INSPECTION PROCEDURE 52051

INSTRUMENT COMPONENTS AND SYSTEMS - PROCEDURE REVIEW

PROGRAM APPLICABILITY: 2512

52051-01 INSPECTION OBJECTIVES

01.01 To determine whether technical requirements contained in the facility SAR for safety-related instrumentation have been adequately translated into applicable 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 plans, instructions, and procedures for the control and installation of safety-related instrumentation have been established in licensee and contractor QA manuals and whether these conform to the QA program described in the facility SAR.

01.03 To determine whether any generic problems or other weaknesses exist within the operation of organizations responsible for quality assurance programs and work specifications/instructions for control and installation of instrumentation.

Inspection Schedule

Inspection	May Be Started	Must Be Started	Must Be Completed
Initial	Four months before work is started	Before work is started	Substantially complete before work is 20% complete
Followup	After work is 40% complete	After work is 50% complete	Before work is 70% complete

52051-02 INSPECTION REQUIREMENTS

02.01 Quality Assurance Program. Review licensee/contractor commitments and procedures covering the span of documents to be prepared for assuring the quality of safety-related instrumentation.

a. Complete the requirements of IP 35100 for each onsite organization associated with safety-related instrumentation. Additionally, determine whether these procedures are consistent with the QA program described in the SAR.

b. Determine whether responsibility assignments for procedures preparation, review, and approval include groups with necessary technical expertise.

c. Determine whether groups 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.

02.02 Specific Technical Review Areas. In addition to the broad areas covered by IP 35100, determine whether procedures covering work and inspection activities in the following areas are appropriate for the activity and are technically adequate.

a. Receiving Inspection Procedures. Receiving inspection and related procedures provide means to ensure that:

1. Input 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.

2. Procurement requirements such as qualification tests (seismic, environmental, etc.), 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) are established for the various types of instrument components and meet applicable storage classification levels regardless of the location of the stored component.

2. Storage inspection procedures require initial verification of storage conditions and periodic verification for the duration of the storage period. They must also ensure that special and inplace storage requirements are met.

c. Work Procedures. Work procedures are established to ensure that:

1. NRC requirements and SAR commitments are properly translated into the work procedures (construction specifications, drawings, and work instructions) for adequate control and installation of instrument components and associated items. Areas to review shall include, but are not limited to, the following:

(a) Instrument components (type, range, accuracy, materials, etc.) are identified, located, oriented, and supported as specified.

(b) Physical separation and independence requirements of redundant components are met.

(c) Slope of instrument lines with respect to applicable requirements.

2. Interface controls are adequate when multiple contractors are involved.

3. Procedures cover special handling, installation, 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. Inspection procedures are 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, calibration, test, maintenance, and protection conform to applicable design and construction specifications.

3. Records of initial and followup 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 nonconformances 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 and are incorporated into the as-built records.

02.03 Followup Procedure Review. When instrument components and systems are about 50% 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. Note significant changes made (revisions, deletions, additions, etc.), and determine whether the changes are appropriate and whether NRC requirements and licensee commitments remain in these procedures.

02.04 Additional Inspection. Additional inspections, as determined by Regional management, may be conducted in the inspection areas covered above when licensee performance is classified as Category 3 by SALP program, or if Regional management concludes that recent findings will likely result in a SALP Category 3 rating. In these cases, particular consideration should be given to an expanded sample of items to be inspected under Sections 02.01, 02.02c, and 02.02d above.

52051-03 INSPECTION GUIDANCE

General Guidance

a. Instrument components and systems 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 safety-related instrument components and associated items: sensors, transmitters, isolators, signal conditioners, controllers and other

actuating devices, recorders, 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. (Instrument cables and terminations are covered in IP 51061.)

b. Applicable portions of the SAR, Safety Evaluation Report (SER), and NRR/licensee questions and answers should be reviewed during inspection preparation. Determine specific licensee procedural and work instruction commitments relative to construction and inspection QA requirements for instrumentation. The inspector should then utilize the above information during the review of the licensee's construction specifications, drawings, work and inspection procedures to determine whether SAR requirements are adequately translated into the appropriate documents.

c. To be adequate, procedures that control activities such as storage, installation, inspection, calibration, and testing 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. It may be appropriate to complete portions of this IP in conjunction with similar requirements of IP 51051 and 51061. Where the same contractor, procedures, and personnel are utilized for activities covered by the above IPs, it is not necessary to repeat similar inspection requirements for each of these IPs. (If so, the NRC inspection records should reflect that both electrical and instrumentation areas have been addressed.)

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 issue of whether the licensee is maintaining adequate control, 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, being unresolved and requiring resolution, or being in violation and requiring correction. When significant inadequacies are identified indicating weakness within the responsible organization, the inspector should inform cognizant Regional supervision. The issue should be addressed also at the appropriate level of licensee management.

03.01 Specific Guidance

a. Inspection Requirements 02.01 and 02.02. The expertise of the inspector is important for the proper completion of the inspection. The individual selected to perform 02.01 should have a general knowledge of and background in quality assurance, and the individual selected for 02.02 should be thoroughly knowledgeable of the technical requirements associated with instrumentation systems. One inspector may perform both requirements if the inspector exhibits appropriate knowledge in both areas.

b. Inspection Requirement 02.02. For the purpose of this IP, the term "work procedures" includes construction specifications, drawings, and work instructions.

(Procedures describing methods of fabrication, construction, and/or installation are sometimes called construction procedures.)

c. Inspection Requirement 02.02a

1. The SAR should identify and describe all safety-related components which must operate in a hostile environment (e.g., high radiation, temperature, humidity) during or after an accident (e.g., loss-of-coolant, steamline break). 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. This is a particularly significant area for NRC review.

2. Receiving inspection procedures should reflect the requirements of RG 1.38/ANSI N45.2.2 or equivalent requirements.

d. Inspection Requirement 02.02b

1. Special storage requirements are typically specified by the manufacturer or an industry standard, such as ANSI N45.2.2.

2. Instrument components may be released for installation on the merits of certifications if the organization involved has established satisfactory program control and audit requirements in this area (ANSI N45.2.13). However, certifications do not release the licensee from having other records for operation and for the life of the plant.

e. Inspection Requirement 02.02c

1. Procedures should be reviewed to ensure that technical requirements in the SAR are reflected in construction specifications, drawings, work instructions, and work procedures.

2. 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.

3. Model number and type (only) are not considered to be adequate identification. 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 SAR.

4. 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.

5. The licensee is required to meet IEEE Standard 279, and may be committed to RG 1.75 which endorses IEEE 279 with certain modifications. For example, 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.

6. 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.

f. Inspection Requirement 02.02d

1. The licensee/contractor procedures involved will differ from site to site, and may take various forms such as formal procedures, instructions, checklists, drawings, etc. Review the inspection procedures and compare with the applicable requirements and construction specifications. Evaluation should indicate whether adequate quality-related inspection procedures 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. 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.)

3. When compressed air systems are used for both safety-related and nonsafety-related applications, procedures should include means to ensure that a failure in the nonsafety-related portion of the compressed air system will not cause a failure in the safety-related portion of the system.

g. Inspection Requirement 02.02e. 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.

1. The SAR should include or 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.

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.

(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:

(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) Approval signature of a responsible individual.

3. 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.

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

03.02 Background Information

a. General. Nuclear plant instrumentation systems monitor measure, and/or control important plant variables; provide automatic protection against unsafe or improper plant operation; and initiate actuating signals to limit the consequences of an accident should it occur. Instrumentation includes indicators and alarms to reflect the status of various plant variables, interlocks to help prevent operator errors, and manual controls to enable the operator to take corrective action if necessary. Safety related instrumentation includes the following systems, although the names and specific arrangements may vary for different facilities:

1. Reactor Trip System. This system monitors specific plant parameters and provides timely and automatic reactor shutdown (scram) when certain pre-established limits are reached. Various instrument channels in this system are independent and physically separate from each other to increase system reliability.

2. Engineered Safety Features Actuation System. This system senses selected plant variables or conditions, determines whether pre-established limits have been exceeded and initiates appropriate corrective action to limit the consequences of undesirable events.

3. Systems Required for Safe Shutdown. Although there is usually no safe shutdown system per se, various monitoring and control instrumentation is used for safe reactor shutdown and for maintaining safe shutdown

conditions. This system usually includes instrumentation outside the main control room for hot and cold shutdown.

4. Safety-Related Display Instrumentation. This category of instrumentation provides the operator with sufficient information to perform manual safety functions; to monitor the status of safety equipment in such plant systems as reactor coolant, containment, engineered safety features, and control rod position.

5. Radiation Monitoring System. This system provides instrumentation to monitor plant radiation levels in such locations as the main steamlines (BWRs), process liquids, and building ventilation systems.

b. Instrumentation Terminology

Accuracy - (1) The degree of conformity of an indicated value to a standard or ideal value. (2) The ratio of the error to the full-scale output. (Accuracy is usually expressed in terms of units of the measured variable or as within a specified percentage of full-scale output.)

Attenuation - (1) A decrease in signal magnitude between two points or between two frequencies; (2) the reciprocal of gain.

Auctioneering - Refer to Signal Selector.

Cascade Control - Control in which the output of one controller is the set point for another controller.

Channel - An arrangement of instrument components used to originate a signal and, more generally, the path along which signals can be sent. (A channel loses its identity when outputs of channels are combined.)

Common Mode Voltage - A voltage of the same polarity on both sides of a differential input relative to ground.

Control Action - The nature of the change of the output effected by the input.

Floating Control Action - The rate of change of the output is a predetermined function of the input.

Proportional Control Action - A continuous linear relationship exists between output and input.

Derivative (Rate) Control Action - The output is proportional to the rate of change of the input.

Integral (Reset) Control Action - The output is proportional to the time integral of the input.

Controller (Automatic Controller) - A device which operates automatically to regulate a controlled variable.

Damping - The energy dissipating characteristics which, together with the natural frequency, determine the limit of frequency response; for transducers, the response-time characteristics.

Dead Band (Dead Zone) - The range (or zone) through which an input can be varied without initiating an observable response. (The dead band is usually expressed in percent of span. It is sometimes intentional and adjustable.)

Dead Time - The interval of time between initiation of an input change and the start of the resulting observable response.

Disturbance - Any undesired change that takes place in a process which tends to adversely affect the value of the controlled variable.

Drift - An undesired change in output over a period of time which is not a function of the measured variable.

Element (Primary Element) - A device or device component that quantitatively converts the measured variable into a form suitable for measurement. (The sensing portion of a transmitter is a primary element.)

Error - The algebraic difference between the indicated value and the true value of the measured variable.

Feedback Control - Control in which a measured variable is compared with its desired value to produce an error signal which is acted upon in such a way as to reduce the magnitude of the error.

Gain (Closed Loop Gain) - The ratio of the output change to the input change under specified conditions.

Hysteresis - The maximum difference in output when the measured variable is approached first with increasing and then with decreasing values.

Integrating - Providing an output which is a time integral function of the measured variable.

Instrumentation - (1) A collection of instrument devices and associated items used for observation, measurement or control; (2) the application of a collection of devices for the purpose of observation, measurement, or control.

Logic Device - Refer to Trip Logic.

Proof Pressure - The maximum pressure which may be applied to the sensing element (of a transducer, for example) without changing performance beyond specified tolerances.

Range - The region between the limits within which a quantity is measured, received, or transmitted.

Redundancy, Degree of - The difference between the number of components or channels monitoring a variable and the number of components or channels which, when tripped or actuated, will cause a system trip or actuation.

Reliability - The probability that a device will perform its intended function for a period of time and under the operating conditions specified.

Repeatability - The closeness of agreement among a number of measurements of the output for the same value of the input approaching from the same direction.

Reproducibility - The closeness of agreement among repeated measurements of the output for the same value of the input, approaching from both directions. (Reproducibility includes hysteresis, deadband, and repeatability.)

Sensing Element (Sensor) - The element or component directly responsive to the value of the measured variable. It is used to detect and/or measure a specific process variable or condition.

Sensing Line - A pipe or tube connecting the process being sensed to the sensor (transducer/transmitter) filled with process fluid, or a filled capillary.

Sensitivity - The ratio of the change in output magnitude to the change in the input. Sensitivity usually denotes the smallest change in value of a measured variable to which an instrument responds. It is related to the dead zone of the instrument.

Set Point - (1) An input variable which sets the desired value of the controlled variable; (2) the value of a monitored variable at which the output changes from its normal state to an alternate state.

Signal - A physical variable - one or more parameters of which carries information about another variable (which the signal represents).

Single Failure - Any single event which results in the loss of function. (Multiple failures resulting from a single event are generally considered to be a single failure.)

Span - The algebraic difference between the upper and lower range values.

Time Constant - The length of time required for the output (of a transducer, for example) to change to 63% of its final (new) value as a result of a step change of the input.

Transducer - An element or device which receives information in the form of one quantity and converts it to information of another quantity. (A transmitter is a transducer which responds to a measured variable by means of a sensing element and converts it to a transmission signal which is a function only of the measured variable.)

Transient Response - The response to a step change. (Refer to Time Constant also.)

Trip - A change in state of an instrument component (usually a bistable device) or subsystem.

Trip Actuator - A mechanism that carries out the final action of a trip logic device.

Trip Logic (Logic Device) - An arrangement of components designed to recognize specific combinations of input signals - usually from trip channels. The components are usually bistable devices, i.e., an output signal is either present or absent.

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 ensure and document that all safety-related instrument components and subsystems have met

applicable acceptance criteria or to identify and document non-conformances in specific areas.

b. Inspection procedures do not include adequate inspection requirements and acceptance criteria

c. Inadequate means to control location and status of instrument components; especially during removal for calibration, repair, modification, or replacement.

d. Inadequate procedures to control the evaluation, approval and use of field changes. (Means should be established also by the licensee/contractor to ensure that only the latest approved field changes and other revisions or changes are being used for construction and inspection activities.)

52051-04 REFERENCES

04.01 General

10 CFR 50, Appendix A - General Design Criteria for Nuclear Power Plants, Criteria 1, 2, 3, 4, 5, 13, 20, 21, 22, 23, 24, 25, 26, 34, 35, 38, 41, 54, 55, 56, 57, 63, and 64

10 CFR 50, Appendix B - Quality Assurance Criteria for Nuclear Power Plants

Facility Safety Analysis Report - Chapters 1, 3, 4, 5, 6, 7, 8, 15, and 17, including pertinent codes and standards referenced in the SAR

04.02 NRC Regulatory Guides

Regulatory Guide 1.11 - Instrument Lines Penetrating Primary Reactor Containment

Regulatory Guide 1.12 - Instrumentation for Earthquakes

Regulatory Guide 1.26 - Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants

Regulatory Guide 1.28 - Quality Assurance Program Requirement (Design and Construction) (ANSI N45.2)

Regulatory Guide 1.29 - Seismic Design Classification

Regulatory Guide 1.30 - Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment (ANSI N45.2.4/IEEE 336)

Regulatory Guide 1.32 - Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants (IEEE 308)

Regulatory Guide 1.38 - Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage, and Handling of Items for Water-Cooled Nuclear Power Plants (ANSI N45.2.2)

Regulatory Guide 1.39 - Housekeeping Requirements for Water-Cooled Nuclear Power Plants (ANSI N45.2.3)

Regulatory Guide 1.47 - Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems

Regulatory Guide 1.53 - Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems (IEEE 279 and IEEE 379)

Regulatory Guide 1.58 - Qualification of Nuclear Power Plant Inspection, Examination, and Testing Personnel (ANSI N45.2.6)

Regulatory Guide 1.62 - Manual Initiation of Protective Actions

Regulatory Guide 1.63 - Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants (IEEE 317)

Regulatory Guide 1.75 - Physical Independence of Electric Systems (IEEE 384)

Regulatory Guide 1.89 - Qualification of Class 1E Equipment for Nuclear Power Plants (IEEE 323)

Regulatory Guide 1.97 - Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident

Regulatory Guide 1.100 - Seismic Qualification of Electric Equipment for Nuclear Power Plants (IEEE 344)

Regulatory Guide 1.105 - Instrument Setpoints (ISA S67.04)

Regulatory Guide 1.123 - QA Requirements for Control of Procurement of Items and Services for Nuclear Plants (ANSI N45.2.13)

Regulatory Guide 1.144 - Auditing of Quality Assurance Programs for Nuclear Power Plants

Regulatory Guide 1.146 - Qualification of Quality Assurance Program Audit Personnel for Nuclear Power Plants (ANSI N45.2.23)

Regulatory Guide 1.151 - Instrument Sensing Lines (ISA S67.02)

04.03 Instrument Society of America (ISA) Standards

ISA RP3.1 - Flowmeter Installations, Seal and Condensate Chambers

ISA RP4.2 - Standard Control Valve Manifold Design

ISA S5.1 - Instrumentation Symbols and Identification

ISA RP7.3 - Quality Standard for Instrument Air
ISA S7.4 - Air Pressures for Pneumatic Controllers and Transmission Lines

ISA RP25.1 - Materials for Instruments in Radiation Service

ISA S26 - Dynamic Response Testing of Process Control Instrumentation

ISA S37.1 - Electrical Transducer Nomenclature and Terminology

ISA S50.1 - Compatibility of Analog Signals for Electronic Industrial Process Instruments

ISA S51.1 - Process Instrumentation Terminology

ISA RP60.9 - Piping Guide for Control Centers

END