

INSPECTION TECHNICAL PROCEDURE

I-124

ELECTRICAL CABLE INSTALLATION INSPECTION

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INSPECTION TECHNICAL PROCEDURE I-124, REV. 0 ELECTRICAL CABLE INSTALLATION INSPECTION

1.0 PURPOSE

The procedure provides guidance for assessing the Contractor's activities for installing electrical cable. This guidance is based on the requirements set forth in the Safety Requirements Document (SRD), the Quality Assurance Program (QAP), and the Integrated Safety Management Plan (ISMP).

This procedure includes guidance to assess the adequacy and effectiveness of the following:

- Electrical cable installation procedures
- Electrical cable installation
- Training and qualification of personnel
- Records system demonstrating the accomplishment of the required electrical cable installation activities.

2.0 OBJECTIVES

This procedure provides guidance for inspectors to verify the Contractor has developed and implemented an effective program for installing important-to-safety electrical cable at the River Protection Project (RPP) Waste Treatment Plant (WTP). This includes addressing programs for the following: (1) implementing commitments regarding the installation of electrical cable; (2) managing and providing oversight to ensure electrical cable installation and related quality control have been adequately addressed by specifications, drawings, and procedures; (3) managing and providing oversight to assure the as-installed condition of electrical cable is in accordance with the design; and (4) recording installation (pulling) activities for important-to-safety electrical cable.

This inspection procedure is one component of a complete construction inspection program. This and other inspection procedures will be used, as needed, to provide assurance that construction activities are being conducted as required by authorization basis commitments and Contractor procedures. It is not expected that 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 inspectors should verify that the Contractor/subcontractors with construction responsibilities for electrical cable installation have approved implementing procedures describing administrative controls, and work processes implementing the design requirements. (QAM Policy Q-05.1, Sections 3.1.1 and 3.3; ISMP Sections 1.3.9, 1.3.13, 3.5, and Table 9-2; and SRD, Safety Criterion (SC) 4.1-2 and 7.3-5)
- 3.1.2 The inspectors should verify procedures provide for QC inspections of important-to-safety installations to ensure the as-installed condition of electrical cable meet specified engineering requirements and drawings. As part of the assessment of the QC inspection procedures, ensure the procedures include or reference appropriate quantitative or qualitative acceptance criteria for determining the prescribed activities have been accomplished satisfactorily. (QAM Policy Q-05.1, Section 3.5.1; ISMP Sections 1.3.9, 1.3.13, 3.5, and Table 9-2; and SRD, SC 4.1-2 and 7.3-7)
- 3.1.3 The inspectors should verify the Contractor has established procedures for ensuring craft and QC inspection personnel, performing quality related electrical cable installation and testing activities, are qualified to perform their assigned work. (QAM Policy Q-02.2, Section 3.3.2; SRD, SC 7.2-2, and 7.3-3; and ISMP, Sections 1.3.12, 3.5, 3.15, 6.1.3, and Table 9-2)

3.2 Adequacy and Effectiveness of Construction Activities

The inspectors should verify the installation of electrical cable is being accomplished under controlled conditions using 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, Sections 1.3.12, 3.5, and Table 9-2)

3.3 Adequacy and Effectiveness of the Training and Qualifications of Personnel

The inspectors should verify craft, testing, and QA/QC personnel involved in the performance of electrical cable installation and inspection activities are qualified to perform their job functions. (QAM Policy Q-02.2, Sections 3.3.2, 3.3.1 and 3.3.3; SRD, SC 7.2-2 and 7.3-3; and ISMP, Sections 1.3.12, 3.5, 3.15, 6.1.3, and Table 9-2)

3.4 Adequacy and Effectiveness of Records

The inspectors should verify the as-built records of electrical cable installation and testing are as specified, reviewed by the Contractor for accuracy, and assurance the recorded information meets project requirements, approved, and stored and maintained sufficient to support technical and Contract requirements. (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, Section 8 and Table 8-1)

4.0 INSPECTION GUIDANCE

Several codes or standards for electrical cable installation are referenced in the SRD. The guidance provided below was obtained from Institute of Electrical and Electronics Engineers (IEEE) Standards (i.e.: IEEE 308-91, 379-94, 384-92, 603-91, 628-87, 741-90) committed to by the Contractor. Many of the installation requirements included in the Contractor's procedures will come from the cable supplier. Care should be taken to ensure the requirements important to the operation of the cable in the manufacturer's technical manual(s) are included in the Contractor's procedures.

Included in Section 4.2 below, are important attributes and suggested sample selections. The inspector can follow the suggestions or choose samples more appropriate for the inspection due to construction progress, completion of Contractor's QA/QC reviews, or inspector experience. The inspector should use judgment in determining sample selection, focusing on examination of 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 Construction Implementing Procedures

The adequacy and effectiveness of the Contractor's procedures is assessed by how well the procedures conform to the requirements in the manufacture's manual and the requirements of any identified codes or standards that are necessary to ensure proper installation of important-to-safety electrical cables.

4.1.1 Review the implementing procedures for installation of important-to-safety electrical cables provided by the Contractor. The inspectors should verify the procedures (1) are approved and (2) specify the requirements from the manufacture's technical manual(s) and any codes or standards identified by the Contractor.

Determine whether the procedures contain information sufficient to ensure the following attributes are specified and controlled within the limits permitted by the applicable standard.

- Temperature limits for handling and pulling electrical cables during extreme low temperatures
- Cable pulling lubricants are used and are compatible with the cable outer surface
- Cable lubricants are non-hardening
- Cable lubricants are non-combustible
- Pulling winch capacity
- Support of cable reels during pulling

- Use of tension measuring devices
- Increased cable pulling tensions due to pulling cable from reel
- Direction of cable pulls with regard to location of bends in conduit
- Maximum number of bends in conduit
- Size of bends, boxes, and fittings for raceways
- Use of single or multi-roller cable sheaves for installing cables around corners
- Maximum pulling tensions
- Maximum side wall pressure
- Minimum bending or training radius
- Use of feeder devices
- Types of acceptable pulling ropes and cables
- Sealing the ends of high voltage power cables during and after pulling
- Temporary cable support in manholes
- Use of pulling eyes and swivels
- Cable support for vertical runs.

4.1.2 Review the QC inspection procedures for pulling important-to-safety electrical cables. The inspectors should verify the procedures (1) are approved, and (2) provide for adequate QC inspections to ensure the cables are installed in accordance with engineering drawings, procedures, and authorization basis requirements. The QC procedures should ensure the electrical cables are installed in accordance with the manufacture's manual and the applicable electrical code(s).

Determine whether the QC inspection procedures are adequate to verify the attributes listed in Section 4.1.1 above.

4.1.3 Ensure the procedures require the equipment such as the pulling tension measuring device is calibrated and maintained. The calibration standards should be traceable to industry recognized criteria (i.e., the National Standards Institute).

4.1.4 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, manufacturer's technical manuals, and applicable codes or standards which apply to the work that will be observed to ensure familiarity with the requirements and acceptance criteria pertinent to the planned observations. During the field observations, the inspector should carry a copy of the sections of the procedure and industry standards pertinent to the planned observations, and verify work is being accomplished using procedures of the proper revision.

Select three electrical cable pulls for which installation is in progress (if possible). Work observation inspections should verify the cable is installed to conform to the latest approved-for-construction drawings, installation specifications, technical manual requirements, and procedures. Verification of the following attributes is suggested for inspection during work observation activities:

- A permanent marker in accordance with the design documents identifies the ends of the cables.
- The ends of the cables are sealed against the entrance of moisture and contamination. The ends of high voltage power cables are sealed during and after installation. The ends of all other cables are sealed during and after installation in wet locations. Cables such as aluminum, mineral-insulated, paper, and varnished cambric are resealed after pulling, regardless of location.
- Manufacturer's recommended low temperature limits are followed when pulling during extreme low temperatures. Handling and pulling cables in extremely low temperatures can cause damage to the cable sheathing, jacketing, or insulation. To prevent damage of this nature, the cables should be stored in a heated building at least 24 hours prior to installation.
- Cable pulling lubricants are compatible with the cable outer surface and will not setup or harden during cable installation.
- Cable lubricants are non-hardening and will not setup as to prevent the cable from being pulled out at a later time.
- Cable lubricants are non-combustible and will not support combustion.
- Cable pulling winches and other necessary installation equipment are of adequate capacity to ensure a steady continuous pull on the cable.
- Bare wire rope is not to be used to pull cable into conduits because of possible damage to the conduits.
- A swivel is attached between the pulling eye and the pulling cable. Projections and sharp edges on pulling hardware are taped or otherwise covered to protect against snagging at

conduit joints and to prevent damage to the conduit.

- Cables are pulled only into clean raceways. A mandrel is pulled through all underground ducts prior to cable pulling. All abrasions or sharp edges that might damage the cable are removed.
- Cable reels are supported so the cable(s) may be unreeled and fed into the raceway or conduit without being subjected to a reverse bend as the cable is pulled from the reel.
- A suitable feeder device is used to protect and guide the cable from the reel into the raceway. The radius of the feeder device is not less than the allowed minimum bending radius of the cable. If a feeder device is not used, the cable will be hand guided into the raceway.
- A tension measuring device is being used on runs when cable pulling force calculations indicate allowable stresses may be approached. Pulling tension will increase when the cable is pulled from the reel. Turning the reel and feeding slack cable to the duct entrance will reduce the pulling tension. Whenever a choice is possible, the cable should be pulled so that the bend or bends are closest to the reel. The worst condition possible is to pull out of a bend at or near the end of the run.
- The conduits are not overfilled. Guidance on conduit fill can be found in American National Standards Institute/National Fire Protection Association (ANSI/NFPA) 70-1996.
- The manufacture's recommended maximum pulling tension, sidewall pressure, minimum bending radius, and training radius are followed (also see ANSI/NFPA 70-1996 for guidance). Failure to follow the manufacture's recommendation can cause damage to the cable conductor, insulation, shield, or jacket.
- The cable end within a pulling device is removed from the cable prior to termination.
- After the cable pull is complete, the manufacture's recommendations for minimum training radius are followed.
- Cables installed in vertical cable trays are secured to the cable tray at least every five feet.
- The weight of vertical cable is supported by holding devices in the trays, in the ends of the conduits, or in boxes inserted at intervals in the conduit system. Cable with copper conductors, regardless of their voltage class, installed in vertical runs, will be supported in accordance with the following table.

Maximum Distances Between Cable Support		
Conductor Sizes AWG or kcmil	Maximum Distance	
	Feet	Meters
14 to 1/0	100	30
2/0 to 4/0	80	24
250 to 350	60	18
Over 350 to 500	50	15
Over 500 to 750	40	12
Over 750	35	10

During the field observations, the inspector should interview and obtain the names of a sample of the craft and QC personnel performing the observed activities to assess whether their knowledge of the job and procedures is satisfactory. The sample size will be determined by the number of Contractor personnel performing the activity and generally should be one to four for each discipline (craft and QC personnel). Information on these same personnel will be used pursuant to Section 4.3, below, to determine the adequacy of their experience and training.

4.3 Adequacy and Effectiveness of the Training and Qualification of Personnel

During the observation of work activities (Section 4.2, above), the inspector should carry a copy of the procedures specifying the Contractor's requirements for education and experience levels, training, and certification. The inspector should interview four craft and four QA/QC personnel involved in the performance of electrical cable installation activities, and record which jobs they were performing. The inspector should verify the personnel were sufficiently knowledgeable of procedure requirements. The inspector should also review the training and qualification records for those individuals to determine whether they met the requirements.

4.4 Adequacy and Effectiveness of Records

The inspector should select a sample of ten (10) records generated during the conduct of electrical cable installation activities, and records of qualification for those craft and QA/QC personnel selected during the performance of Section 4.3, above. The inspector should verify the records selected for examination were approved by proper authority and were stored and maintained in such a manner as to demonstrate conformance with procedure requirements.

5.0 REFERENCES

10 CFR 830, "Nuclear Safety Management Regulation," *Code of Federal Regulations*, as amended, Section 830, Subpart A, "Quality Assurance Requirements"

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.

ANSI/NFPA 70-1996, American National Standards Institute/National Fire Protection Association.

6.0 LIST OF TERMS

IEEE	Institute of Electrical and Electronics Engineers
ISMP	Integrated Safety Management Plan
QA	quality assurance
QAM	Quality Assurance Manual
RPP	River Protection Project
SC	Safety Criterion
SRD	Safety Requirements Document
WTP	Waste Treatment Plant
QC	quality control

Attachments: None