

INSPECTION TECHNICAL PROCEDURE

I-118

ELECTRICAL TERMINATIONS INSTALLATION INSPECTION

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Table of Contents

1.0	PURPOSE	1
2.0	OBJECTIVES	1
3.0	INSPECTION REQUIREMENTS	2
3.1	Adequacy and Effectiveness of Construction Implementing Procedures.....	2
3.2	Adequacy and Effectiveness of Construction Activities	2
3.3	Adequacy and Effectiveness of the Training and Qualification of Personnel	2
3.4	Adequacy and Effectiveness of the Records System.....	2
4.0	INSPECTION GUIDANCE	3
4.1	Adequacy and Effectiveness of the Construction Implementing Procedures.....	3
4.2	Adequacy and Effectiveness of Construction Activities	4
4.3	Adequacy and Effectiveness of Training and Qualification of Personnel.....	5
4.4	Adequacy and Effectiveness of the Records System.....	5
5.0	REFERENCES	6
6.0	LIST OF TERMS.....	6

INSPECTION TECHNICAL PROCEDURE I-118, REV.0 ELECTRICAL TERMINATIONS INSTALLATION INSPECTION

1.0 PURPOSE

This inspection procedure provides guidance to assess the Contractor's activities for the termination of electrical cables at plant equipment. 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 procedure assesses the adequacy and effectiveness of the following items:

- Procedures and programs for accomplishing termination activities and ensuring cabling is landed at the proper terminal locations
- Contractor work activities implementing the cable termination and cable landing activities
- Training and qualification of personnel implementing the program and procedures
- The records system demonstrating the management and completion of the required termination activities.

2.0 OBJECTIVES

This inspection procedure verifies the Contractor has established and implemented effective programs and procedures to ensure electrical cable terminations are accomplished according to requirements. This includes programs and procedures for (1) implementing designers' requirements for terminating electrical cables in electrical panels and at the loads; (2) managing and providing oversight to ensure termination activities are performed according to the established procedures, drawings, and programs; and (3) managing and providing oversight to ensure the as-constructed condition of the facility equipment is according to the design requirements.

This inspection procedure is one component of a complete construction inspection program. This inspection procedure and others will be used, as needed, to ensure construction activities are being conducted as required by authorization basis commitments and Contractor procedures. During the construction phase, a significant portion of this inspection procedure is expected to be accomplished at least once for the Contractor and each major subcontractor involved with the activities covered by this procedure. However, the entire procedure is not expected to be completed during any one inspection 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 and any subcontractors with responsibilities for installing cable termination devices and landing cables within panels and at loads have approved procedures describing the administrative controls and work processes to be implemented to ensure that the terminations and cable connections have been accomplished according to design requirements. (QAM, Policy Q-05, Sections 3.1.1 and 3.3; ISMP, Table 1-3, item 5; and SRD, Safety Criterion (SC) 4.1-2 and 7.3-5)
- 3.1.2 The inspector should verify procedures provide for inspections to ensure important-to-safety aspects of the electrical termination work are verified and documented. (QAM, Policy Q-05.1, Section 3.5.1; ISMP, Table 1-3, items 5 and 8; and SRD SC 4.1-2, and 7.3-7)
- 3.1.3 The inspector should verify the Contractor has established procedures for ensuring craft and inspection personnel performing cable termination 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 the work is being accomplished under controlled conditions according to the Contractor's approved procedures. (QAM, Policy Q-05.1, Section 3.1.1; SRD, SC 4.1-2 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 quality control (QC) personnel involved in performing cable termination and inspection activities are qualified to perform their job functions. (QAM, Policy Q-05.1, Section 3.1.1; SRD, SC 7.3-5; and ISMP, Table 1-3, item 5)

3.4 Adequacy and Effectiveness of the Records System

The inspector should verify records reflect the required quality of the electrical cable terminations is achieved and they are as specified by approved procedures, reviewed for accuracy and assurance the recorded information meets project requirements, approved, and 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; ISMP, Section 8 and Table 1-3, item 4)

4.0 INSPECTION GUIDANCE

There are no generally recognized industry standards for accomplishing termination installations. There are several lug and crimping tool manufacturers and each has its own tailored methods for termination completion. Each crimping tool manufacturer specifies the conditions resulting in proper lug attachment to the cables for each type and size of lug. In addition, each architect/engineer organization has unique practices for termination installation, documentation, and cable attachment. To ensure uniformity of termination work, electrical contractors translate the suppliers' and engineers' requirements into programs and procedures for completing and inspecting termination activities in the field. Those programs and procedures include requirements for inspecting critical attributes in the procedures. The National Fire Protection Association (NFPA), Standard 70, the "National Electric Code," briefly discusses terminations generally in Article 110-14. The *American Electricians' Handbook*, in Division 2, provides greater detail regarding termination practices.

Suggested sample selections are included in some of the inspection elements described below. However, use judgment in determining sample selection based on construction progress, completion of Contractor's quality assurance/QC reviews, or inspector experience, focusing on examining the most important aspects of the particular activity being inspected. The intent is to establish a high level of assurance that the end product meets requirements.

4.1 Adequacy and Effectiveness of the Construction Implementing Procedures

4.1.1 The inspector should review the termination equipment manufacturers' and designers' requirements and the Contractor's procedures and drawings for the termination of important-to-safety cables. The objective of these reviews is to ensure designers' and crimping tool manufacturers' requirements are included in procedures. As noted above, there are no generally recognized standards for terminal installations. However, several important attributes should be addressed in the following procedures and drawings:

- Cable stripping. The cable insulation must be stripped to the proper distance from the end. The cable conductor should not be damaged during the stripping process.
- Proper lug size provisions.
- Proper attachment of the lug to the cable and proper torquing of lug bolts.
- Crimping tools and dies. Crimping tools and dies should be numbered, controlled, and issued from a central location. The die should be verified using a go/no-go gauge prior to issue to verify die and tool acceptability and, when returned, to ensure that the tool and die remain acceptable after use. Crimping tools used on important-to-safety equipment should never be stored in craft tool bins or in an uncontrolled manner.
- Bend radius limitations. The bend radius at the termination should continue to conform to the limitations in the "National Electric Code," NFPA 70-99.

- Circuit identification and landing. The circuit must be properly identified and landed to the proper terminal block and location, using the proper torque.
- Cable insulation. Power cables having greater than 600 volts often have special insulation requirements at the termination location, and the completed termination must conform to drawing requirements.
- Terminal documentation card. The termination documentation card should identify the circuit, crimping tool serial number, die number, and craftsman performing the termination. Cable size is often included on the termination documentation and a provision is included for documenting the completion of the QC inspection.

4.1.2 The inspector should review the Contractor's procedures to ensure inspections and tests are provided and scheduled to verify termination crimping devices are in proper working order, terminals have been properly installed on cables, cable bend radius conforms to appropriate acceptance criteria, and configuration of the completed cable installation conforms to drawing and quality requirements.

4.1.3 No additional guidance.

4.2 Adequacy and Effectiveness of Construction Activities

Before performing work observation inspections in the field, the inspector should review the Contractor's procedures for accomplishing termination installation 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, focusing on determining whether job and procedure knowledge is satisfactory. Obtain the names and job functions of those interviewed and use them later to verify proper implementation of personnel qualification requirements and determine record adequacy, as specified in Sections 4.3 and 4.4 below.

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. Observe work activities in progress on some of the terminations and completed termination work on the others. Verify the Contractor is performing the termination activities as required by procedures and drawings. In addition, consider the following suggested inspection items during work observation activities:

- For terminations with lugs, verify the insulation butts up, or nearly so, against the lug and is not inside of the lug sleeve (this minimizes bending stress on the wire which can cause wire breakage); the end of the wire is visible at the end of the lug sleeve and does not extend past the end of the sleeve into the bolt head area (this ensures that there will be sufficient wire contact with the termination lug sleeve and that the bolt head has a

maximized contact surface area and will retain the torque value); and the lug has been properly crimped with the crimp indentation in the approximate center of the sleeve and not extending over either end of the lug sleeve.

- For high voltage power cables, verify the termination, the insulation sleeve covering the termination, and the method of connection to the equipment service terminal conform to drawing requirements.
- Verify the proper torque has been applied to termination lug bolts as required by procedures.
- Verify the lug is located on the proper terminal location according to drawing requirements.
- Verify the cable is properly identified as required by the Contractor's procedure and drawing requirements.

4.3 Adequacy and Effectiveness of 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 performing and inspecting cable termination activities. If not accomplished during performance of Section 4.2 above, interview and collect the names of at least the following personnel:

- Three craftsmen involved in implementing the termination requirements of the procedures
- Three QC personnel involved in verifying termination activities have been accomplished.

During the interviews, the inspector should verify personnel are sufficiently knowledgeable of applicable procedure requirements. Also, examine the training and qualification records of the craft and QC personnel interviewed. Determine whether the records demonstrate conformance with the Contractor's requirements for personnel training, qualification, and certification.

4.4 Adequacy and Effectiveness of the Records System

The inspector should sample and examine the completed records that result from accomplishing the termination procedures on the terminations selected in Section 4.2 above. Focus on verifying the records conform to applicable procedure requirements.

The inspector should examine the records for accomplishing termination and for training and qualifying personnel to verify approval by proper authority, storage and maintenance according to procedure requirements, and the acceptable performance of the documented activity.

5.0 REFERENCES

American Electricians' Handbook, 13th Edition, McGraw-Hill, 1996.

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

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

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.

6.0 LIST OF TERMS

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