this Section with minimum 5 year's experience.
- B. Provide testing and inspections in accordance with Division 01 General Requirements and MEPF Scope of Works.
- C. Preconstruction Testing/ Reports
 - 1. Submit reports of independent tests demonstrating that the products and systems are in accordance with the specified performance requirements.
 - 2. Where test results for a material or product are not available, undertake testing to show compliance with the Specification at an independent testing laboratory acceptable to the Engineer.
 - 3. The provision of testing data or the carrying-out of tests does not relieve the Contractor of his responsibilities regarding the performance requirements, durability or service life requirements.

1.8 DIVISION OF RESPONSIBILITY

- A. Routine work performed by the Contractor prior to and in addition to tests performed by the testing firm:
 - 1. Cleaning of equipment and apparatus
 - 2. Insulation-resistance and continuity test

3. Rotation test
 4. Equipment bolt torquing
 5. Inspect for physical damage
 6. Proper equipment connection and operation
 7. Coordinate exact motor overload requirements
- B. The Contractor has the option to assign all or any portion of above listed routine work to the testing firm at his own expense.
- C. The Contractor provides a suitable and stable source of electrical power to each test site as required by the testing firm.
- D. The Contractor notifies the Engineer when equipment becomes available for acceptance tests. Work must be coordinated to expedite project scheduling.
- E. The Contractor is responsible for approving a short circuit analysis and coordination study prepared and certified by an independent testing or Engineering firm or manufacturer.
- F. The Contractor notifies the Engineer prior to commencement of any testing.
- G. Report any system, material, or workmanship which is found defective on the basis of acceptance tests to the Engineer in writing.
- H. The testing firm maintains a written record of all tests and, upon completion of project, assembles and certifies the final test report.
- I. Safety and Precautions:
1. Safety practices include, but are not limited to, the following requirements:
 - a. Local Codes and Regulations
 - b. Applicable state and local safety operating procedures
 - c. Engineer's safety practices
 - d. IEC
 - e. IET
 2. Testing performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.
 3. The testing firm provides a designated safety representative on the project to supervise the testing operations with respect to safety.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The testing agency provides all test equipment.
- B. Care and Precautions:
 - 1. The Contractor is responsible for any damage to equipment or material due to improper test procedures or test apparatus handling. The Contractor shall replace or restore to original condition any damaged equipment or material at no additional cost.
 - 2. Provide and use safety devices such as rubber gloves and blankets, protective screen, barriers and danger signs to adequately protect and warn all personnel in the vicinity of the tests.
 - 3. Use test equipment that is calibrated and certified traceable to the National Bureau of Standards.
 - a. Certification date: No later than 6 months.

PART 3 - EXECUTION

3.1 ACCEPTABLE TESTING FIRMS

- A. Provide testing firm qualifications for consideration under the provisions of Volume 2 – General Requirements.

3.2 EXAMINATION

- A. Verification of Conditions
 - 1. Examine areas for compliance with requirements for installation and conditions affecting performance of the Work.
 - 2. Identify conditions detrimental to a proper and timely completion and notify the Engineer of the unsatisfactory conditions.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 SITE QUALITY CONTROL

- A. General
 - 1. Provide all materials, supplies, tools, equipment, labour and services required to perform all tests as specified in this Section.
 - 2. Correct all deficiencies revealed by tests. Replace at the Contractor's cost, all materials and equipment found faulty.
 - 3. The testing intent is to assure that all electrical equipment, both Contractor and Employer supplied, is safe and is operational within industry and manufacturer's tolerances and is installed in accordance with the Specification.
 - 4. The test and inspections determine the suitability for energization.
 - 5. Use the International Electrical Testing Association (NETA) guidelines for all testing procedure and acceptance test values of results.
 - 6. Complete all test prior to commissioning and final acceptance.

3.4 APPLICATION

- A. Summary
 - 1. Test all cable, equipment and systems listed above to assure proper installation, setting, connections, and functioning in accordance with the Drawings, Specifications, and the manufacturer's recommendations. The field testing shall be extensive, and complete as specified, to provide positive assurance of a totally correct installation and operation of equipment.
 - 2. Furnish all necessary test equipment to satisfactorily perform all tests specified within this section.
 - 3. When conducting tests, comply with the following:
 - a. Notify the Engineer at least 2 weeks prior to commencement of any testing.
 - b. Conduct all tests in the presence of the Engineer except when advised that his presence will not be necessary.

- c. Include all tests and inspections recommended by the equipment manufacturer, whether required by these Specifications or not, unless specifically waived by the Engineer.
 - d. Maintain a written record of all tests showing date, personnel conducting the test, equipment or material tested, tests performed, manufacturer and serial number of testing equipment and results.
- 4. Tests include, but are not limited to, the following:
 - a. All Wiring: Free of shorts unintentional and grounds.
 - b. Molded case breakers 160 amperes and larger. Time and instantaneous tripping, physical condition, contact resistance, insulation resistance.
 - c. Power Circuit Breakers: Calibration to time/current curves, physical condition, contact resistance, insulation resistance.
 - d. Grounding system: Ground resistance (impedance), ground integrity.
 - e. Secondary Service Bus Ducts: Proper torque on connections, insulation resistance, physical condition.
 - f. Motor Controls: Proper overload heater sizes.
 - g. Ground Fault System: Neutral free of improper grounds and pick-up.
 - h. Protective Relays: Pick-up, timing, insulation resistance, physical condition, acceptance test as per manufacturer instruction.
 - i. Switchboards, Panelboards, and similar circuit breaker equipment: Insulation resistance, physical condition.
 - j. Feeder Cables: Insulation resistance.
 - k. Motors: Proper rotation, insulation resistance.
 - l. UPS: Load and Duty Testing.
 - m. Lighting Control System.
 - n. Emergency Lighting Central Battery System: Load and duty testing, functional testing.
 - o. ATS: Functional testing.
- B. Minimum Acceptable Test Results:
 - 1. Ground System: The main ground electrode system resistance to ground no greater than 1 ohm or in line with the authority having jurisdiction, whichever is more onerous.
 - 2. Electrical Apparatus and System Insulation Resistance:
 - a. Rating of Equipment of 250 volts maximum: Use 500 Volt D.C. test voltage. Minimum insulation resistance, 1 mega ohm.
 - b. Rating of equipment of 600 volts: Use 1000 Volt D.C. test voltage. Minimum insulation resistance, 1 mega ohm.
 - 3. Wire and Cables Under 600 Volts:
 - a. Rating of cables of 300 volts maximum Use 500 Volt D.C. test voltage. Minimum insulation resistance, 1 mega ohm.
 - b. Rating of cables of 600 volts maximum: Use 1000 Volt D.C. test voltage. Minimum insulation resistance, 1 mega ohm.

3.5 TECHNICAL REQUIREMENTS

A. Grounding Systems:

1. Tests include measurement of ground resistance at the following equipment and structures:
 - a. All primary and secondary switchgear.
 - b. All power transformer frames and neutral grounds.
 - c. All secondary switchboards located within buildings.
 - d. Other miscellaneous grounds selected at random in a manner to be representative of the entire installation.
 - e. Ground system ground rods, including those in manholes.
 - f. Isolated instrumentation system.
2. Use "3 probe - fall of potential" method ground tests made on system ground rods. All other ground tests may be measured to system ground by use of ground reference method.
3. Verify that ground system installation is completed before performing testing work.
4. Ground circuits showing more than 5 ohms resistance will be considered defective and repaired by the Contractor at his own expense.

B. Switchboard Breakers:

1. Electrical Tests:
 - a. Megger test breaker. Voltage 1000 + 2x rated voltage phase to phase, phase to ground with breaker closed, cross pole breaker open.
 - b. Check trip free operation.
 - c. Test trip devices using the primary injection current method. Verify trip timing to manufacturer's specification values.
 - d. For Test values that fail to meet the NETA or manufacturer guidelines:
 - 1) Include equipment, device, test values and failure reason on the daily report submitted to the Engineer.

C. Digital or Analog Instruments:

1. Ammeter:
 - a. Check connections from current transformer.
 - b. Check ammeter function for proper operation.
2. Voltmeter:
 - a. Check connections from potential transformer.
 - b. Check voltmeter function for proper operation.

D. Electronic Power Monitors:

1. Check connections to potential and current transformers.
2. Verify operation of monitor parameters and compare read-out values to actual measured values.

E. Instruments Transformers (Current and Potential Transformers):

1. Physically check polarity mark orientation on all CT's and PT's with 3 line diagrams and manufacturer's drawings.
2. Where CT's are used for protective relaying, the following tests shall be performed:

- a. Electrically check for correct polarity markings.
 - b. High current ratio test by injection of primary currents. Current readings shall be taken at relays, meters and instrument test blocks to verify CT ratio with connected burden.
 - c. Electrically check all PT polarity markings.
- F. Ground Fault System:
 - 1. Complete testing work before the initial energization of the service equipment.
 - 2. Determine the relay pickup current is within the limits of the device tolerance by primary injection of current at the C.T. and effecting a main protective device trip operation.
 - 3. Determine the relay pickup by current injection at the sensor and operate the interrupting device.
 - 4. Test the relay timing function by current injection. Verify timing to manufacturer's specification values.
 - 5. Verify no nuisance tripping for simulated line – neutral load using current injection.
 - 6. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.
 - 7. Test the system's neutral insulation resistance to ensure no shunt ground paths. Remove the neutral-ground disconnect like, neutral meggered clear and link replaced.
 - 8. Operate the monitor (test panel) to ensure proper indication and test operation sequence.
 - 9. Affix calibration labels to all equipment tested. Labels data: Test, Engineer, firm name and relay trip date as calibrated (trip time and relay setting in amperes).
 - 10. During construction, set relay pickups at minimum values. Set final ground fault system settings to the 'approved' coordination study values.
- G. Metal Enclosed Switchgear and Switchboard Assemblies:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect for physical damage and code violations.
 - b. Inspect for proper alignment, anchorage, and grounding.
 - c. Inspect for proper identification of protective devices and switches.
 - d. Physically test all electrical or mechanical interlocks to assure proper function.
 - e. Inspect for proper operation of space heaters and thermostat settings.
 - 2. Electrical Tests:
 - a. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground.
- H. Transformers - Dry-Type, larger than 300 KVA:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect for physical damage, proper installation, anchorage and grounding.
 - b. Verify proper auxiliary device operation such as fans, temperature indicators, etc.
 - 2. Electrical Tests:
 - a. Perform insulation resistance tests winding-to-winding and winding to- ground.
 - b. Perform turns ratio test between windings for all tap positions.

- I. Conductors Over 600 Volts:
 - 1. Visual and Mechanical Inspections:
 - a. Inspect exposed cable section for tracking corona or physical damage.
 - b. Inspect shield grounding, cable support and termination.
 - c. Clean all creepage surfaces of termination.
 - 2. Electrical Tests:
 - a. Perform D.C. hipotential test using ICEA method:
 - 1) The test conductor will be raised to a maximum test voltage and held for a total of 15 minutes. Record and plot readings of leakage current (Y axis) versus time (X axis) on 30 second intervals for the first 2 minutes and every minute thereafter.
 - 2) Perform voltage decrement test by reducing the applied voltage to zero and monitoring voltage decay versus time.
 - 3) Perform shield continuity test by ohmmeter method. Ohmic value shall be recorded.
 - 4) Apply grounds upon completion to drain all absorpic potential to zero.
 - 3. Equipment to be Tested: All medium voltage feeder cables.
 - 4. Disconnect equipment that might be damaged by this test. Perform tests with all other equipment connected to the circuit.
- J. Medium Voltage Metal Enclosed Air Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect for physical damage, proper installation, anchorage, and grounding. Clean interior, insulations, arc chutes and interphase barriers.
 - b. Perform mechanical operator tests in accordance with manufacturer's instructions. Clean and lubricate contacts and mechanism as applicable.
 - c. Check contact alignment, wipe and pressure.
 - d. Check fuse linkage and element for proper holder and current rating. Record fuse data.
 - e. Check key interlock for safe operation and proper key distribution.
 - 2. Electrical Tests:
 - a. Perform contact resistance test across each switch blade and fuse link.
 - b. Perform insulation resistance test phase-to-phase and each phase-to-ground.
 - 3. Equipment to be Tested: All medium voltage switches.
- K. Circuit Breakers - Medium Voltage and Medium Voltage Vacuum:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect for physical condition.
 - b. Inspect breaker to cell alignment and grounding.
 - c. Perform mechanical operator and contact alignment tests on the breaker and its operating mechanism in accordance with manufacturer's instructions.
 - d. Check tightness of accessible hardware connections.
 - e. Clean mechanism, insulating surfaces and contacts.

- f. Check indicator for contact wear in accordance with manufacturer's instructions.
 - 2. Electrical Tests:
 - a. Measure contact resistance.
 - b. Trip circuit breaker by operation of each protective device.
 - c. Perform an insulation resistance test phase-to-ground, phase-to phase and across open contacts.
 - d. Perform insulation resistance test on control wiring.
 - e. Perform insulation power factor test in accordance with Doble procedure. (Air circuit breakers).
 - f. Perform vacuum bottle integrity tests on each phase in accordance with manufacturer's instructions. (Vacuum circuit breakers).
 - 3. Equipment to be tested: All medium voltage circuit breakers provided under this work, and all existing circuit breakers reused, reconnected, or reinstalled.
 - 4. Protective Relays:
 - a. Visual and Mechanical Inspection:
 - 1) Inspect relays for physical damage, presence of foreign material, moisture, condition of spiral spring, disc clearance and corrosion.
 - 2) Clean cover glass and relay components as required.
 - 3) Check for freedom of movement, proper travel, alignment and tightness of mounting hardware and tap screws.
 - b. Electrical Tests:
 - 1) Perform insulation resistance test on each circuit branch to frame.
 - 2) Perform the following tests at the settings specified by the Employer / Engineer:
 - a) Pickup parameters on each operating element.
 - b) Timing 'a' 3 points on time characteristic curve.
 - c) Pickup target and seal in units.
 - d) Special tests as required to check operation of restraint, directional, and other elements per manufacturer's instructions.
 - e) Perform functional test to ensure relay contacts trip the associated breaker on auxiliary device.
 - f) Perform phase angle and magnitude contribution tests on all polarity sensitive relays after energization to vectorially prove proper polarity and connection.
 - c. Equipment to be Tested: All protective relays.
- L. Thermographic Survey:
 - 1. Visual and Mechanical Inspection:
 - a. Remove all necessary covers prior to scanning.
 - b. Inspect for physical, electrical, and mechanical condition.
 - 2. Equipment to be Scanned as follows:
 - a. Medium/low voltage switchgear.

- b. Busways.
 - c. Transformers-Dry-Type (larger than 300 KVA).
 - d. Main distribution switchboard.
 - e. Bus ducts.
- M. All Low Voltage Wiring
 - 1. Perform and record all tests to BS7671 and latest regulations issued by the local authority having jurisdiction.

3.6 LOAD BALANCING

- A. Connect all branch lighting and power circuits to panel boards to balance the actual loads (wattage) within 5%. If required, transpose branch circuits when the work is complete to meet this requirement.
- B. The Contractor shall perform all necessary tests to show that the above requirement has been fulfilled. Make such tests after the project is occupied and the normal loads have been established. Furnish all layout, meters, connections, and accessories for these tests, make the tests other than during regular hours and as agreed with the Engineer.

3.7 RETESTING

- A. Retest any equipment which does not pass initial tests, or where subsequent testing is required for acceptance as directed by the Employer / Engineer.

3.8 REPLACEMENT OF DEFECTIVE MATERIAL OR EQUIPMENT

- A. Repair or replace any material or equipment found defective or cannot pass the tests specified in this Section at no additional cost to the Employer.
- B. Complete correction of defective material or equipment and retesting within the Contract period.
- C. If the equipment or material cannot pass the second test, remove the defective equipment and replace it with equivalent equipment that meets the Specifications. Such replacement shall be at no additional cost to the Employer.
- D. Remove defective equipment or material from the site no later than 15 days from the date of notification by the Employer / Engineer or his representative.

3.9 FIELD ADJUSTMENTS

- A. The Testing firm is responsible for final setting and adjustments on protective devices in accordance with Division 26 - Short-Circuit Analysis and coordination study and approved by the Engineer.
- B. Properly remedy defects in Work or equipment that appear during tests and test again subject to acceptance by the Engineer.

3.10 SAFETY AND PRECAUTIONS

- A. Safety practices include, but are not limited to, the following requirements:
 - 1. Local Codes and Regulations.
 - 2. Applicable national and local safety operating procedures.
 - 3. Employer's safety practices.

4. International Electrotechnical Commission.
 5. Institution of Engineering and Technology.
- B. Testing performed with apparatus de-energized. Exceptions shall be thoroughly reviewed to identify safety hazards and devise adequate safeguards.
- C. The testing firm provides a designated safety representative on the Project Site to supervise the testing operations with respect to safety.

END OF SECTION 26 01 26