

# NRC INSPECTION MANUAL

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## INSPECTION PROCEDURE 51061

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### ELECTRIC CABLE - PROCEDURE REVIEW

PROGRAM APPLICABILITY: 2509

#### 51061-01 INSPECTION OBJECTIVES

01.01 To determine whether technical requirements contained in the facility safety analysis report (SAR) for safety-related electric cable, terminations and associated items have been adequately translated into applicable construction specifications, drawings, work procedures, and instructions, and whether these documents are of sufficient detail and clarity for adequate work performance and control.

01.02 To determine whether applicable quality assurance plans, instructions and procedures for the control and installation of safety-related electric cable, terminations, and associated items have been established in licensee and contractor QA manuals and whether these conform to the QA program described in the facility SAR.

01.03 To determine whether any generic problems or other weaknesses exist within the operation of organizations responsible for quality assurance programs and work specifications and instructions for control and installation of electric cable, terminations, and associated items.

#### Inspection Schedule

<u>Inspection</u>	<u>May Be Started</u>	<u>Must Be Started</u>	<u>Must Be Completed</u>
Initial	Six months before work is started	Before work is started	Substantially complete before work
Followup	After work is	After work is	Before work is 70%

#### 51061-02 INSPECTION REQUIREMENTS

02.01 Quality Assurance Program. Review licensee and contractor commitments and procedures covering the span of documents to be prepared for assuring the quality of safety-related electric cable and terminations.

- a. Complete the requirements of IP 35100 for each onsite organization associated with safety-related electric cable and terminations. Additionally, determine whether these procedures are consistent with the QA program described in the SAR.
- b. Determine whether responsibility assignments for procedures preparation, review and approval include groups with necessary technical expertise.
- c. Determine whether groups that review and approve quality records are required to have the necessary technical expertise to ensure that the information to be recorded meets applicable requirements.

02.02 Specific Technical Review Areas. In addition to the broad areas covered by IP 35100, determine whether procedures covering work and inspection activities in the following areas are appropriate for the activity and are technically adequate.

- a. Receiving Inspection Procedures. Receiving inspection and related procedures provide means to ensure that:
  1. Received components are as specified, properly identified and controlled - or otherwise noted.
  2. Inputs from other groups or other organizations to be used during receiving inspection activities are properly utilized; such as the results of source inspections, environmental qualification tests and other required quality tests.
  3. Procurement requirements such as qualification tests (seismic, environmental, etc.), functional tests and other quality tests (material, physical and chemical) have been successfully completed or status of how and when such requirements will be satisfied is documented and adequately controlled.
- b. Storage Procedures. Storage procedures provide means to ensure that:
  1. The proper storage environments (as specified by the construction specifications and the manufacturers) are established for the various types of electric cable and cable system components and meet applicable storage classification levels regardless of the location of the stored item.
  2. Storage inspection procedures require initial verification of storage conditions and periodic verifications for the duration of the storage period. They must also ensure that special and in-place storage requirements are met.
- c. Work Procedures. Work procedures are established to ensure that:
  1. NRC requirements and SAR commitments are properly translated into the work procedures (construction specifications, drawings and work instructions) for adequate control and installation of electric cable and associated items. Areas to review shall include, but are not limited to, the following:
    - (a) Raceway completion (edge softeners, bushings, supports, identification, sharp edges, etc.) and condition (free of debris) before use.
    - (b) Cable type and size.
    - (c) Cable temperature (if stored in cold weather).
    - (d) Cable splices (where allowed).

- (e) Pulling attachments, lubricating compounds, and tension (including calibration of tension devices).
  - (f) Bending radius (during and after installation).
  - (g) Cable identification.
  - (h) Cable routing.
  - (i) Separation and independence.
  - (j) Segregation (power, control, instrument).
  - (k) Cable supports (grips).
  - (l) Handling of cable and termination materials to ensure protection from damage and contamination (includes the protection of cable ends from moisture).
  - (m) Protection of cables from adjacent construction activities.
  - (n) Hold points.
  - (o) Termination activities such as:
    - (1) Application of materials (lugs, tapes, stress cones, connectors, terminal blocks, etc.).
    - (2) Use of calibrated torque wrenches and crimping tools.
  - (p) Raceway loading.
  - (q) Fire barriers and seals as required.
2. Interface controls are adequate when multiple contractors are involved.
- d. Inspection Procedures. Inspection procedures have been established and include the following:
1. Positive identification of the cable system and/or activity to be inspected and the specific inspection method(s) to be used.
  2. All the technical aspects of inspection requirements to sufficiently determine whether installation, testing, maintenance and protection conform to applicable design and construction specifications.
  3. Identification of the specific acceptance criteria and verification that acceptance criteria are met, including special requirements.
  4. All required data that is to be recorded on inspection reports and to whom the completed reports are to be transmitted.
  5. Qualification of inspection personnel.
  6. Review and evaluation of inspection reports.

- e. Construction Testing Procedures. Procedures for cable system and component testing provide means to ensure that:
  - 1. Required construction testing is controlled and performed as specified using qualified personnel.
  - 2. Cable systems and components to be tested are properly identified along with tests to be conducted.
  - 3. Proper type of test equipment (range, accuracy, calibration, etc.) is specified.
  - 4. Special conditions of testing, prerequisites, sequence, precautions, etc., and acceptance criteria are specified and meet requirements.
  - 5. Type of data to be recorded and method of reporting results are specified.
  - 6. Test results are evaluated by qualified personnel.
  - 7. Discrepancies are resolved.
  
- f. Personnel Qualification. A program has been established for ensuring that all craft, examination and inspection personnel associated with electric cable systems are trained and qualified to perform their assigned duties. The program includes:
  - 1. The proper use of installation equipment (tension devices, pulling compounds, etc.).
  - 2. The proper handling, supporting and protection of cables and cable segments stored in place.
  - 3. Approved methods for cable end protection.
  - 4. Identification of requirements for the installation of safety-related cables.
  - 5. Approved methods for cable termination and splices.
  
- g. Change Control Procedures. Procedures have been established to control design and field changes for cable systems and ensure:
  - 1. Coordination among participating design and construction organizations.
  - 2. Retrieval of voided drawings and specifications at work sites is controlled.
  - 3. Periodic inspection of drawings, specifications, and procedures used in the field.

02.03 Followup Procedure Review. When cable and terminations are about 50% installed, review work and QA/QC procedures pertaining to installation and inspection. Review a selected sample of procedures addressed in Sections 02.01 and 02.02, above. Note significant changes made (revisions, deletions, additions, etc.) and determine whether the changes are appropriate and whether NRC requirements and licensee commitments remain in these procedures.

02.04 Additional Inspection. Additional inspections may be conducted in the areas covered above if Regional management concludes that recent findings **when evaluated by the SDP will likely result in an assigned color of 'white or above'**. In these cases, particular

consideration should be given to an expanded sample of items to be inspected under Sections 02.01, 02.02c and 02.02d, above.

## 51061-03 INSPECTION GUIDANCE

### General Guidance

- a. This IP applies, but is not limited, to all safety-related electric power, control and instrument cables, terminations, splices, fire barriers and seals. The term "cable" includes all conductors such as wires, cables and busbars. The term "termination" includes all electric conductor terminations such as lugs, splices, connectors, and terminal strips which directly contribute to the electrical continuity of the circuit. Terminations also include potheads, bushing, stress cones, taping, compounds, and other devices or techniques which directly contribute to the continuity of the electrical insulation system.
- b. Applicable portions of the SAR, Safety Evaluation Report (SER) and NRR/licensee questions and answers should be reviewed during inspection preparation. Determine specific licensee procedural and work instruction commitments relative to construction and inspection (QC) requirements for electric cables and terminations. The inspector should then utilize the above information during review of the licensee's construction specifications, drawings, work, and inspection procedures to determine whether SAR requirements are adequately translated into the appropriate documents.
- c. Procedures control activities such as storage, installation, inspection, calibration and testing. To be adequate, they must contain sufficient detail to assure that the specific work steps which affect the functioning of the installed equipment will be performed properly. These work steps are to be identified and adequately controlled. While reviewing procedures, be aware of and look for inadequacies that could lead to construction deficiencies and/or indicate an inadequate management control system.
- d. It may be appropriate to complete portions of this IP in conjunction with similar requirements of IPs 51051 and 52051. Where the same contractor, procedures and personnel are utilized for activities covered by the above IPs, it is not necessary to repeat similar inspection requirements for each of these IPs. (If so, the NRC inspection records should reflect that electrical, instrumentation, and electric cable areas have been addressed.)
- e. The inspector should bear in mind that the procedures selected for detailed NRC review cover only a representative sample of the procedures involved. Thus, substantive errors or departure from requirements identified in NRC's sample raises the issue of whether the NRC inspector and/or the licensee should conduct additional examinations to determine the extent of the identified problem.
- f. Findings from this inspection activity should address each functional area as being satisfactory, being unresolved and requiring resolution, or being in violation and requiring correction. When significant inadequacies are identified indicating weakness within the responsible organization, the inspector should inform cognizant regional supervision. The issue should be addressed also at the appropriate level of licensee management.

### 03.01 Specific Guidance

- a. Inspection Requirements 02.01 and 02.02. The expertise of the inspector is important for the proper completion of the inspection. The individual selected to perform 02.01 should have a general knowledge of and background in quality assurance, and the individual selected for 02.02 should be thoroughly knowledgeable of the technical requirements associated with electric cables and terminations. One individual may perform both requirements if he/she exhibits appropriate knowledge in both areas.
- b. Inspection Requirement 02.02. For the purpose of this IP, the term "work procedures" includes construction specifications, drawings, and work instructions. (Procedures describing methods of fabrication, construction or installation are sometimes called construction procedures.)
- c. Inspection Requirement 02.02a
  1. Receiving inspection procedures should reflect the requirements of RG 1.38/ANSI N45.2.2 or equivalent requirements. They should contain provisions for assuring that:
    - (a) Cable and termination materials are in conformance with purchase specifications including special requirements.
    - (b) Adequate marking and identification are provided.
    - (c) As-received cleanliness and protection are adequate.
    - (d) Receiving inspection reports are complete.
    - (e) Control and disposition of non-conforming items are adequate.
  2. The SAR should identify and describe all cable and associated items which must operate in a hostile environment (e.g., high radiation, temperature, humidity) during or subsequent to an accident (e.g., loss of coolant, steamline break). Where environmental qualification testing or other qualification provisions are specified, means shall be established to assure that the results of this testing are documented, reviewed, and determined to be acceptable. This is a particularly significant area for NRC review.
  3. Procedures shall include provisions to assure that the applicable environmental, functional, and other quality tests have been passed by the cable, pulling compounds, and termination materials. The design criteria for these tests should be specified or referenced in the procurement documentation.
  4. The following tests may be required to be performed either sequentially or synergistically: radiation, fire resistance, high potential, insulation resistance, continuity, temperature, humidity, submergence, steam or water impingement, chemical spray, aging, and/or chemical compatibility with pulling compounds or soil (if direct burial).
  5. Fire barriers and cable penetration seals require qualification. The tests and criteria can be found in 10 CFR 50, Appendix R, Section M; IEEE 634, Cable Penetration Fire Stop Qualification Test; and ASTM/ANSI E119, Fire Tests of Building Construction and Materials.

- d. Inspection Requirement 02.02b
  - 1. Special storage requirements are typically specified by the manufacturer or an industry standard, such as ANSI N45.2.2. The requirements should include such things as taping or sealing cable ends; controlling material and cable or cable reel identification; maintaining proper ambient temperature; separation from nonconforming items; and placement on dunnage.
  - 2. Cable and termination materials may be released for installation on the merits of certifications if the organization involved has established satisfactory program control and audit requirements in this area (ANSI N45.2.13). However, certifications do not release the licensee from having other records for operation and for the life of the plant.
- e. Inspection Requirement 02.02c. Appropriate and adequate construction specifications and other work instructions for a particular activity should be approved and available before that activity is started.
- f. Inspection Requirement 02.02c1(a). The procedure should require QC acceptance of raceway installations before routing cable.
- g. Inspection Requirement 02.02c1(b). Some method or procedure should be established to assure that the cable is properly qualified for the environment in which it is to be located.
- h. Inspection Requirement 02.02c1(d). Splices in certain locations, such as raceways, may not be allowed. Refer to RG 1.75 and licensee commitments.
- i. Inspection Requirement 02.02c1(i). Refer to the following for information pertaining to separation and independence: 10 CFR 50, Appendix A, General Design Criteria 5, 17, 21, and 22; RG 1.75; and IEEE Standard 384.
- j. Inspection Requirement 02.02c1(p). Procedures should require verification that loading requirements (both thermal and mass) are not exceeded in final cable routings in trays, busways, conduits, etc. This verification should include review of actual cable routing, cable routing records, and design calculations.
- k. Inspection Requirement 02.02c1(q). Only specified materials should be used for fire barriers, fire stops, and fire retardants; and installation should be in accordance with approved procedures. Cables may have to be derated when fire retardant materials are used.
- l. Inspection Requirement 02.02d
  - 1. The licensee or contractor procedures involved will differ from site to site, and may take various forms, such as formal procedures, instructions, checklists, drawings, etc. Review the inspection procedures and compare with the requirements in the applicable codes and construction specifications. Evaluation should indicate whether adequate quality-related inspection procedures are established and are based on appropriate criteria, and further, whether the results of the licensee's inspection will be transmitted to responsible quality assurance and management personnel.
  - 2. Provisions should include monitoring or surveillance of installed cables by inspection (QC) personnel to assure that adequate protection is provided against possible damage from adjacent construction activities, including

construction traffic. (Where protective means used during construction may affect proper operation, provisions should be provided for timely removal.)

- m. Inspection Requirement 02.02d4. Records of initial and followup inspections must include the specific results of the inspection. This should include the specific characteristics being inspected (or the actual measured values), the inspector's determination of acceptability, and identification of any nonconformances found.
- n. Inspection Requirement 02.02e
  - 1. This item does not include preoperational testing. Construction testing generally verifies that certain components pass specific tests as required but is not a test of system capability, especially systems that include nonelectrical equipment.
  - 2. The intent of this requirement is to determine whether adequate QA procedures have been established to assure that the required testing is satisfactorily completed and corrective action, if required, is properly performed.
- o. Inspection Requirement 02.02f
  - 1. It is particularly important that licensee management have an established program for ensuring that all personnel involved in cable system installation activities are suitably proficient, skilled, or otherwise qualified by experience or training to perform their assigned duties.
  - 2. An effective indoctrination and training program should be in place to assure that suitable proficiency is achieved and maintained for craft personnel. This is especially true for electricians conducting special tests.
  - 3. Inspection personnel shall be qualified in accordance with RG 1.58 (ANSI N45.2.6) or similar requirements.
- p. Inspection Requirement 02.02g. Cable routing changes are made quite frequently after the start of cable pulling. It is important to determine whether an adequate system of controls for these changes is established, especially for field-initiated changes. The established procedures to control these changes should result in correct and prompt changes to route slips, pull cards, or whatever means the electricians and inspectors use to determine cable routing. Procedures should be established also to periodically verify that the system is working properly.

03.02 Prevalent Problems and Concerns. The inspector should be alert to problems of a generic nature, such as:

- a. Adequate procedures or other means have not been established to assure and document that all safety-related systems have met applicable acceptance criteria, or to specifically document nonconformances.
- b. Inspection procedures do not include adequate inspection requirements and acceptance criteria.
- c. Inadequate means to control location and status of electric cable and components - especially during removal for repair or replacement.
- d. Inadequate procedures to control the evaluation, approval and use of field changes. (Means should be established also by the licensee or contractor to assure that only



the latest approved field changes and other revisions or changes are being used for installation and inspection activities.)

51061-04 REFERENCES

10 CFR 50, Appendix A - General Design Criteria for Nuclear Power Plants, Criteria 1, 2, 3, 4, 5, 17, 18, 19, 20, 22, 24, 34, 35, 38, 39, 40 and 46

10 CFR 50, Appendix B - Quality Assurance Criteria for Nuclear Power Plants

Facility SAR, Chapters 1, 3, 5, 6, 7, 8, 9 and 17, including pertinent codes and standards referenced in the SAR

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