

INSTRUMENTATION AND CONTROL SYSTEMS

PROGRAM APPLICABILITY: 2630, 2694, 2696

88140-01 INSPECTION OBJECTIVES

Note the term licensee refers to licensees, holders of certificates of compliance, applicants for a license, contractors, subcontractors, vendors, and other employers subject to NRC authority.

01.01 To determine whether technical requirements detailed or referenced in the facility's licensing documents (i.e., Construction Authorization Request (CAR), License Application, Safety Analysis Report (SAR) or Quality Assurance Plan (QAP)) associated with Items Relied on for Safety (IROFS) instrumentation and controls (I&C) in Quality Level (QL)-1 systems, and associated items have been adequately addressed in the licensee and/or contractor 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 (QA) plans, instructions, and procedures for IROFS I&C, and associated items have been established in licensee and contractor QA/Quality Control (QC) manuals and whether these conform to the QA program described in the approved QAP.

01.03 To determine, through direct observation and independent evaluation of work, whether the licensee's work and inspection performance relative to IROFS I&C in QL-12 systems, as applicable, are being controlled and accomplished in accordance with approved specifications, drawings, and procedures.

01.04 To determine whether the licensee is adequately implementing the QA program associated with I&C including preparing, reviewing, and maintaining a system of quality records; whether the records reflect work accomplishment consistent with NRC requirements, licensing document commitments, and the QAP; and whether the records indicate any potentially generic problems, management control inadequacies, or other weaknesses that could have safety significance.

88140-02 INSPECTION REQUIREMENTS

02.01 QA Procedure Review. For the Licensee and each contractor with QA responsibilities, review commitments and procedures covering the scope of documents to be prepared for assuring the quality of I&C systems that are designated as IROFS.

- a. Determine whether the installation procedures for I&C IROFS are consistent with the QA program and licensing document commitments.
- b. Determine whether responsibility assignments for procedures preparation, review and approval, include groups with necessary technical expertise.
- c. Determine whether Licensee individuals or contractors 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.
- d. Determine whether construction drawings incorporate the most recent design requirements.

02.02 Specific Technical Review Areas. Determine whether procedures covering work and inspection activities in the following areas are appropriate for the activity and are technically adequate:

- a. Receipt Inspection Procedures (IPs). Receipt inspection and related procedures provide means to ensure that:
 1. Material is in good condition, not damaged in shipment and that shipping and handling requirements have been met.
 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, certificate of conformance, 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 instructions) are established for the various types of I&C system components and meet applicable storage classification levels regardless of the location of the stored item.

2. Storage IPs requires 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 and shelf life limits are not exceeded.
- c. Work Procedures. Work procedures are established to ensure that:
1. Licensing document commitments are properly translated into the work procedures (construction specifications, drawings and work instructions) for adequate control and installation of IROFS I&C system components and associated items.
 2. Interface controls are adequate when multiple contractors are involved.
 3. Procedures cover special handling, installation, termination, and maintenance requirements, including those pertaining to protection, preservation of internal cleanliness, and maintenance of component qualification requirements. For example, all covers, seals, plugs, internal preservatives, and protective coatings are left intact until installation and/or use, as appropriate.
- d. Inspection Procedures. QC IPs is established to ensure that:
1. All safety-related aspects of construction specifications, drawings, and work instructions are included in the scope of planned inspections.
 2. The technical aspects of inspection requirements and acceptance criteria are sufficient to determine whether the components and their installation (including terminations and interface seals), calibration, test, maintenance, and protection conform to applicable design and construction specifications.
 3. Records of initial and follow-up inspections 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 nonconformance(s) found.
- e. Construction Testing and Calibration Procedures. Procedures are established to ensure that special conditions of testing and calibration of process instruments (prerequisites, sequence, special handling, removal, precautions, etc.) are included and described in proper detail as required to conduct and monitor the work performed. For example, if density compensation is required for a liquid level instrument, the proper technique for density correction should be included in the calibration procedure.
- f. Change Control Procedures. Procedures have been established to control design and field changes to ensure that:

1. Retrieval of voided drawings and specifications at work sites is controlled.
2. Field changes are subject to adequate design control processes and are incorporated into the as-built records.

02.03 Follow-up Procedure Review. When I&C systems are in process of being installed, review work and QA/QC procedures pertaining to installation and inspection. Review a selected sample of the procedures addressed in Sections 02.01 and 02.02, above, and note significant changes made (revisions, deletions, additions, etc.). Determine whether the changes are appropriate and whether regulatory requirements and licensee commitments remain in these procedures.

02.04 Additional Inspection. Additional inspections may be conducted in the inspection areas covered above if Regional management concludes that the licensee performance is determined to have weaknesses requiring extensive corrective action.

02.05 Inspection of Systems and Components.

a. General.

1. Inspection of selected components and associated items of the instrument systems listed below shall be accomplished by observation and evaluation of both in-process and completed work at the appropriate stage of completion for the activity to be inspected.
2. Sample selection shall be based on importance to operational safety and shall include redundant components and a diversity of components and locations.
3. Before inspection of selected items, review the specifications, drawings, work procedures, QA/QC procedures and work schedules applicable to the systems and components selected for inspection. If applicable review all previously issued NRC inspection reports in the area. The following sample sizes are considered to be minimum.
 - (a) Before inspection of selected items, review the specifications, drawings, work procedures, QA/QC procedures and work schedules applicable to the systems and components selected for inspection. If applicable review all previously issued NRC inspection reports in the area.
 - (1) For each periodic inspection of the activities in Section 02.06, select several process variables (i.e., safety sensor) in the safety control subsystems that are required to be monitored for initiation of the system safety function.
 - (2) Complete the inspection requirements of subsections 02.06.a through 02.06.f below for the selected process variables and

associated items in the applicable safety control subsystem.
The sample shall include redundant components if applicable.

(b) Emergency Control System.

For each periodic inspection of the activities in Section 02.06, select several process variables which are used by the emergency control system to mitigate the consequence of a hazardous occurrence.

(c) IROFS Display Instrumentation.

(1) For each periodic inspection of the activities in Section 02.06.d, select several process variables which are displayed to provide information to the operator so that required manual safety actions can be taken using the emergency control system.

(2) Complete the inspection requirements of subsections 02.06.b through 02.06.f for components pertaining to the process variables selected for that subsection.

(b) Emergency Control System.

(1) For each periodic inspection of the activities in Section 02.06, select one process variable which is used by the emergency control system to mitigate the consequence of a hazardous occurrence.

(2) Complete the inspection requirements of subsections 02.06.a through 02.06.f for the instrument components and associated items pertaining to the emergency control system variable selected. The sample shall include redundant components if applicable.

(c) IROFS Display Instrumentation.

(1) For each periodic inspection of the activities in Section 02.06.d, select one process variable which is displayed to provide information to the operator so that required manual safety actions can be taken using the emergency control system.

(2) Complete the inspection requirements of subsections 02.06.b through 02.06.f for components pertaining to the process variable selected for that subsection.

02.06 Inspection Activities.

- a. Receipt Inspection. Observe and evaluate portions of receipt inspection activities pertaining to instrumentation components and associated items selected in the appropriate subsections of Section 02.05. Determine whether receiving inspection activities are being controlled and performed in a manner which will ensure that applicable requirements are satisfied in the following areas:
1. Components and receiving documents are properly identified.
 2. Physical condition (damage, deterioration, etc.).
 3. Documentation relative to quality requirements (e.g., results of functional and qualification testing) received with components and associated items is reviewed and meets the requirements. Where qualification testing of components to be placed in a harsh environment is not a requirement of the specification, review existing documentation that establishes acceptance criteria and environment requirements that define what means will be used to assure that applicable environmental qualification will be satisfied.
 4. Control of nonconforming components.
 5. Adequate number of qualified personnel are available to perform the receiving inspection function.
- b. Storage. Observe and evaluate storage activities and conditions for the inspection samples selected in appropriate subsections of Section 02.05. Determine whether:
1. Components are stored in the proper storage level designation.
 2. Components are properly identified.
 3. Storage conditions (temperature, humidity, cleanliness, etc.) are controlled and monitored as specified.
 4. Licensee and contractor inspection and monitoring activities are being performed in accordance with procedural requirements.
 5. Nonconforming items placed in storage are identified and/or segregated, as required.
 6. In-place storage requirements are satisfied.

7. An adequate number of qualified personnel are available to perform the required storage functions.
- c. In-Process Installation. Observe and evaluate portions of the in-process installation activities for the inspection sample selected in appropriate subsections of Section 02.05. Determine whether:
1. The latest approved revision of applicable construction specifications, drawings, and/or procedures are available and used by the installers.
 2. The components are as specified, such as: type, range, proof pressure/rating and material. Wiring and terminations associated with the components are observed and evaluated per IP 88137.
 3. Associated mounting hardware and supports are of the type and material specified and properly located.
 4. The components are installed in the proper location and orientation by qualified craft personnel using suitable equipment and tools.
 5. The required component identification is properly maintained or established.
 6. Licensee and contractor inspections are performed, or scheduled to be performed, before closing out the work to be inspected.
 7. Inspection activities are timely and properly completed by qualified personnel.
 8. Installed components are adequately protected from damage by adjacent construction activities.
 9. Nonconformance issues are identified and handled in accordance with established procedures. Where corrective action is being taken, determine whether it meets the appropriate requirements.
- d. Completed Work. Observe and inspect the completed installation of I&C system components for the samples selected in subsections of Section 02.05. Determine whether:
1. Location, configuration and installation (including mounting and anchoring) are in accordance with the latest approved design or construction specifications and drawings.
 2. Specified instrument components and associated items have been used.
 3. Components have been correctly and permanently identified.

4. Cleanliness requirements have been maintained or otherwise satisfied.
5. Installed equipment is adequately protected from adjacent construction activities and protective coatings, plugs, bushings, and other materials have been used as specified.
6. Instrument components and associated items, such as sensing lines and power supplies; maintain physical and electrical independence between redundant parts.
7. IROFS protection systems and normal plant control systems are adequately separated and isolated from each other.
8. Nonconforming components or conditions have been identified and controlled in accordance with approved procedures.
9. Status of completion, maintenance, and readiness for pre-operational testing is indicated or otherwise documented.
10. Adequate actions or provisions have been taken or maintained (as needed) to ensure that the validation of the environmental qualification of instrument components is maintained.
11. Wiring and terminations, including grounding, are installed in compliance with construction drawings and specifications.

e. As-Built Verification.

1. When I&C system components as selected in appropriate subsections of Section 02.02, are installed and inspected, obtain the latest revision (as-built, if available) of instrument and installation drawings.
 - (a) Review construction specifications and other applicable documents referenced by drawing or otherwise.
 - (b) Compare the actual installation of the components selected with the drawings.
 - (c) Select several additional components from drawings and determine whether they are of the correct specified type (i.e., function, range, accuracy, qualification, material, etc.) and whether they have been installed, located, oriented, supported, protected, etc. in accordance with the drawing.
2. Before performing items (a), (b), and (c), above, verify the status of any outstanding design changes on the selected drawings (or related specifications).

3. Discrepancies observed may result from in-process changes, such as those initiated in the field. If in-process changes are involved, determine whether the licensee has properly controlled and documented these changes for engineering review, approval, and subsequent incorporation into the final as-built drawings.
- f. Construction Testing and Calibration. Observe construction testing and calibration activities for applicable components from the sample selected in subsections of Section 02.02. Determine whether:
1. The latest revision of applicable procedures and/or specifications are available at the work location and used by personnel performing the testing and calibration.
 2. Properly identified, traceable and calibrated measuring and test equipment are used.
 3. Equipment or components calibrated are able to obtain the set point, degree of accuracy, and/or tolerance specified or otherwise noted.
 4. Required testing and calibration results are recorded during the activity, not after the work has been completed.
 5. Components are adequately identified as having been tested or calibrated.
 6. Personnel performing the testing and calibration are properly qualified.
 7. Test and calibration personnel adhere to any special handling or removal requirements.

02.07 Additional Inspection. Additional inspections may be conducted in the inspection areas covered above, if Regional management concludes that the licensee performance is determined to have weaknesses requiring extensive corrective action.

02.08 Record Control and Review. Review licensee and contractor requirements covering the scope of records for IROFS I&C system components.

- a. Determine who prepares each quality-related record, who reviews the records for accuracy and who ensures that the recorded information meets requirements.
- b. Evaluate the information obtained above and determine whether the established record management system satisfies QA Program and licensing document commitments.

02.09 Inspection Records. Review and evaluate pertinent quality records. Determine whether: (1) adequate preparation, control, review, and evaluation of these records have been made; (2) they reflect that regulatory requirements have been met and (3)

the system of records is functioning properly. The selection shall include records of components in the safety control subsystems (e.g. MP and AP), emergency control system, sensors, and safety parameter displays, if applicable.

a. Receipt Inspection Records.

1. Receipt inspection documents properly and uniquely identified received instrument components and associated items.
2. Applicable engineering and functional specifications (regarding size, type, material, etc.) of received items were met or otherwise noted.
3. The required instrument component characteristics, material, performance tests, environmental and seismic qualification tests, nondestructive tests, and other specification requirements were met or otherwise noted.
4. Original records or certification system met requirements of applicable criteria.

b. Storage Records.

1. Required storage conditions were maintained. (Note: Verification of these conditions may require verification of log sheets recording the ambient conditions or through the use of recorders.
2. Storage inspections were properly made at specified intervals.
3. Records of nonconforming items in storage areas were properly maintained.

c. Installation Records.

1. Most recent and approved design and construction documents were used during installation.
2. Specified instrument components and associated items were installed in the location specified or otherwise noted.
3. Materials and methods used for supports and anchors (including welds) met applicable specifications.
4. Required inspections were performed, recorded, reviewed, and evaluated by qualified personnel.
5. Inspection records were complete and satisfied documentation requirements.
6. Physical separation and independence requirements were met.

7. Required protection was provided after installation.
 8. Verify that required special installation procedures were implemented.
- d. Construction Testing and Calibration Records.
1. Required tests and calibrations were performed as required.
 2. Records indicate that approved procedures and equipment were used.
 3. Test equipment was periodically checked and calibrated as specified.
 4. Test data and results were properly documented and evaluated, and corrective action, if required, was taken.

02.10 Training/Qualification Records. Review and evaluate a selected sample of personnel qualification records and determine whether:

- a. A system of craft and inspection personnel qualification records meets stated requirements and is being maintained in a current status.
- b. The records are sufficient to reasonably support qualification in terms of certification, experience, proficiency, training, testing, etc., as applicable.
- c. Action has been taken by responsible licensee organizations to independently authenticate the record material.

02.11 Nonconformance and Deviation Reports. Review and evaluate a selected sample of nonconformance and deviation reports, and determine whether:

- a. Records are legible, complete and promptly reviewed by qualified personnel.
- b. Reporting requirements of 10 CFR Part 21 and Part 70 were recognized during evaluation and appropriate action was taken where necessary.
- c. Records have been routinely processed, timely evaluated, and controlled through established channels for resolution of the root cause as well as the immediate problem.
- d. Records are properly identified, stored, indicate current status, and can be retrieved in a reasonable time.
- e. Nonconformance reports include the status of corrective action or resolution, and adequate justification is provided for use-as-is disposition.

02.12 Change Control Records. Review and evaluate a selective sample of five change control records, and determine whether:

- a. Records associated with design and field changes, as well as related work and inspection procedure changes, reflect timely review and evaluation by qualified personnel and are of the type approved for that purpose.
- b. Records of periodic inspections assure that only the most recently approved documents, including design changes, were used in the field.
- c. Design changes are subject to adequate design control, including consideration of the impact of the change on the overall design and on as-built records.
- d. Records of nonconformity to design requirements include preparation of a nonconformance report even if the nonconformance is resolved through the design change process.

02.13 Audit Records. Review and evaluate licensee and instrument contractor(s) audit records in general and two recent audits associated with instrumentation in detail (one licensee audit and one contractor audit, if available) and determine whether:

- a. Audits have been performed in accordance with the schedule and functional areas established in the audit plan.
- b. Audit records are sufficient to verify that the intended purpose and scope of the audits were achieved.
- c. Audit findings have been reported in sufficient detail to permit a meaningful assessment by those responsible for corrective action, final disposition, and trending.
- d. The licensee and contractor has taken proper and timely follow-up action on those matters in need of correction.
- e. Auditing organizations and personnel are independent of the work being audited.
- f. All elements of the QA program are being audited periodically.

02.14 Additional Inspection. Additional inspections may be conducted in the inspection areas covered above if Regional management concludes that the licensee's performance is determined to have weaknesses requiring extensive corrective action.

88140-03 INSPECTION GUIDANCE

03.01 General Guidance.

- a. I&C system components consist of those elements that are designed to measure, monitor, transmit, modify, display, alarm, record and/or control various

plant variables or conditions. This IP, and other instrumentation IPs, apply, but are not limited, to the following IROFS instrument components and associated items: sensors, transmitters, isolators, signal conditioners, controllers and other actuating devices, recorders and other printing devices, indicators, alarms, switches, logic devices, interlocks, bypasses, instrument valves, fittings, tubing, instrument air supplies, internal power supplies or regulators, protective devices, control boards, racks, panels, cabinets, supports, anchor and mounting hardware, communication devices, multiplexers, data concentrators, engineering workstations, human-machine interface devices (e.g., displays), interconnecting means for integrity and applicability, and network management devices and tools.

- b. During inspection preparation, applicable portions of the licensing documents should be reviewed by the inspector to determine specific licensee procedural and work instruction commitments relative to construction and inspection (QA) requirements for I&C system components. The inspector should then utilize the above information during review of the licensee's construction specifications, drawings, work, and IPs to determine whether licensing document requirements are adequately translated into the appropriate documents.
- c. Procedures that control activities such as receipt, storage, installation, inspection, calibration, testing, and software modification, upgrading, and/or patching 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. If a contractor utilized procedures and personnel for activities covered by the other IPs, it is not necessary to repeat similar inspection requirements for each of these IPs. It should be noted that software validation is covered by IP 88112.
- 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 concern of whether the licensee is maintaining adequate control of the process, and 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, unresolved and requiring resolution, or in violation and requiring correction. When significant inadequacies are identified indicating weakness within the responsible organization, the inspector should inform cognizant NRC management. The issue should be addressed also at the appropriate level of licensee management.

- g. Because the instrumentation is so important and extensive, inspection activities are to be conducted periodically. In-process installation inspections should be scheduled to match appropriate installation activities.
- h. It is expected that the scope of periodic inspections will vary with construction progress, problems encountered, etc. Additional inspections should be made when and where conditions warrant.
- i. Any installation activity that has been delayed or suspended for more than one year, or has been subject to significant procedural, design, or personnel change, should be re-evaluated immediately after resumption of the work or after the above changes have been made. Determine whether additional NRC inspection is required.
- j. The inspector may not be able to observe all facets of all work activities in progress relative to instrument components and systems selected for inspection. However, portions of activities directly affecting plant safety must be covered.
- k. In addition to observing whether specific instrument components and associated devices are as specified (properly identified, located, mounted, etc., as required), it is important also to ascertain whether certain components or conditions do not exist where prohibited. For example, instrument components are not exposed to potential hazards from other construction activities. Because of the complexity of digital components, and the potential for interconnection between safety components and between safety and non-safety components, the inspector should consider these issues during the inspection. Although the safety sensor may be hardwired to the controller, the controller may be communicating over a digital bus with other controllers, the operator, or an annunciator system. Also, some sensors are “smart” in that they have on-board diagnostics and calibration tables, so, even though they are “hardwired,” they could still be using some communication link with the controller (e.g., HART superimposes digital monitoring and command signals on an analog 4-20mA signal).

03.02 Specific Guidance.

- a. Inspection Requirement 02.01. The expertise of the inspector is important for the proper completion of the inspection. The individual selected to perform Section 02.01 should have a general knowledge of and background in QA, and the individual selected for Section 02.02 should be thoroughly knowledgeable of the technical requirements associated with instrumentation systems. One individual may perform both requirements if he/she possesses appropriate knowledge in both areas.
- b. Inspection Requirement 02.02. For the purpose of this IP, the term “procedures covering work” includes construction specifications, drawings, and work instructions. (Procedures describing methods of fabrication, construction or installation are sometimes called construction procedures.)

c. Inspection Requirement 02.02.a.

1. Receiving IPs should reflect the requirements that the licensee has committed to for example, of Nuclear Quality Assurance (NQA)-1-1994, Supplement 7S-1 and/or Subpart 2.2, or equivalent requirements.
2. The licensee should identify and describe all I&C components with IROFS which must operate in a hostile environment (e.g., high radiation, temperature, humidity) during or after an accident.
3. Where environmental qualification testing, or other qualification provisions (such as seismic) are specified, the licensee shall establish means to assure that the results of this testing are documented, reviewed, and determined to be acceptable. If this is not performed when components are received, the procedures should specify the organization that will be performing this review and the controls to ensure that all such documentation requirements are satisfied before the component is placed in use.
4. The inspector should also be aware of memory-related integrated circuit chips (Programmable read only memory (PROMs), flash memory, etc.) that have certain versions of application code (i.e., specific version of firmware). The inspector should verify that the configuration management program is tracking these versions - not just firmware, but all electronic devices that may have embedded processors, memory, etc. In addition, for safety-related electronic components, the inspector should verify that the supplier or licensee followed the supply chain to ensure no unauthorized replacements have occurred.
5. Instrument components may be released for installation on the merits of certifications of conformance if the organization involved has established a satisfactory program control and audit requirements in this area (NQA-1-1994, Supplement 7S-1 Subpart 8.2.1). However, certifications of conformance do not release the licensee from having other records (such as environmental or seismic qualification records) for operation and for the life of the plant.

d. Inspection Requirement 02.02.b.

1. Special storage requirements are typically specified by the manufacturer or an industry standard, such as NQA-1-1994 Subpart 2.2. The requirements should include such things as identification and markings on I&C components, protective covers, preservatives, etc.
2. The inspector should verify that the storage procedures have provisions for initial and periodic inspection of storage conditions for components which have special storage requirements. Procedures should be available

for conducting periodic “storage inspections” of components which have been installed during the time period between installation and turnover to the operations staff.

3. The inspector should consider verifications of proper firmware, component versions, and verify that unauthorized substitutions have not been made (This is over and above certain environmental considerations, e.g., humidity and temperature for electronic components.)
- e. Inspection Requirements 02.02.c. Procedures should be reviewed to ensure that technical requirements in the licensing document are reflected in construction specifications, drawings, work instructions, and work procedures. Areas to review shall include, but are not limited to, the following:
1. I&C system components (type, range, accuracy, materials, etc.) are identified, located, oriented, and supported as specified by design.
 2. Physical separation and independence requirements of redundant components are met.
 3. Instrument sensing lines are sloped to meet applicable requirements. Instruments connected to chemical processes for which it is not feasible to use direct sensing lines are might be connected via armored capillary tubing and/or diaphragm seals which have been appropriately protected from potential damage from construction or operating activities. Appropriate and adequate construction specifications, procedures and other work instructions for a particular activity are required to be approved and available before that activity is started.
- f. Inspection Requirement 02.02.c.3.
1. It is not considered adequate identification to include only the instrument model number and type. Procedures should specify a unique identification number, along with the model number and name of manufacturer. Adequate (positive) identification is important because similar-looking instrument components can be significantly different with respect to range, output signal, etc. Safety-related instrumentation should be listed in the licensing document.
 2. Anchor bolts holding or mounting instrument components should be of the type, size and length specified. Provisions should exist to prevent indiscriminate cutting of reinforcement steel during the drilling of anchor holes.
 3. Procedures should be established to ensure that independence and separation requirements of safety-related functions from normal control functions are met, especially safety functions that provide protection against normal control system malfunctions. This separation should

include electrical and data communication isolation. (Note: Given the high automation in the MOX facility, data communication isolation should be verified from both a random failure and a cyber security perspective.)

4. Means should be established, such as procedures or checklists, to ensure that redundant sensing lines are protected from common mode failures. That is, redundant lines will not fail from a single accident; especially an accident or failure for which they are supposed to provide protection.
5. Evaluate sensitivity to grounding connections and lightning protection system downcomers.

g. Inspection Requirement 02.02.d.

1. Inspection Requirement 02.02.d.2. Review the IPs and compare with the requirements in the applicable codes and construction specifications. Evaluation should indicate whether adequate quality-related IPs 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. Inspection Requirement 02.02.d.3. Provisions should include procedures for monitoring or surveillance of locally mounted instruments by inspection (QC) personnel. They should ensure that maintenance requirements while "stored in place" are satisfied and 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.)

h. Inspection Requirement 02.02.e. This area is to be inspected by NRC inspectors who are knowledgeable in the area of instrumentation in general and calibration and testing in particular.

The licensee should reference general testing and calibration requirements, and work procedures should provide detailed instructions. Additionally, the QA manual should include general surveillance procedures relative to the calibration of process instruments, i.e., calibration activities should be monitored (inspected or audited, as appropriate) in accordance with established procedures.

1. These procedures should include verification of the following:
 - (a) Calibration data sheets (or equivalent) are being used as specified.
 - (b) Calibration ranges and accuracies are current and approved for use. (Accuracy requirements should be defined.)

- (c) Calibration and instrument setting procedures are current and approved for use, including identification of any special calibration test equipment or test equipment minimum accuracy specifications needed for safety related instruments. Such specifications should be consistent with the project instrument setpoint and loop accuracy procedure requirements.
 - (d) Calibration techniques are appropriate for the component to be calibrated. For example, if density compensation is required for a liquid level instrument, the proper technique or correction for density should be included in the calibration procedure. Although density compensation is a basic requirement for accurate level measurement, it is periodically overlooked for water-calibrated instruments.
 - (e) Controls for removal and handling of components during calibration.
2. Calibration data records for process instruments should include information and data specified by industry standards which the licensee is committed to such as:
- (a) Specific identity of the instrument calibrated.
 - (b) The specific identity of the measuring and test equipment used to perform the calibration.
 - (c) The “as-left” calibration data.
 - (d) Date of calibration.
 - (e) Identity of the technician performing the calibration.
 - (f) Calibration schedule documentation review.
 - (g) Approval signature of a responsible individual. Certificates of calibration should be available at the site for measuring and testing equipment used to perform these calibrations. These certificates should show that the standards used to establish the accuracy of the test equipment are traceable to a nationally recognized standard. Procedures should require that the performance and accuracy of test equipment are demonstrated by periodic checking.

This item does not include pre-operational testing. Construction testing generally verifies that certain components perform as intended, but it is not a test of system capability.

- i. Inspection Requirement 02.05.a.3.(c). Examples of process variables used by the emergency control system are some manual and automatic controls for

power distribution, ventilation, and seismic isolation systems. Associated and interrelated devices include signal conditioning components, isolation devices, interlocks, bypasses, selector switches, resets, overrides, instrument tubing, racks, panels, and their supports, instrument wiring and wiring terminations. The licensing documents should include the specific variables, as well as the logic and devices, used in the system.

Examples of sensors which provide information to automatic controllers are devices for measuring/monitoring temperature, mass, physical dimension, component identification bar codes, and machine tool positions.

Examples of controllers which are required to mitigate accidents are the safety controllers and emergency controls. The licensee should specify the specific variables, as well as the logic and logic devices used in the system.

- j. Inspection Requirement 02.06.a. Receipt inspection activities should be inspected for compliance with procedures identified and/or reviewed during inspection, Subsection 02-02.a. NQA-1-1994, Subpart 2.2 or equivalent requirements are applicable here.
 - 1. The licensee should identify and describe all instrument components which must operate in a hostile environment (e.g., high radiation, temperature, humidity) during or subsequent to an accident. Where environmental qualification testing, or other qualification provisions (such as seismic) are specified, receiving inspection activities should include verification that required testing has been satisfactorily completed.
 - 2. All required documentation may not be received with the components. If not, the inspector should at this time determine that the licensee is following their system for identifying, controlling, and maintaining the status of the required documentation. This system should ensure eventual documentation of satisfactory completion of required testing.

- k. Inspection Requirement 02.06.b. Storage activities should be inspected for compliance with procedures identified and/or reviewed during inspection, Subsection 02-02.b. NQA-1-1994, Subpart 2.2 or equivalent requirements are applicable here.
 - 1. Control of storage conditions for equipment stored in place usually requires special effort. The inspector should note whether the procedurally required storage conditions are being maintained.
 - 2. Readily visible and permanently marked tags or other identifying scheme should be used for all nonconforming components and materials, and records relative to the nonconformance should be available at the site and readily retrievable.

I. Inspection Requirement 02.06.c. Because of the uncertainties associated with scheduling of in-process installation inspections, it is expected that the scope of these periodic inspections will vary considerably. The intent is to observe the more important installation activities for a variety of instrumentation components and associated items during the time such activities are in progress.

1. Inspection Requirement 02.06.c.1. While reviewing construction specifications and drawing, also look for missing or inappropriate approvals.
2. Inspection Requirement 02.06.c.2. Drawing and construction specifications used in the field should be reviewed periodically to ensure that the most recent approved revisions are used and components are as specified.
3. Inspection Requirement 02.06.c.3. For some of the supports and anchorages, the inspector should directly measure or otherwise independently verify that requirements pertaining to such items as location of equipment, location of supports, and bolt size are as specified.

During installation of equipment, anchorage holes are sometimes drilled in concrete structures. Indiscriminate cutting of reinforcing steel should not be allowed. Verify the adequacy of procedures to ensure the activity is not included

The inspector should ensure that proper welding requirements, from codes and standards that the licensee has committed to, are specified and controlled. Standards may include American Welding Society (AWS) D1.1, Structural Welding Code, for welding of supports. Instrument tubing welds are generally in accordance with welding code requirements associated with the system or component being monitored, e.g., American National Standards Institute (ANSI) B 31.3, American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, as appropriate. The inspector should verify that the construction specifications and drawings specify the welding requirements to be used.

4. Inspection Requirement 02.06.c.4. "Qualified craft personnel" means those employees who have achieved suitable proficiency to do their assigned tasks by appropriate training and/or previous experience and who understand the installation procedures, drawings, and specifications necessary for their work.
5. Inspection Requirement 02.06.c.7. The observation of inspection (QC) activities should include in-process and final inspections.

"Timely and properly completed" includes performing the proper inspections at the specified frequency and sequence.

Two or three QC inspectors should be interviewed to determine whether they are familiar with the quality requirements associated with the instrumentation being inspected, what construction specifications and other criteria are used to determine acceptance, how their inspection results are recorded, etc. The intent is to determine the effectiveness of instrumentation inspection personnel and management systems for indoctrination, training, and qualification of personnel.

NQA-1-1994, Supplement 2S-1, or equivalent requirements are applicable to inspection personnel.

m. Inspection Requirement 02.06.d.

1. Inspection Requirement 02.06.d.1. Some instrument lines, racks, panels, and their supports, or other anchoring means are required to meet seismic requirements. (The licensing document should indicate where applicable.) If specified for lines, racks, or panels selected for inspection, ascertain whether these requirements are met.

If the installation is different from approved drawings and specifications, determine whether the change is adequately documented and forwarded for review and approval.

2. Inspection Requirement 02.06.d.2. Sometimes similar instrument components are put in identical cases. The inspector should ascertain whether the various components inspected are as specified. This can be done by observing the name plate for identification numbers. For example, the model number may be the same on two components, but the ranges and identifying numbers will be different.
3. Inspection Requirement 02.06.d.3. The inspector should ascertain whether component identification is adequate. The installed instrument components should be uniquely identified on the component itself, the installation records, calibration records, and inspection records.
4. Inspection Requirement 02.06.d.5. Temporary protection during construction is generally required. Protection from overhead construction activities, especially welding and concrete placement, warrants special attention. Additionally, protection from inadvertent damage during plant operation and maintenance must be adequate and properly installed. Because it can be easily damaged, instrument tubing requires special attention. This is especially important when instrument tubing runs are part of a safety system that may be damaged by an event or accident for which the safety system is supposed to provide protection.
5. Inspection Requirement 02.06.d.7. Safety functions are to be independent of normal plant control functions, especially safety functions that provide protection against control malfunctions.

6. Inspection Requirement 02.06.d.8. The intent is to verify that nonconforming conditions are identified and result in the initiation of appropriate nonconformance documentation. Where revisions are made, verify that they are in accordance with approved corrective action dispositions.

- n. Inspection Requirement 02.06.e. The intent is to determine whether instrument components and associated items are being installed according to properly approved drawings and changes, such as engineering, design, field change requests, and changes to correct nonconforming conditions. As this inspection requirement is to verify "as-built" systems, a new sample should be selected if it is found that extensive rework is in progress. However, the NRC inspector should verify that the changes are properly handled in accordance with established procedures.
 1. Appropriate standards can be used as a guide in this area. For example, NQA-1-1994, Supplement 3S-1, requires that where changes to previously verified designs have been made, design verification shall be required for the changes, including evaluation of the effects of those changes on the overall design. Additionally, 10 CFR 50, Appendix B, Criterion III, states in part that design and field changes shall be subject to the same design control procedures as the original design.
 2. Changes may be made to instrument systems during construction that are different from the original design. Such changes will result in the accumulation of various types of design change documents. Since these changes reflect as-built conditions, they should be adequately controlled and available for future evaluations on the effect other design changes have on the overall design.

Additionally, the as-built process should result in proper and timely updating of the master drawings and specifications to incorporate such changes. Thus, an excessive number of accumulated changes not incorporated into the as-built records and affected analyses should be pursued. The NRC inspector should determine how the licensee ensures that the affect of each subsequent change will be adequately evaluated.
 3. Obviously, the inspection requirements associated with as-built verification cannot be done until the work to be inspected is essentially complete. Consequently, this inspection requirement should be scheduled during later periodic inspections.

- o. Inspection Requirement 02.06.f. The inspector should review the specified calibration requirements and procedures before observing these activities. If special requirements are specified, such as density compensation during liquid level instrument calibration, the inspector should determine whether these requirements are being adhered to.

If calibration activities are in progress, determine whether the most recently approved calibration information is being used, and whether required procedures are being adhered to. The values of instrument ranges and zero set points are sometimes changed after receipt of the instruments at the site. The inspector should assure (by selective sampling) that current data are used for checking and calibrating instruments, and that these changes are within the limits of the instrument components involved.

As these inspection requirements cannot be done until testing and calibration activities are in progress, inspection in this area should be scheduled accordingly.

Final calibration and trip settings may be done later, usually during pre-operational testing or during startup preparation.

The intent of these requirements is to verify that nonconforming conditions associated with instrument components and systems are identified by the licensee and result in the initiation of the appropriate nonconformance documentation and corrective action.

- p. Inspection Requirement 02.07. The inspection requirements related to additional inspection are intentionally general. The extent and type of additional inspection should be based primarily on the findings.
- q. Inspection Requirement 02.09.a. Where environmental qualification testing, or other qualification provisions (such as seismic) are specified, records should be available to verify that required testing has been satisfactorily completed. If these records are not available at the time of component receipt, the inspection records should identify the need for subsequent receipt and review of these documents.

It is important to ensure that qualification testing has been successfully completed. Qualification documents should be reviewed to substantiate that the equipment is qualified to applicable standards and to the appropriate environment.

A variety of terms is used for documentation that confirms that certain specifications are met or that specific tests have been satisfactorily performed. For the acceptability of these documents, refer to the requirements of NQA-1-1994, Supplement 7S-1.

- r. Inspection Requirement 02.09.b. Control of storage conditions for equipment stored in place usually requires special effort. The inspector should note whether the specified storage conditions are reflected in the storage inspection records. Refer to NQA-1-1994, Subpart 2.2 for guidance applicable to in-place storage.

- s. Inspection Requirement 02.09.c. Licensee and contractor inspection personnel should use checklists or other means to ensure proper identification of installed equipment. Checklists or records of inspection should be generated during the inspection, and these records should be readily retrievable for review by the NRC inspector. "Properly installed" means that the installation meets applicable NRC requirements and licensee commitments, including specified separation or installation of protective barriers. The as-installed inspection records should match the applicable requirements. In order for the inspector to ensure that the records reflect actual conditions (identification, instrument range, location, etc.), some instrument components selected should be the same as those selected in Section 02.02 of this procedure. (If the installation differs from the approved installation documents, a nonconformance report and a design change should have been generated.)

During installation of equipment or supporting components for the equipment, anchorage holes are sometimes drilled in concrete structures. The work and/or inspection records should indicate (or at least infer) that no indiscriminate cutting of reinforcing steel was done during drilling of anchor holes.

Installation and inspection records must contain sufficient detail to permit identification of the specific revisions or change notices used in these activities. Permanent records must provide a clear audit trail to any applicable change or nonconformance documentation. See also subsection 02.02.a.3 above.

- t. Inspection Requirement 02.09.d. In addition to the records indicating satisfactory testing and calibration, the records should reflect that the range, response time, etc., for instrument components are appropriate for postulated accident conditions as well as for normal operating conditions. The procedures for testing and calibration should contain the necessary criteria.

Where special requirements are necessary, such as density compensation during liquid level instrument calibration, the records should reflect that such requirements were adhered to.

- u. Inspection Requirement 02.11. The sample size and diversification of selection should be sufficient to determine whether the system used to handle and control nonconformance issues is working in an effective manner.

The effectiveness of the management control system in this area can be determined, in part, by how adequately and promptly the root cause of nonconforming activities are identified and corrected.

- v. Inspection Requirement 02.13. Audit records should reflect that adverse audit findings were promptly evaluated and corrected in an adequate manner. The root cause involved should be identified to preclude repetition.

03.03 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 I&C IROFS components have met applicable acceptance criteria or to identify and document non-conformances in specific areas.
- b. IPs do not include adequate inspection requirements and acceptance criteria.
- c. Inadequate means to control location and status of instrumentation components - especially during removal for calibration, modification, 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.)

88140-04 RESOURCE ESTIMATE

This IP is expected to take, on the average, 32 to 40 hours for each review of licensee and contractor activities. This IP should be conducted as needed.

The first inspection should be early in the project and focus on review of procedures and work activities involving receipt inspection and storage and process control. The second two iterations should focus on observation of work, verification of as-built configurations, and review of applicable records.

Periodic inspections and regional inspectors should focus on observation of work activities, protection of installed equipment, and review of documentation, audits, and corrective actions involving I&C components and installation activities.

Additional inspections by specialist inspectors should be scheduled if significant problems are identified during specialist or resident inspector's reviews.

88140-05 REFERENCES

American National Standards Institute (ANSI)/Instrument Society of American (ISA). ANSI/ISA-67.04.01-2000, "Setpoints for Nuclear Safety-Related Instrumentation."

ANSI/ Institute of Electrical and Electronic Engineers (IEEE) Standard (Std.) 336-1985, "IEEE Standard Installation, Inspection, and Testing Requirements for Power Instrumentation, and Control Equipment at Nuclear Facilities."

ANSI/IEEE 802.3 Standards Series, "IEEE Standards for Local Area Networks: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications."

IEEE Std 384-1992, "Standard Criteria for Independence of Class 1E Equipment and Circuits."

IEEE Std 344-1987, "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Generating Stations."

IEEE Std 338-1987, "IEEE Standard Criteria for Periodic Testing of Nuclear Power Generating Station Class 1E Power and Protection Systems."

IEEE Std 518-1982, "IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources."

IEEE Std 1023-1988, "IEEE Guide for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations."

IEEE Std 1050-1996, "Guide for Instrumentation and Control Equipment Grounding in Generating Stations."

ISA-S12.13-Part 1-1995, "Performance Requirements, Combustible Gas Detectors."

ISA RP12.13-Part II-1987, "Installation, Operation, and Maintenance of Combustible Gas Detection Instruments."

NUREG-0700, "Human System Design Review Guidelines," NRC: Washington, D.C.

NUREG-0800, Standard Review Plan, Branch Technical Position HICB-11, "Guidance on the Application and Qualification of Isolation Devices," NRC: Washington, D.C.

NUREG-0800, Standard Review Plan, Branch Technical Position HICB-17, "Guidance on Self-Test and Surveillance Test Provisions," NRC: Washington, D.C.

NUREG-1821, Final Safety Evaluation Report on the Construction of the Mixed Oxide Fuel Fabrication Facility at the Savannah River Site, South Carolina. Section 11.6, "Instrumentation and Control Systems" including standards referenced therein.

Regulatory Guide (RG) 1.118, Revision 3, "Periodic Testing of Electric Power and Protection Systems," NRC: Washington, D.C.

RG 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," NRC: Washington, D.C., January 2000.

RG 1.75, Revision 2, "Physical Independence of Electric Systems," NRC: Washington, D.C., September 1978.

RG 1.100, Revision 2, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," NRC: Washington, D.C., June 1988.

RG 3.17-1974, "Earthquake Instrumentation for Fuel Reprocessing Plants."

END

ATTACHMENT 1

Revision History for IP 88140

Commitment Tracking Number	Issue Date	Description of Change	Training Needed	Training Completion Date	Comment Resolution Accession Number
N/A	04/01/10 CN 10-010	IP 88140 is a newly issued procedure. Issued for fuel facility construction inspection program to improve effectiveness and efficiency by incorporating and consolidating vendor inspection requirements.	None	N/A	ML080720407