

Activity I&C/Electrical Equipment

1.0 Purpose This guideline provides a method to evaluate safety-related instrument and electrical and component modification installation and inspection activities during the plant's operational phase.

2.0 Scope This guideline has been developed for use in the review and evaluation of Class 1 and Class 1E electric power instrumentation and control equipment. It is not intended to apply to connecting cables, raceways, sensing line installation, welding activities, and structural support areas. The following areas are considered:

- Receiving activities.
- Storage activities.
- In-process installation activities.
- Completed work activities.
- Testing.

References

1. IEEE Standards.
2. NRC Inspection Procedure S2053, "Instruments Components and Systems."
3. NRC Inspection Procedure S1053, "Electrical Components and Systems."

3.0 Guidelines

3.1 In preparation for and during the conduct of this surveillance

- Obtain and review implementing procedures, instructions, and drawings governing this activity.
- Prepare a guide or checklist using the selected items from this guideline.
- Review past surveys, audits, surveillances, and other evaluations/assessments.
- Ensure that checklists include, where applicable, actual observations of performance, general plant conditions, radiological work practices, housekeeping, work document controls and use, and safety practices.

Note: Refer to Chapter 1 for specific details on the attributes listed above.

3.2 Using the latest reviewed and approved plant instructions, it is recommended that the evaluator prepare a surveillance checklist or other appropriate documentation of the requirements therein for use in the evaluation of the program implementation. Other appropriate plant requirements, such as those contained in instruction letters, etc., are also to be considered for use in the evaluation.

Note: Observation of real-time activities is emphasized and desired for surveillance. Specific situations, wherein the individual is experienced and knowledgeable in the area, may occur where completion of the checklist is performed after the observation.

- 3.3 Identify and review NRC and audit program findings and previous surveillance reports relative to instrument and electrical equipment and component installation activities. Include significant historical problems and open items in the evaluation documentation for verification of progress toward corrective action completion.
- 3.4 The selection of instrument and electrical equipment and components for evaluation should be based on their importance to operational safety and shall include redundant components and a diversity of components and locations. Some of the items selected should be located in harsh environment areas.
- A. Electrical components and systems consist of those plant items that are designed to supply, use, control, transform, condition, or interrupt electric power. The evaluator should consider items such as the following:
1. Diesel generator system components and associated electrical auxiliaries.
 2. DC systems and inverters.
 3. Distribution, control, and protective apparatus such as transformers, switch-gear, large and small motors, motor-generator sets, motor control centers, and heaters.
 4. Associated components such as controllers on motor-operated valves, solenoid valves, limit switches, interlocks, containment penetrations, circuit breakers, fuses, and control panels.
 5. Balance-of-plant electrical components that may affect safety-related electrical equipment.
- B. Instrumentation has extensive applications in sensing and displaying plant process variables and providing for reactor protection during normal, abnormal, and emergency operations. The evaluator should consult instrument safety classifications and consider the following types of equipment:
1. Instrumentation sensing reactor trip system process variables such as neutron flux, core coolant temperature, pressurizer pressure (PWR), reactor vessel water level (BWR), turbine trip and interrelated devices associated with signal conditioning, isolation interlocks, and bypass.
 2. Instrumentation involving the engineered safety features' actuation system which monitors variables in containment pressure, pressurizer level and pressure (PWR), reactor coolant temperature, reactor vessel level (BWR), and high containment pressure.
 3. Equipment involving important to safety/balance-of-plant equipment such as the instrument air system used for safety-related control components.
- 3.5 Observe and review receiving inspection practices involving instrument and electrical equipment and components to evaluate implementation of the following:
- A. Identification appears on the instrument and electrical equipment and components and in the receiving documents.
- B. Physical condition of the instrument and electrical equipment and components is assessed to identify damage, deterioration, etc.

C. Documentation relative to quality requirements (e.g., results of functional and qualification testing) is reviewed to and meets requirements.

1. Where environmental qualification testing or other qualifications (such as seismic) are invoked, receiving inspection should verify satisfactory testing.

Note: The evaluator should recognize that qualification testing of components to be placed in a harsh environment (e.g., inside containment) is sometimes not a specification requirement. Attention to specific item specification requirements and exceptions is necessary.

2. It is not mandatory that all documentation be available on-site at equipment/material arrival, but a program must be implemented to identify the conditional status of the material pending the receipt, review, and acceptance of the documentation.

3.6 Observe and evaluate storage activities and conditions to assess the following:

- A. Components are stored in the proper storage level designation. Storage levels depend on the importance of the equipment and its susceptibility to damage and deterioration. The most stringent controls are required for special materials such as chemicals that are sensitive to environment. Actual equipment classifications should be applied.
- B. Proper identification is provided. The evaluator should recognize when evaluating storage activities that various items are provided in hermetically sealed packagings to provide for optimum protection. Coverings usually are removed only prior to release for site installation. Measures, however, should be implemented for confirming specific model number, equipment ratings, and other unique component electrical characteristics.
- C. Temperature, humidity, cleanliness, etc., conditions are established, controlled, and monitored.
 1. It is especially important that motor storage requirements (e.g., heaters energized, periodic shaft rotation, insulation tests) and battery maintenance requirements are being met.
 2. Assess whether specific manufacturer maintenance requirements, if ignored, would void warranty or make condition of equipment indeterminate.
- D. In-place storage requirements, where necessary, are developed and satisfactorily implemented. In these cases special efforts are usually required to implement established requirements. Attention should be given periodicity of inspections particularly for those items in longer term storage.

3.7 Observe and evaluate portions of the in-process instrument and electrical equipment and component installation activities. Determine whether

- A. The latest approved revision of applicable work plan, construction specifications, drawings, and/or procedures are available and used by the installers.
- B. The components are as specified, such as type, accuracy, range, proof pressure/rating, and material. Installed components should be uniquely identified on the component, the installation records, calibration records, and inspection records. It should be recognized that similar-looking electrical and instrumen-

tation items can be inadvertently installed in the wrong location. Positive identification and control is necessary.

- C. The components are installed in the proper location and orientation by qualified craft personnel using suitable equipment and tools.
 - 1. Installation requirements should be according to approved drawing, procedure, work traveler, specification, etc.
 - 2. Certain installation tools (e.g., torque wrenches and crimping tools) should be in the calibration control program.
 - 3. During installation of equipment, anchorage holes are sometimes drilled in concrete structures. Indiscriminate cutting of reinforcing steel should not be allowed and when identified properly disposed.
 - 4. Determine, particularly for large electrical components that are being moved during the installation stage, that consideration is being given such points as types of rigging used, attachment points, center of gravity, and top side positioning to avoid equipment damage.

Note: Specific site procedures should exist for other handling during receipt and storage.

- D. Inspection activities are timely and properly completed by qualified personnel. Such inspections can include, for example: verification of leveling and alignment, clearance and tolerances, location and routing of lines for physical separation considerations, tightness of connections and fastenings, freedom of movement, correct polarity, proper grounding, terminations, fluid levels and pressures, leak tightness, and identification.
 - 1. Hold/witness points should be established on equipment/component work plans.
 - 2. Attention should be given the specified frequency of the inspections and their sequence.
 - 3. Installation and inspection activities should be documented during the activity. Specific numeric values for inspection criteria should be used where applicable. Functional operation checks of doors, switches, knobs, pull-out trays, and cleanliness checks are usually either satisfactory/unsatisfactory.
- E. Installed components are adequately protected from damage by adjacent construction activities, e.g., welding, cutting, grinding, and concrete work.
- F. Internal wiring of instrumentation panels, boards, or equipment is being conducted and verified according to approved drawings. Additionally, the location of components, contact configuration of electromechanical devices, relays, and switches is verified. Point-to-point continuity checks, maintenance of minimum internal separation between redundant Class 1E wiring, crimping, and other wiring inspection requirements as defined by applicable site procedure should be conducted and documented on required inspection records.
- G. Nonconformances are identified and handled in accordance with procedures. Repair or use-as-is dispositions are properly documented, justified, and approved. Where corrective action is being taken, determine whether it meets the defined requirements.

3.8 Observe and evaluate portions of the completed instrument and electrical equipment and component installation.

Determine whether applicable requirements are being met in the following areas:

- A. Location, configuration, and installation (including mounting and anchoring) are according to the latest approved design or construction specifications and drawings. Verify that discrepancies are properly controlled and subsequent changes are documented, engineering review and approval is conducted, and final as-built drawings are updated. Direct comparison between the drawing and the actual installation is recommended.
- B. Specified instrument and electrical components, materials, and associated items have been used. Attention should be given component model numbers, ranges, accuracy, type, and unit of measurement.
- C. Components have been correctly and permanently identified.
 - 1. In those cases where components and equipment are substituted and transferred between units, determine that practices are according to approved procedure and positive identification is maintained.
 - 2. Particular attention should be given the location, size, color, and printed equipment identification codes provided on nameplates. Specific site rules apply.

Note: Precautions should be taken when drilling is used for attachment of nameplates. Drill filings can interfere with the functioning of equipment and care should be exercised that insulation on internal wiring is not cut.

- D. Verify that cleanliness requirements have been maintained or otherwise satisfied. Periodic housekeeping inspections should be maintained throughout the construction period until operational practices are applied.
- E. Verify that equipment is adequately protected from adjacent construction activities and protective coatings, plugs, and bushings and other materials have been used as specified. Attention should be given temporary measures taken to protect panels, electrical enclosures, motors, etc., from damage. Cautions and administrative controls should be established for their removal prior to energization when overheating and equipment cooling considerations would apply.
- F. Verify that equipment and components are protected from hostile environments, such as high-pressure piping, rotating equipment, and nonseismically supported equipment. Both those obvious and questionable areas identified in the plant should receive additional attention to determine if established requirements are actually satisfied.
- G. Verify that electrical components, motors, and power distribution centers maintain specified physical and electrical separation and independence between redundant components.
- H. Verify that nonconforming components or conditions have been identified and controlled in accordance with approved procedures.

- I. Verify that status of completion, maintenance, and readiness for pre-operational testing is indicated or otherwise documented.
- J. Verify that adequate actions or provisions have been taken or maintained (as needed) to ensure that the validation of the environmental qualification of instrument components is maintained.

3.9 Review and evaluate installation activities that resulted in or were a result of changes to drawings, specifications, procedures, and other related documents as applicable. Determine if the following are implemented:

- A. Design and field changes, as well as work and inspection procedure changes, were reviewed and evaluated by qualified personnel and are of the type approved for that purpose.
- B. For periodic inspections, only the most recent approved document, including design changes, were used in the field.
- C. Deviations to design requirements include preparation of a CAQR even if the deviation is resolved through the design change process.

4.0 Other Guidelines for Consideration

- 4.1 See Chapter 1, "General Quality Surveillance Guidance."
- 4.2 See Chapter 12, "Cleanliness."
- 4.3 See Chapter 12, "Corrective Maintenance."
- 4.4 See Chapter 12, "Equipment History."
- 4.5 See Chapter 12, "Housekeeping."
- 4.6 See Chapter 12, "Material Control."
- 4.7 See Chapter 12, "Fuse Control."
- 4.8 See Chapter 14, "Design Change Control."