ANSI/IEEE Std 336-1985
(Revision of of IEEE Std 336-1980)

An American National Standard

IEEE Standard Installation, Inspection, and Testing Requirements for Power, Instrumentation, and Control Equipment at Nuclear Facilities

Sponsor
Nuclear Power Engineering Committee
of the
IEEE Power Engineering Society

Approved December 13, 1984
IEEE Standards Board

Approved April 30, 1985
American National Standards Institute

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Foreword

(This foreword is not a part of IEEE Std 336-1985, IEEE Standard Installation, Inspection, and Testing Requirements for Power, Instrumentation, and Control Equipment at Nuclear Facilities.)

This standard originally set forth the requirements for the installation, inspection, and testing of important instrumentation and electric equipment in a nuclear power generating station during its construction phase. This standard was prepared by the Institute of Electrical and Electronics Engineers in response to a request by American National Standards Committee N45 on Reactor Plants and Their Maintenance. The N45 committee was chartered to promote the development of standards for the location, design, construction and maintenance of nuclear reactors and plants embodying nuclear reactors, including the equipment, methods, and components specifically for this purpose.

In May of 1969 the IEEE Joint Committee on Nuclear Power Standards (JCNPS) established an ad hoc committee on the Installation, Inspection, and Testing of Electric and Instrumentation Equipment. The purpose of this committee was to prepare a standard for general industry use that would define the requirements for installation, inspection, and testing of instrumentation and electric equipment that are necessary to ensure attainment of a safe and reliable nuclear power generating station. The ad hoc committee was composed of representatives of key segments of the nuclear industry, including utilities, reactor suppliers, construction contractors, component manufacturers, and consultants.

In 1977 the standard was revised to provide clarity and simplification. In 1979 the standard was again revised to expand the scope to include operating plant modifications that are comparable in nature and extent to those related activities occurring during the initial construction of the station. These revisions were developed by Subcommittee 8 of the Nuclear Power Engineering Committee (NPEC).

This standard was revised to allow application of the requirements to include Nuclear Facilities other than Nuclear Power Generating Stations. Nuclear facilities include facilities for power generation, spent fuel storage, waste storage, fuel processing, plutonium processing, and fuel fabrication.

Suggestions for improvement gained in the use of this standard will be welcomed. They should be addressed to:

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An American National Standard

IEEE Standard Installation, Inspection, and Testing Requirements for Power, Instrumentation, and Control Equipment at Nuclear Facilities

1. Introduction

1.1 Scope

This standard sets forth the requirements for installation, inspection, and testing of power, instrumentation, and control equipment and systems during the construction phase of a nuclear facility. These requirements also cover modifications and those operating phase activities that are comparable in nature and extent to related initial construction activities of the facility.

The intent of this standard is to establish requirements for safety systems equipment. (Safety systems equipment is defined in IEEE Std 603-1980 [5].[1]) However, this standard may also be applied to non-safety systems equipment.

1.1.1

This standard does not set forth specific requirements for the following, though they are related to the above equipment and systems

1) Installation, inspection, and testing of welds
2) Cleaning and flushing of instrument sensing lines
3) Aligning or verifying alignment, or both, of rotating equipment
4) Verifying structural integrity of supports for equipment
5) Activity governed by Section III of [6]
6) Preoperational tests of the integrated systems and equipment
7) Periodic testing and maintenance after initial operation
8) Receiving inspection and test
9) Non-destructive examination when required

1.1.2

During the construction phase and when modifications are being performed, this standard shall be used in conjunction with the applicable portions of ANSI/ASME NQA-l-1983[l] and ANSI/ASME NQA-2-1983 [2]. During the operations phase this standard shall be used with the applicable portions of ANSI/ANS 3.2-1982 [3].

[1]The numbers in brackets correspond to those of the references listed in Section 2.

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1.2 Applicability

The requirements set forth in this standard apply to the work of any organization that participates in the installation, inspection, testing, or modification of power, instrumentation, and control equipment and systems in a nuclear facility from the time that the equipment is turned over for installation until it is integrated into a system.

The extent to which the individual requirements of this standard apply either wholly or in part depends upon the nature and scope of the work to be performed and the importance of the item or service involved.

1.3 Responsibility

It is the responsibility of the organization invoking this standard to identify the equipment and systems to which this standard is applicable. The planning operations stipulated in Section 3.2 shall specify the inspections and tests to be performed on the identified equipment and systems consistent with this standard. The work of establishing practices and procedures and providing the resources, in terms of personnel, equipment, and services, to implement the requirements of this standard, may be delegated to other organizations. Such delegation shall be documented. In any case, the organization invoking this standard shall retain responsibility for overall program effectiveness.

2. References

When the following standards referred to in this document are superseded by a revision approved by the American National Standards Institute, the revision is not mandatory until it has been incorporated as part of this standard.

[1] ANSI/ASME NQA-1-1983, Quality Assurance Program Requirements for Nuclear Power Plants .[2]

[2] ANSI/ASME NQA-2-1983, Quality Assurance Requirements for Nuclear Power Plants.

[3] ANSI/ANS 3.2-1982, Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants.

[4] IEEE Std 498-1985, IEEE Standard Requirements for the Calibration and Control of Measuring and Test Equipment Used in the Construction and Maintenance of Nuclear Power Generating Stations.

[5] IEEE Std 603-1980, IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.

[6] 1984 ASME Boiler and Pressure Vessel Code.

3. General Requirements

Measures shall be established and implemented for planning and control of installation, inspection, and testing activities to verify conformance to specified requirements.

[2]ANSI publications are available from the Sales Department of American National Standards Institute, 1430 Broadway, New York, NY 10018.

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3.1 Prerequisites

The following applicable documents relating to the specific equipment to be installed shall be available in legible form at a predetermined retention area or area of usage.

1) The latest applicable approved-for-construction drawings
2) Installation specifications
3) Manufacturers' instructions
4) Evidence of compliance by manufacturer with purchase requirements, including quality documentation
5) Records of inspections and tests during receiving and on-site storage, handling, and maintenance

3.2 Planning

The installation, inspection, and testing activities shall be performed in accordance with documented plans that define the operations to be used, the systematic, sequential progression of operations for each item or system, the responsibilities of parties concerned for each operation, and the measures employed to preserve the quality of equipment.

Planning shall take into account the need for the preparation and control of procedures and work instructions necessary to comply with the requirements for installation, inspection, and testing of equipment and systems.

Planning shall include a review of the system and equipment specifications and drawings and of the construction work plans and schedules to assure that installation, inspection, and testing activities have been incorporated and that they can be accomplished as specified.

3.3 Procedures and Instructions

Procedures shall be prepared and documented as determined by the planning in 3.2. These procedures and instructions may be in the form of manuals or drawings. These documents shall be kept current by controlled supervision so that installation, inspections, and tests axe performed in accordance with the latest approved design and manufacturers' instructions. The documents shall include or reference:

1) Installation specifications
2) Inspection and test objectives
3) Precautions to avoid equipment or system damage during installation, testing, or inspection
4) Inspection and test equipment required
5) Sequence of tests
6) Sequential actions to be followed
7) Frequency of inspection or test
8) Test prerequisites
9) Appropriate approvals
10) Suitable form for reporting data
11) Provision for identification of test equipment and date of next required recalibration (where required) for interpretation of test results
12) Inspection and test acceptance limits
13) References
14) Other pertinent items

The above items shall be included as a check list and shall be marked as required or not appropriate when preparing procedures or instructions.

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3.4 Results

Inspection and test results shall be documented in a suitable test report or data sheet. Each report shall identify the item to which it applies, the procedures or instructions and its revision number used in performing the task, and the identification of the following:

1) Conditions encountered that were not anticipated, including nonconformance
2) Identity of inspector or testor
3) Completion date

Test reports or data sheets shall include an evaluation of the acceptability of the results and provide for identifying the individual who performed the evaluation.

3.5 Measuring and Test Equipment

Measuring and test equipment used to determine compliance with specifications shall be controlled in accordance with the requirements of IEEE Std 498-1985 [4].

3.6 Nonconforming Items

Defects, deficiencies, discrepancies, or other nonconforming situations shall be resolved in accordance with established procedures. These procedures shall provide for identifying, documenting, and obtaining authorization for resolving each nonconforming situation.

3.7 Personnel Qualification

Personnel performing the verifications required by this standard shall be qualified in accordance with an approved quality assurance program.

4. Preinstallation Verification

Verifications shall be performed just prior to installation.

1) The following, relating to the specific equipment to be installed, shall be available at the construction site in legible form:
   a) The latest applicable approved-for-construction drawings
   b) Installation specifications, procedures, or any special work instructions
2) Identification of materials and equipment in accordance with the latest approved-for-construction drawings, equipment lists, and specifications
3) Documentation of protective measures taken during storage
4) Physical integrity by visual examination of materials and equipment for damage, corrosion, contamination, and condensation

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5. Installation

5.1 Equipment Placement

Equipment shall be located, installed, assembled, and connected in strict accordance with the following:

1) Latest approved-for-construction drawings
2) Installation specifications and procedures, where required by the planning of 3.2

5.2 Precautions

Care shall be exercised in following the provisions of the documents listed in 5.1 for operations such as:

1) Cable pulling
2) Cable splicing
3) Cable terminating
4) Cable and instrument sensing line routing, including maintenance of required separation between redundant systems
5) Tagging or identifying, or both, various items, including cable, and temporary conditions
6) Installing electric and instrumentation penetration assemblies and assuring the integrity of the containment seals
7) Installation of fire stops and fire barriers
8) Installation of instrumentation piping or tubing
9) Mounting and supporting of equipment
10) Removal of temporary shipping supports and holddown bolts
11) Installation of environmental and pressure seals

6. Verification During Installation

Verification during installation shall include inspections and tests performed in accordance with the QA program requirements.

6.1 Inspections

Inspections performed during installation shall include the following

6.1.1 Inspections to Verify Correctness of Installation

Inspections shall be performed to verify that equipment is being located, installed, assembled, and connected to comply with latest approved-for-construction drawings and installation specifications and procedures. Inspections shall include such items as verification of:

1) Leveling and alignment (nonrotating equipment)
2) Clearances and tolerances
3) Location, support, and routing of cables and sensing lines
4) Tightness of connections and fastenings and use of proper tools
5) Freedom of movement
6) Polarity
7) Grounding and shielding
8) Terminations
9) Fluid levels and pressures

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10) Absence of leaks
11) Physical integrity
12) Identifications
13) Circuit fusing
14) Equipment rating
15) Fire stops and fire barriers
16) Installation of mountings and supports
17) Lubrication of bearings
18) Environmental and pressure seals

6.1.2 Inspections to Verify Housekeeping and Protective Measures

Inspections shall be performed to verify the adequacy of housekeeping in work areas [2].

Inspections shall be performed on a regular schedule and properly documented to verify that the following protective measures are adequate.

1) Protective measures applied for lay-up during construction are in accordance with procedures or specifications
2) Protective measures to prevent damage as a result of adjacent activity
3) Protective measures to prevent damage to measuring and test equipment during field use

6.1.3 Inspections of Temporary Conditions

Inspections shall be performed to verify that all temporary connections, such as jumpers and bypass lines and temporary setpoints of control equipment, are clearly identified and documented so that subsequent restoration can be ascertained prior to placing the item in service.

6.2 Tests

Manufacturers' tests on fabricated items may be accepted for equipment not disturbed during the construction phase. Tests performed during installation shall be those specified in the planning in 3.2 and shall include a selection of the following.

6.2.1 Electrical Tests

1) Tests to ascertain circuit continuity, absence of improper grounds and short circuits, correct polarity and correct direction of rotation
2) Tests to ascertain proper phasing and functioning of equipment, including indicating meters, recorders, transducers, targets and lamps, annunciators and alarms, controls, interlocks, protective relays and breakers
3) Voltage breakdown tests on fluid insulation
4) Overpotential tests as specified
5) Insulation resistance measurements as specified

When overpotential tests are performed, the manufacturers' recommendations shall be considered.

6.2.2 Physical and Chemical Tests

1) Chemical analysis of fluids for oxygen or moisture content and purity
2) Radiation testing to confirm that radiation sensors and controlling devices are properly functioning.

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6.2.3 Mechanical Tests

Leak or flow tests shall be performed to demonstrate the operation of electric instrumentation equipment or systems. As a minimum, such tests shall be applied to pressure sensing and transmitting devices operating in steam, hydraulic, or pneumatic interconnecting piping or tubing and associated instruments to ascertain that they can withstand systems pressure ratings.

Pressurized equipment that is a part of electric apparatus, such as heat exchangers, circulating systems, actuating systems, and electric and instrumentation containment penetrations, shall be tested.

7. Post-Installation Verification

7.1 Inspections

Installed equipment and systems shall be inspected to verify that:

1) Equipment and materials have not sustained damage during installation
2) Good and proper workmanship has prevailed
3) The installation has been made in accordance with specified requirements
4) All nonconforming items have been satisfactorily resolved
5) Appropriate protective measures are applied for lay-up after installation
6) All temporary conditions, such as jumpers, lifted leads, bypass lines, and temporary setpoints, have been clearly identified so that subsequent restoration can be ascertained prior to placing the items in service.

To satisfy the above objectives, it may be necessary to repeat some of the inspections defined in 6.1.

7.2 Tests

Installed equipment and systems shall be tested to demonstrate that they have been installed in accordance with design requirements and that the operation gives the desired result. Temporary electrical connections, temporary piping sections, abnormal chemical solutions, unspecified setting of devices, the temporary blocking or the effecting of any other abnormality previously made shall be rectified before final testing except in cases where fuel loading or other operations prevent using the complete assembly for the test. In these instances, a documented notice stating the temporary test conditions shall be prepared and be referenced to the appropriate test report or data sheet.

In final testing that precedes preoperational testing, normal system readout devices and installed transducers shall be used as far as possible to monitor the operation. Where the installed equipment is not adequate for the purpose of conducting tests, special measuring instruments and simulating devices shall be used. Test equipment used shall have adequate capacity and tolerance and be compatible with the system under test.

7.2.1 Equipment Tests

Tests shall be performed to demonstrate that the installed equipment is in an acceptable condition to be energized where manufacturers' tests or calibrations cannot be accepted (see 6.2).

Tests and shakedown runs shall be made on energized systems where necessary to evaluate operation and to properly condition for service (for example, the seating of brushes or bearings, the stabilization of instrumentation and burn-in of electronic devices).

Tests shall be made to assure that instrumentation and control channels are properly calibrated. If the calibration is dependent upon location or orientation, then calibrations shall be made with these devices in their normal positions.

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Tests shall be made to determine that proper operation is obtained over the range of the device. Particular attention shall be given to verifying independence and dependence, as appropriate, of the elements of the systems.

Items requiring calibration shall be identified by tags or labels indicating the identity of the person who performed the calibration and the date of the next required calibration.

7.2.2 System Tests

Tests shall be made to verify that all parts of a system properly coordinate with each other. Tests shall be made with attention given to demonstrating required independence and dependence of subsystems. Consideration shall be given to the need for demonstrating freedom from unwanted or harmful effects of Conducted or induced electrical noise.

A review shall be made of testing that has preceded the final integrated system testing, including the tests made on equipment with particular attention given to those that demonstrate functional or operational results. When these tests serve as a prerequisite or a part of the test of the completed system, a review of construction activity that may have affected the results shall be made.

The final construction-phase testing shall be made with all equipment of subsystems complete except where an operation requires that temporary electrical connections, piping sections, or structural supports be installed to make the tests.

8. Data Analysis and Evaluation

Procedures shall be established for processing inspection results and analyzing and evaluating test data. These procedures shall include requirements for reduction of inspection and test data for review or evaluation against acceptance criteria. The data shall be analyzed and evaluated to verify completeness, achievement of objectives, and correct operation of equipment and systems, and to identify any additional inspection or tests required.

9. Records

Copies of construction records such as approved procedures, personnel qualifications, test equipment calibration records, deviation or exception records, and inspection and test records shall be prepared. These shall be placed with other project records as required by codes, standards, specification, or project procedures.

10. Supplementary Provisions for Multiunit Stations and Operating Plants

For construction activity in nuclear facilities where one or more units are already operating or have reached a stage in their construction where the fuel has been loaded in the reactor and associated systems energized for whatever purpose, the following measures shall be taken in addition to the provisions defined elsewhere in this standard.

10.1 Planning and Preparation

Instructions, procedures, or drawings shall be prepared to control installation, inspection, and testing activities at areas of interface between the new and existing units. These instructions and procedures or drawings shall define the following:

1) The areas of interface between the new and existing units
2) Access control and authority for work at these interface areas
3) Nature of potential hazards to or from the existing equipment
4) Precautions required to be taken during installation
5) Supplementary objectives for inspection and testing

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10.2 Documentation

10.2.1

The instructions, procedures, or drawings described in 10.1 shall be kept current by revisions.

10.2.2

The equipment or systems which are associated with existing unit(s) that are electrically energized or charged with pressurized or radioactive fluids and which are in the vicinity of the construction activity associated with the new unit shall be properly tagged or identified.

10.2.3

The documentation associated with installation described in 10.2.2 shall also include:

1) The identification of the equipment or system defined in 10.2.2 which poses a potential hazard in the vicinity of current construction activity
2) Identification of the potential hazard of such neighboring energized systems as voltage, radiation level, fluid pressure, or temperatures

10.2.4

Authorizations for access to and work at the areas of interface between the new and existing units shall be documented.

10.2.5

Provisions of Section 9. shall be implemented to supplement or supersede documents or records as required.

10.3 Installation

10.3.1

Suitable protective barriers shall be erected, where needed, to prevent damage to equipment or systems associated with the existing unit(s).

10.3.2

Spare capacities available in the existing facility, such as in cable raceways or in panelboards, shall not be used unless expressly indicated on the latest applicable approved-for-construction drawings or installation specification. This does not prohibit authorized temporary use of such spare capacities.

10.3.3

When working in an area common to the new and the existing units, such as the cable spreading room, control room, or radioactive waste building, care shall be especially exercised to avoid interference with existing facilities and to maintain required separation, where appropriate, between the systems associated with existing and new units.

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10.4 Inspection

10.4.1

Inspection shall be performed to verify that the requirements of 10.2 and 10.3 have been satisfied.

10.4.2

Inspection shall be performed to verify that the existing facilities are properly protected from construction activity.

10.5 Testing

In testing integrated electrical control or instrumentation systems, or both, where the plant design calls for interconnection between the existing and new systems, care shall be exercised to prevent tripping or otherwise disturbing the operation of equipment or systems associated with the existing unit(s).

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