

**INSPECTION TECHNICAL PROCEDURE**

**I-126**

**ELECTRICAL CIRCUIT TESTING INSPECTION**

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# **INSPECTION TECHNICAL PROCEDURE I-126, REV. 0**

## **ELECTRICAL CIRCUIT TESTING INSPECTION**

### **1.0 PURPOSE**

This inspection procedure provides guidance to assess the Contractor's activities for the testing of important-to-safety electrical cables following cable installation. This guidance is based on the requirements set forth in the Safety Requirements Document (SRD), the Integrated Safety Management Plan (ISMP), and the Quality Assurance Manual (QAM).

This inspection procedure assesses the adequacy and effectiveness of the following:

- Procedures and programs for accomplishing testing activities and assuring cabling was not damaged during cable pulling activities
- Contractor work activities implementing the cable testing activities
- Training and qualification of personnel implementing the program and procedures
- System of records demonstrating management and accomplishment of required testing activities.

### **2.0 OBJECTIVES**

This procedure provides inspection requirements and guidance for inspectors to verify the Contractor has established and implemented effective programs and procedures to ensure important-to-safety electrical cables are tested following cable pulling activities and testing is accomplished in accordance with requirements. This includes programs and procedures for: (1) verifying cable continuity and cable insulation resistance conforms to manufacturer's requirements following cable pulling work; (2) managing and providing oversight to ensure testing activities are performed in accordance with the established procedures, drawings, and programs; and (3) managing and providing oversight to ensure the as-constructed condition of the facility equipment is in accordance with the design requirements.

This procedure is one component of a complete construction inspection program. This and other inspection procedures will be used, as needed, to provide assurance construction activities are being conducted as required by authorization basis commitments and Contractor procedures. It is not expected completion of the entire procedure will be accomplished during any one inspection and/or every time the inspection procedure is used.

### **3.0 INSPECTION REQUIREMENTS**

#### **3.1 Adequacy and Effectiveness of Construction Implementing Procedures**

- 3.1.1 The inspector should verify the Contractor/subcontractor with responsibilities in the area of installing cables has approved procedures describing the administrative controls and work processes to be implemented. Verify these procedures and controls ensure cables have been tested to verify the as-installed continuity and cable insulation conforms with design requirements. (QAM, Policy Q-05.1, Sections 3.1.1 and 3.3; SRD Safety Criteria (SC) 4.1-2 and 7.3-5; and ISMP, Table 1-3, item 5)
- 3.1.2 The inspector should verify procedures provide for inspections to ensure important quality-related aspects of the electrical cable continuity and insulation testing work are verified and documented. (QAM, Policy Q-05.1, Section 3.5.1; SRD, SC 4.1-2, 4.4-12, and 7.3-7; and ISMP, Table 1-3, items 5 and 8)
- 3.1.3 The inspector should verify the Contractor has established procedures for ensuring craft and inspection personnel performing cable continuity and insulation testing work are qualified to perform their assigned work. (QAM, Policy Q-02.2, Section 3.3.2; and ISMP, Table 1-3, item 2)

#### **3.2 Adequacy and Effectiveness of Construction Activities**

The inspector should verify work is being accomplished under controlled conditions in accordance with the Contractor's approved procedures. (QAM, Policy Q-05.1, Section 3.1.1; SRD, SC 4.1-2, 4.4-12, and 7.3-5; and ISMP, Table 1-3, item 5)

#### **3.3 Adequacy and Effectiveness of the Training and Qualification of Personnel**

The inspector should verify craft and QC personnel involved in the performance of cable insulation and continuity inspection activities are qualified to perform their job functions. (QAM, Policy Q-02.2, Sections 3.2.2, 3.3.1, and 3.3.3; and SRD, SC 7.3-3)

#### **3.4 Adequacy and Effectiveness of the System of Records**

The inspector should verify records reflect the achievement of required quality of the electrical cable installation; are as specified by approved procedures; have been reviewed for accuracy and assurance the recorded information meets project requirements; have been approved; and are stored and maintained sufficient to support technical requirements and contractual regulatory compliance. (QAM, Policy Q-17.1, Sections 3.1.2, 3.3.1, and 3.6.1; SRD, SC 4.0-3, 4.1-2, and 7.3-4; and ISMP, Table 1-3, item 4)

## **4.0 INSPECTION GUIDANCE**

Important-to-safety cabling must be inspected to verify the cabling did not sustain damage during installation and retains the characteristics mandated by the designer and provided by the manufacturer. Cables are subjected to high tensile forces during cable pulling activities that may result in damage to the cable insulation or conductor breakage. Accordingly, the Contractor should verify cable continuity and insulation resistance conforms to the designer's and manufacturer's expectations following installation.

The National Electric Code (NFPA-70, 1999 Edition) requires in Article 110-7 that all wiring shall be installed so that, when completed, the system will be free from short circuits and from grounds other than those required or permitted in Article 250 (Grounding). (NFPA-70 is referenced as as implementing standard in SC 4.4-12.) Insulation damage may result from cable pulling activities and degrade the insulation resistance below that provided by the cable manufacturer and the designer. Insulation integrity is especially critical for cables in 600 volts, and greater, circuits. Accordingly, the Contractor is obligated to verify cable insulation integrity conforms to the minimum requirements specified by the manufacturer. Insulation integrity is usually tested by performing megger tests or high potential testing on the cable.

### **4.1 Adequacy and Effectiveness of Construction Implementing Procedures**

- 4.1.1 The inspector should review the cable manufacturer's and designer's requirements and the Contractor's procedures for the testing of continuity and insulation integrity on cables important to safety. The objective of these inspections is to ensure requirements for insulation and continuity testing, following cable pulling, are included in procedures.
- 4.1.2 The inspector should review the Contractor's procedures to ensure inspections and tests are scheduled and provided to verify the continuity and insulation test equipment is in proper working order, and acceptance criteria have been provided and verified.
- 4.1.3 No additional guidance is necessary.

### **4.2 Adequacy and Effectiveness of Construction Activities**

Prior to performing work observation inspections in the field, the inspector should review the Contractor's procedures for accomplishing cable continuity and insulation testing and inspection activities. During the field observations, the inspector should carry a copy of the procedure(s) pertinent to the planned observations.

During the field observations, the inspector should interview a sample of the craft and QC personnel performing the observed activities. The interviews should focus on determining whether job and procedure knowledge is satisfactory. The names and job functions of those interviewed should be obtained and later used to verify proper implementation of personnel qualification requirements, as specified in Sections 4.3 and 4.4, below.

Continuity testing may be performed using a number of techniques; for example, a radio frequency signal verification throughout the length of the cable or, as is more common, a simple sound device actuated by a transmitter attached to the cable at the other end. Insulation testing may be performed with the termination lug on or off the cable. Generally, insulation testing of cables is performed with the cable disconnected at both ends; although, in the case of power cables, testing can be done with the cables terminated since power equipment, generally, has insulation resistance acceptance criteria equivalent to that of the cable. However, insulation testing of control and instrument cables is usually performed with the cables de-terminated at each end because of the potential for damaging electronics and control circuits with the introduction of high voltages needed to test insulation resistance.

The inspector should select a sample of about ten instrument cables, ten control cables, ten low voltage power cables, and ten high voltage power cables for inspection from each of the major buildings. The inspector should observe testing activities in progress on some of the cables and verify completed continuity and insulation testing work on the others. The inspector should verify the Contractor is performing the testing activities as required by procedures. The expectation is the inspector will observe work performance on at least a subset of the sample selected, above. The inspector should verify the cable is properly identified as required by the Contractor's procedure and drawing requirements and the proper cable is being tested.

#### **4.3 Adequacy and Effectiveness of the Training and Qualification of Personnel**

The inspector should review the Contractor procedures specifying the requirements for education, experience, training, and certification of craft and QC personnel associated with the performance and inspection of cable continuity and insulation testing activities. If not accomplished during performance of Section 4.2 above, the inspector should interview and collect the names of at least the following personnel:

- Three craftsmen involved in implementing the testing requirements of the procedures
- Three QC personnel involved in verifying the accomplishment of testing activities.

During the interviews, the inspector should verify personnel were sufficiently knowledgeable of applicable procedure requirements.

The inspector should also examine the training and qualification records of the craft and QC personnel interviewed. The inspector should determine whether the records demonstrate conformance with the Contractor's requirements for personnel training, qualification, and certification.

#### 4.4 Adequacy and Effectiveness of the System of Records

The inspector should sample and examine the completed records, which result from the accomplishment of the testing procedures on the cables selected in paragraph 4.2, above. This inspection should focus on verifying the records conform to applicable procedure requirements.

The records for testing accomplishment, and for the training and qualification of personnel, should be examined to verify approval by proper authority; storage and maintenance in accordance with procedure requirements; and the acceptable performance of the documented activity.

### 5.0 REFERENCES

*Integrated Safety Management Plan (ISMP)*, 24590-WTP-ISMP-ESH-01-001, Rev. 1, Bechtel National, Inc., 2002.

*Quality Assurance Manual (QAM)*, 24590-WTP-QAM-QA-01-001, Rev. 0a, Bechtel National, Inc., 2002.

*Safety Requirements Document (SRD)*, Volume I, 24590-WTP-SRD-ESH-01-001-01, Rev. 0, Volume 2, 24590-WTP-SRD-ESH-01-001-02, Rev 0d, Bechtel National, Inc., 2002.

*National Electric Code*, NFPA-70, National Fire Protection Association, 1999 Edition

*American Electricians' Handbook*, 13<sup>th</sup> Edition

### 6.0 LIST OF TERMS

|      |                                      |
|------|--------------------------------------|
| ISMP | Integrated Safety Management Plan    |
| NFPA | National Fire Protection Association |
| QA   | Quality Assurance                    |
| QAP  | Quality Assurance Program            |
| QC   | Quality Control                      |
| RPP  | River Protection Project             |
| SC   | Safety Criteria                      |
| SRD  | Safety Requirements Document         |
| WTP  | Waste Treatment Plant                |

Attachments: None

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