ATTACHMENT 65001.09

INSPECTION OF ITAAC-RELATED INSTALLATION OF ELECTRIC AND FIBER OPTIC CABLE

PROGRAM APPLICABILITY: 2503

65001.09-01 INSPECTION OBJECTIVES

References to “cable” denote Electrical and Fiber Optic cables.

01.01 To determine whether ITAAC-related installation, tests and verification activities of electric/fiber optic cable are being conducted in accordance with approved design criteria, design specifications, and approved procedures, and that the ITAAC attributes for electrical cable have been met.

01.02 To determine by inspection that electrical/fiber optic cables are properly installed in accordance with industry standards and the requirements described in the licensee’s electrical installation specifications.

01.03 To determine whether required records associated with electric/fiber optic cable installation are being maintained.

01.04 To evaluate the adequacy of the implementation of the specific quality assurance program requirements related to electric/fiber optic cable installation activities and ensure that nonconforming conditions are entered into the corrective action program.

65001.09-02 INSPECTION REQUIREMENTS AND GUIDANCE

General Guidance.

The objective of this inspection procedure is to independently confirm by sampling inspections that the ITAAC attributes for electrical/fiber optic cable have been met. For designs certified under 10CFR Part 52 those attributes generally consist of achieving required cable separation and proper identification of Class 1E cables by color coding.

The inspector should review the ITAAC Matrix for plant design of the inspected facility to determine the ITAAC residing in “families” along Row (09) for “Electric Cable.” Then obtain the NRC approved Design Control Document (DCD) for that design and review the electrical cable ITAAC to determine the attributes requiring inspection for that design. From that information an individual inspection plan can be formulated. This inspection procedure presents methods for inspection of those attributes.

The inspectors should review drawings of the overall physical plant layout regarding the design for the routing and separation of cables of various classes (e.g. voltage level, signal

type, division designation, safe shutdown train) to understand the cable separation methodology. Particular attention should be paid to routing of cables in the control room, cable spreading room, remote shutdown control locations and post-fire safe shutdown designated divisions. The purpose of this review is to confirm that division physical separation is maintained and to guide the inspection sampling of physical separation to critical areas.

A simultaneous objective is to confirm from visual inspection of in progress and completed cable installation that the work was done in accordance with industry standards and the requirements described in the electrical/fiber optic installation specification. Section 02.02 of this document presents cable installation attributes that inspectors should look for. Deficiencies in these attributes may not constitute ITAAC findings but must be brought to the licensee's attention for corrective action and be dealt with as with other construction findings.

The inspectors should maintain complete records of cable samples selected for inspection. The inspection report should record the rationale for selecting the sample and document the attributes inspected.

Inspections should be performed on samples of ongoing work and completed work. These observations will verify adequate procedural implementation and confirm proper cable identification and routing. Inspections should also be made on a larger sample of completed work to independently verify correct cable identification and separation. Samples should include cables inside containment and other areas where harsh environments might exist in accident conditions. Samples should include work of different subcontractors and work performed at various times throughout the project.

02.01 Physical Separation of Cables. It is intended that this inspection activity be performed repeatedly during plant construction. For each of these inspections, the sample selection should include as many examples of completed work products as practical during the available time frame.

Inspection Requirements.

Inspection of in-process work.

a. From the licensee work planning schedules determine what cable installation work is currently in progress. From that population select tasks for inspection that are installing Class 1E electrical cable.

b. Go to the job site and observe work in progress. Verify that work control documents are at the job site and being used. Examine available paper work to determine it appears current and accurate.

c. Interview the job supervisor and craftsmen to confirm that they have adequate instructions and knowledge of the design specified routing of the cable being installed. Determine their planned/expected actions if problems, uncertainties or anomalies are encountered in the work.

d. Record the in-process cable designation and its actual route. If visual inspection of completed work is not sufficient to confirm cable routing, the inspector may need to request licensee to perform signal tracing. Compare the as-installed route to that specified in the engineering control cable routing program.

Guidance.

a. The inspectors should select samples for inspection that will be representative of as many different separation criteria and plant areas as possible. The inspection sample should include cables in trays, conduits, duct banks, etc., to achieve a varied sample of cable configurations. The sample should include some completed cable work inside panels since separation criteria will be different. Effective inspection of cable separation may involve examining areas that are physically difficult to access.

b. The correct and current work control documents should be at the job site and in actual use. Review the plant work control procedures during inspection preparation to determine the licensee specified practices.

c. The workers should have enough knowledge and information to know clearly the intended correct cable routing. They should also know to stop and resolve any anomalies before continuing with cable installation.

d. Once the as-installed cable route is recorded, the inspector should compare it to the engineering specified cable routing program. There should be no discrepancies. If there are any differences, there should be an established method to document them and return the discrepancies to engineering for resolution and approval.

Inspection of completed work.

a. Review and understand the licensee's method of determining and specifying to the field the design intended cable routing. Discuss the methods and their success and failures with engineers to determine any system weaknesses. Confirm that these methods appear to implement and enforce the cable separation criteria specified in the ITAAC.

b. Select a sample of Class 1E cables from each of the Divisions and use the licensee's computerized cable routing system to determine the design specified route of the cables. The sample should be primarily power supply cables but may include some control, instrumentation, and communication (copper/fiber optic) cables if available. Verify that the records show that the Divisions are separated and do not come together in a common raceway.

c. For that same sample of Divisional powered cables determine the raceway cable routes. Review the cable routing system to see if there are any other cables in the same raceway. There should be no other Division or non-Divisional cables in this same raceway.

d. Select a subset of the sample for field observation and, with the assistance of licensee engineers as necessary, visually inspect the cables in the plant to confirm that the cable routing system information is complete and accurate. During the field inspections also observe that the physical separation between Class 1E raceways of different Divisions and between Class 1E raceways and non-Class 1E raceways is consistent with that specified in the ITAAC. The inspection sample should include free-air cables, as well as cables in raceways. Also during the field inspections verify that the different Division cables and raceways are identified by an appropriate color coding scheme as specified in the ITAAC.

e. The ITAAC will typically require that separation is maintained between Class 1E Divisions in accordance with an identified fire area plan. Select a sample of the specified fire areas for field inspection. Visually verify for each fire area that only cables and raceways for the specified Division pass through that fire area.

f. For AP1000, the ITAAC will typically require that Class 1E communication cables which interconnect two Divisions are routed and separated such that the Protection and Safety Monitoring System (PSMS) voting logic is not defeated by the loss of any single raceway or fire area. Examine the cable routing system to locate a sample of such communication cables that interconnect two Divisions. Verify that the cable routing system reflects that no two of these interconnecting cables pass through the same raceway or fire area such that the loss of any single raceway or fire area could defeat the PSMS logic. For a subset of these interconnecting cables, perform visual field inspections to confirm the accuracy of the cable routing system information.

Guidance.

a. The licensee will establish an administrative control system to track and specify as-installed cable routing in the plant. The licensee will normally utilize a computer software program to manage the cable and raceway schedule. With the assistance of licensee engineers, the inspectors should gain access to the system, and become familiar with its methods of operation. Typically this type of software performs certain checks related to cable separation. For example the software would block a designer from routing a Division 1 cable in a Division 2 raceway. Usually an error message is also provided stating the reason the attempted routing of a cable was blocked. Similarly, it would recognize and supervise voltage levels and associated separation criteria. For example, it would block routing a 5,000 V cable in cable tray designated for low-voltage power or block conducive fiber optic cable routing through any A.C. cable tray. The inspector should perform tests of these cable separation criteria checks and blocks provided by the software to confirm that they work as designed. But any automatic block provided by software will also have an override feature, so this should be addressed in the inspection to verify the override is properly used and administratively controlled. In addition, the cable and raceway software may check that raceways carrying a separation code designator cannot be “connected” in the raceway schedule.

Again this should be tested by the inspector or demonstrated to the inspector by licensee personnel.

b. The intent is to select a sample of Class 1E powered cables and query the computer routing system for their routing. Then verify that the cable routing system information reflects that there are no intersections of the various class 1E Division cable routes.

c. The intent is once the cable routes of the selected sample cables have been determined, then query the cable routing system to verify that the system information reflects that there are no other cables in the same raceway. There should be no instances of different Class 1E Divisions or non-Division powered cables routed in the same raceway. Inspectors should pay particular attention to "non-safety" cables which could be routed in redundant 1E division raceways.

d. The licensee should administratively control access to completed cable runs so the inspectors will need to arrange the assistance of licensee engineers to gain access to electrical cabinets, cable trays, junction boxes, pull boxes, patch panel, etc. for visual inspection of cable routing. Licensee representatives should be requested to take the actions necessary so that the inspectors can perform the needed visual inspections. Following inspections the licensee should promptly take the actions required to restore the equipment to its former configuration. Also be aware that proper separation seen in a particular room can be later invalidated by cable installation work performed after the inspection or placement/removal of cable tray covers.

e. The ITAAC will typically specify which fire areas are to contain only certain Division cable runs. The intent is to select a sample of these fire areas and to verify by record review and visual observation that no other Division cables run through the designated fire areas.

f. The intent is to verify by a combination of record review and visual observation that this ITAAC requirement has been met.

02.02 Attributes of Electrical Cable installation.

Inspection Requirements.

While performing observations of in-process cable installations and inspection of completed cable installations as required by section 02.01, inspectors should be alert for the following attributes of cable installation. Any observed substandard work should be brought to the licensee's attention so that non-conforming conditions can be documented in their corrective action system and corrected.

Guidance.

Before commencing inspection the inspector should become familiar with the plant work procedures. The term work procedures is intended to include construction specifications, installation procedures, written instructions, drawings, sketches and any approved

document which is being used to control the construction work or used by craftspersons. This includes procurement, receipt, and storage of materials; and quality control inspections. Procedures used by sub-contractors involved in the project shall be consistent with each other and the licensee's QA program. Review the results of any previous NRC Procedure Review inspections for past performance weaknesses. Any inadequacies concerning completeness, level of detail or correctness of the work procedures should be brought to the licensee's attention for resolution as soon as possible. At about the 50 percent completion point of cable and raceway installation, the inspectors should review the work procedures again for adequacy of any changes that were made since project start.

For samples of installed cable raceway, verify that the size, material (i.e. steel, aluminum, galvanized), and style (i.e. ladder type, solid bottom, etc.) are as specified on the design documents and work procedures. Verify that cable tray covers are installed correctly at the specified locations.

Determine that the location of the raceway is as specified on the construction drawing. Check for generally correct dimensions from column line, from floor or ceiling, and between raceways installed in banks or arrays.

Verify that raceway supports are located at points specified on approved drawings or instructions and that maximum distance between supports is not exceeded. Also verify that raceway supports are constructed according to the approved drawings or instructions.

Verify that raceway identification labels and tray section markers are affixed at locations specified in approved instructions and that they are accurate. Verify that the physical separation criteria are maintained.

Verify that all fittings, clamps, bushings, condulets, flexible conduit, grounding wire and clamps are installed according to approved work procedures. There should be electrical ground grid pads in floors and walls to allow convenient grounding of raceways.

Check that the electrical raceways were included in the pipe whip and jet impingement design studies. Look for instances of safety important cable installed in proximity to steam, feed, or other high energy pipes that could be damaged if the line leaked or ruptured. Look for safety important cables run in the vicinity of high heat sources, such as steam lines, that will accelerate cable aging.

Observe that raceways are installed such that the specified minimum cable bend radius will not be exceeded. To avoid cable pull damage no more than 360 degrees of conduit bends should be included between cable pull points.

Underground ducts and concrete embedded conduits should be installed in a manner to provide for automatic water drainage and/or pump out. Underground ducts should be adequately sealed at entry points to buildings to prevent water intrusion.

Cable installation inspection samples should include power, control, and instrumentation cables from each manufacturer supplying cable. Verify that the correct cable type is installed. This inspection should use all available data such as pull tickets, mark number

descriptions, manufacturer's data, equipment qualification files, jacket marking information, work procedures, design control documents, purchase specifications, dimensional checks and visual examination of the cable. Verify that approved permanent type cable identification tags are installed at specified locations and that they have the correct information.

Verify to the extent possible that installed cables were not damaged during the shipping, storage, or installation activities. This should be accomplished through examination of cables at the receiving/storage locations, installation staging locations, pulling locations and observation of installed cables.

When observing cable pulling activities checks should be made of the following attributes: minimum bend radius should not be exceeded, cable pulling lubrication should be used as specified in work procedures, cable pulling tension limits should typically be calculated before the pull begins and monitored during the pull, and conduit fill limitations should not be exceeded. In field observations, select conduits that appear to be filled to the limit. Then verify that these cables installed in conduits do not exceed ampacity, fill guidelines, nor jamming ratio. Inspections should pay particular attention for situations where licensees might install new cables in existing conduits which already have cables installed. Such "cable pullbys" can damage existing cables due to the pull rope cutting the already installed cables and are an unacceptable practice. Due to the fragile nature of fiber optic cable these attributes are especially sensitive and should be examined closely.

When observing cable tray installations for instances of densely packed trays it should be verified that cables installed meet the design criteria from the ampacity, weight and depth of fill attributes. In cases where power cables are installed in a single layer, check that proper spacing is maintained. Verify that seals and fire stops are qualified for the application and are correctly installed at the specified locations.

Plastic tie wraps do not have a strength rating and experience embrittlement over time and should not be used in a load bearing manner outside of panels. Inspection samples of installed cables should include any special configurations such as long vertical runs and vertical cable supports. There inspectors should verify that appropriate cable supports are installed as prescribed by both copper and fiber optic cable installation procedures. Verify that any cable ties installed inside containment are qualified for the environment.

When inspecting terminations verify that correct lug size and type are used and lugs are properly installed and crimped on the wire. Check whether lugs are compatible with the terminal blocks or bus bar to which they are connected. Also verify that lugs are compatible with cable type (i.e., solid or stranded conductor) and cable system voltage rating. Inspection sample should include all the different generic type terminal blocks and wire types being utilized. Also confirm that terminal block markings match wiring diagram.

When inspecting fiber optic splices and termination connectors on patch panels, verify that the testing procedures for optical power and loss are adequate. The test results should be within an acceptable range indicated by the manufacturer specifications. The test should be recorded and documented with the results from the test equipment. Splices and connectors should be protected to the same degree as the jacket specification on the fiber.

When inspecting small wire terminations some of the important inspection points are: wire protrudes specified dimension beyond barrel, “signature” dimple of the crimp tool indicates that proper compression has been achieved, and hold down screws are torqued to recommended value. Also verify that lugs are compatible with cable type (i.e., solid or stranded conductor) and in accordance with lug manufacturer recommendations (e.g., cable type and voltage rating). When multiple wires are terminated on the same terminal point, check that the installation is in accordance with approved work procedure details and the electrical installation specification requirements. Verify that the maximum number of terminations allowed by procedure on a terminal is not exceeded.

Verify the cable shield wires are grounded at points specified in the design output documents or work procedures and not grounded at any other points. Include drain wire shielded and tape shielded cable in the sample if these both are utilized at the plant inspected.

Select and witness a sample of cables during continuity (or ring out) checks. These tests serve to show that the wire is not broken, the wire is connected to the correct point at both ends and that the end device is powered from the correct train or channel. The continuity checks could be used to satisfy an ITAAC for certain type plants.

Fiber optic cable continuity checks consist of an optical power and optical loss or reflection tests. The tests should be conducted across the entire wave length spectrum ratings of the cable. The two tests show that the cable has not been damaged during installation and connection. The tests should be recorded and documented.

Select and inspect a sample of Environmentally Qualified wire and fiber optic splices and verify that they are correctly made. Inspectors should observe installation of splices and not just solely inspect them after they are installed. A mix of direct observation of terminations and splices and review of documentation is what is intended. Also verify that those EQ splices selected for inspection are made in approved locations.

Post-fire safe shutdown considerations impose special requirements on the separation of cables. A sample of power, control, instrumentation, and communication cables credited for safe shutdown systems should be inspected. In addition, a selection of cables which are important to safe shutdown due to spurious component operation concerns should be inspected. These inspections involve the verification that as-built cable routing meets design criteria, flame retardant cable is installed where required and fire barriers installed on raceways are correctly qualified and properly installed.

02.03 Documentation. While performing the inspection activities of 02.01 the inspectors should verify the following related to as many cable and raceway systems as practical.

Inspection Requirements.

a. All information on the computerized cable and raceway routing system reviewed by the inspectors is accurate. The qualified software for the system provides adequate version control and ensures the fidelity of the electrical/fiber optic installation specification requirements required programmed checks, blocks and flags.

b. The required permanent records for the cable and raceway routing will be maintained.

c. Any discrepancies identified during this inspection are documented in the licensee's corrective action program and adequately resolved.

Guidance.

The cable and raceway routing system records are very important to confirm that the ITAAC cable separation criteria are met at the completion of plant construction and throughout the life of the plant. There should be no discrepancies and any identified during this inspection should be resolved or placed into the licensee's corrective action system for future resolution. The resolution of any items placed in the corrective action system should be confirmed by the NRC during subsequent inspections.

02.04 Problem Identification and Resolution.

Inspection Requirements.

The inspector should confirm that problems identified during the inspection are appropriately entered into the licensee/constructor's corrective action program in accordance with program requirements. The inspector should also confirm that licensee construction and testing procedures contain appropriate criteria defining what constitutes a non-conforming condition and what requires documentation in the corrective action process including the proper characterization and classification of the conditions adverse to quality.

The inspector may review licensee actions to address similar or related problems that were previously identified, in order to check the extent of condition and confirm the effectiveness of the licensee's corrective measures. Ensure that the licensee's program procedures address the extent of condition for similar problems in other areas to avoid repetition of problem conditions.

Guidance.

This inspection is to assure that problems are entered into the applicable process to assure corrective actions appropriate to the circumstances are developed, prioritized, and implemented. Inspections of overall Quality Assurance Program implementation, effectiveness of Problem Identification and Resolution, and Self-Assessment will be performed under the IMC 2504 processes.

65001.09-03 RESOURCE ESTIMATE

It is intended that this inspection procedure will be performed several times during the cable installation period to obtain a wide and varied sample of NRC inspection of cable separation for ITAAC closure. The repetitive frequency of inspections may vary depending

on whether NRC inspections identify findings. This inspection procedure is estimated to use approximately 800 direct inspection hours over the course of facility construction.

65001.09-04 REFERENCES

NRC approved Design Control Document for the facility being inspected.

ANSI/IEEE Std. 422	IEEE Guide for the Design and Installation of Cable Systems in Power Generating Stations, has specifics on cable pulling and proper bend radii.
IEEE Std. 690	IEEE Std. for the Design and Installation of Cable Systems for Class 1E Circuits in Nuclear power Generating Stations, has some information on installation requirements.
IEEE 1428	IEEE Guide for Installation Methods for Fiber-Optic Cables in Electric Power Generating Stations and in Industrial Facilities.
IEEE 1202	Standard for Flame-Propagation Testing of Wire and Cable. These standards apply to both copper and fiber optic cables.
NFPA 262	Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

END

Attachment 1: Revision History for IP 65001.09

Attachment 1

Revision History for IP 65001.09

Commitment Tracking Number	Issue Date	Description of Change	Training Needed	Training Completion Date	Comment Resolution Accession Number
N/A	08/05/09 CN 09-019	Researched commitments for 4 years and found none. Initial issuance to support ITAAC related inspections under 10 CFR 52	No	N/A	N/A