In the event of any differences in interpretation of this guide the Finnish version shall take precedence over this translation.

SUPERVISION OF NUCLEAR POWER PLANT ELECTRIC AND INSTRUMENTATION SYSTEMS AND COMPONENTS

CONTENTS

1 GENERAL

The Institute of Radiation Protection (IRP) exercises supervision of nuclear power plant electrical and instrumentation systems and components (E I systems and components) by conducting pre-inspections for systems and pre-inspections and structural inspections for components, and further supervising the fabrication, testing, revisions, and operation of systems and components.

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According to Guide YVL 2.1, safety-related EI systems and components may belong to Safety Classes 1, 2, 3 and EYT, Class 1 is the most important to safety. The extent of the supervision carried out by the IRP and the requirement level for systems and components are determined by the Safety Classes.

The IRP supervises the adherence to the stipulations of the Act on Radiation Protection (174/57) and the Atomic Energy Act (356/57) as well as the rules, regulations and resolutions bassed upon them. Also nuclear power plant pressure vessels are subject to IRP surveillance, as provided in the Statute on Pressure Vessels (549/73). In addition to the aforementioned legislation, also other acts and statutes for electric utilities and Electric Safety Standards apply to the EI systems and components. Compliance with these regulations is supervised by the Electric Inspectorate.

2 PRE-INSPECTION OF SYSTEMS

The design material for EI system of all Safety Classes is reviewed as part of the Preliminary and Final Safety Analysis Reports.

Chapters 7 and 8 of the guide

USNRC Regulatory Guide 1.70
Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 2, September 1975

are used as a general guideline on the scope of the pre-inspection material. As for details, reference can be made to component pre-inspection documents or applied standards.

The general criteria for EI systems are set forth in the guide.

Institute of Radiation Protection, Jan 27, 1976
General Design Criteria for Nuclear Power Plants

Special attention shall be paid to criteria 12, 13, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28 and 29.

In detailed questions, an example of an acceptable practice is presented in the following guides:

USNRC Regulatory Guide 1.6 (Safety Guide 6)
Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems

USNRC Regulatory Guide 1.9 (Safety Guide 9)
Selection of Diesel Generator Set Capacity or Standby Power Supplies

USNRC Regulatory Guide 1.11 (Safety Guide 11)
Instrument Lines Penetrating Primary Reactor Containment

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

USNRC Regulatory Guide 1.53
Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems

USNRC Regulatory Guide 1.62
Manual Initiation of Protective Actions

USNRC Regulatory Guide 1.63
Electric Panetration Assemblies in Containment Structures for Water-Cooled Nuclear Power Plants

USNRC Regulatory Guide 1.75
Physical Independence of Electric Systems

USNRC Regulatory Guide 1.81
Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants

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

USNRC Regulatory Guide 1.105
Instrument Spans and Setpoints

IEEE Standard 279
Criteria for Protection Systems for Nuclear Power Generating Stations

IEEE Standard 308
Criteria for Class IE Electric Systems for Nuclear Power Generating Stations

IEEE Standard 317
Electrical Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations

IEEE Standard 379
Trial-Use Guide for the Application of the Single-Failure Criterion to Nuclear Power Generating Station Protection Systems

IEEE Standard 384
Trial-Use Standard Criteria for Separation of Class IE Equipment and Circuits

IEEE Standard 387
Trial-Use Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations

IEEE Standard 420
Trial-Use Guide for Class IE Control Switchboards for Nuclear Power Generating Stations

IEEE Standard 450
Recommended Practice for Large Lead Storage Batteries for Generating Stations and Substations

IEEE Standard 484
Recommended Pratice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations

The Safety Analysis Report, or topical reports, shall describe to what extent the requirements set forth in these guides and standards are fulfilled. If deviations from these requirements occur, it shall be demonstrated in the Safety Analysis Report that an equivalent safety standard is achieved by some other means.

Alternatively, a system can be proved acceptable by demonstrating that the requirements in e.g. the following standards, applicable to the system, are fulfilled.

DIN 25417
Notstrohmversorgung in Kernkraftwerken

DIN 25431
Kabeldurchführungen in Reaktor-Sicherheits-behälter

DIN 25434
Reaktorschutzsystem und Überwachung von Sicherheitseinrichtungen

VdTÜV Merkblatt
Sicherheitstechnische Empfehlungen der VdTÜV für die Auslegung von Reaktorschutz-systemen. Blatt 1...11.

SEN 36 90 03 utkast
Kärnkraftanläggningar. Reaktoravställning utan tillgång till kontrollrum. Allmänna bestämmelser.

3
PRE-INSPECTION OF COMPONENTS

The pre-inspection is conducted for components of Safety Classes 1 and 2. The inspection is to verify that the component types are suitable for their intended application and that their quality will be assured to a sufficient degree. The pre-inspection is requested for systems or otherwise suitable component groups.

The following items shall be included in the pre-inspection material

- design bases
- data on type tests and operating experience
- quality control programme

Pre-inspection documents are submitted to the IRP in accordance with Guide YVL 1.2. The subdivision of the material shall conform to this guide.

3.1
Design Bases

The design bases include the values for basic design parameters and performance requirements which the purchaser presents to the manufacturer when placing the order. The details of the data vary depending on the type of component.

Examples of such data are

- power, voltage, current and frequency ranges within which the component shall be able to operate
- conditions in which the component shall retain its functional capability, such as temperature, humidity, pressure, pressure shocks, vibration, radiation, and the flow of surrounding medium
- fire resistance
- performance requirements such as accuracy, stability, signal to noise ratio, retaining of calibration hysteresis, response time, repeatability, loading capacity
- period of time which the component must remain operable without calibration and maintenance
- maintainability

3.2
Data on Type Test and Operating Experience

Applicability tests shall be performed on components of Safety Classes 1 and 2. This requirement applies to clearly specified objects the testing of which is sensible. The details of testing are negotiated with the IRP on a system-specific basis

For standardized components (e.g. electronics cards, relays, sensors, transmitters, cables, electric motors, transformers, generators, batteries) the applicability tests can be replaced by component type tests.

For components (e.g. relays, cables, electric motors, transformers, generators, batteries) which have been used for various purposes in various environments for a long period of time, the IRP may accept extensive operating experience data as a substitute for type tests.

In Safety Class 1, the pre-inspection material shall include applicacility or type test programmes and test results, or the operating experience data accepted as a substitute for the applicability test. In Safety Class 2, these can be replaced by a summary of the tests performed. The IRP shall, however, have access to the programmes and results so that they can be checked in connection with some suitable inspection.

Acceptable type tests are presented in several international and national codes, standards, and guides. Some examples are listed here.

IEC Publication 68
Basic Environmental Testing Procedures for Electronic Components and Electronic Equipment

USNRC Regulatory Guide 1.40
Qualification Tests of Continuous-Duty Motors Installed Inside the Containment of Weter Cooled Nuclear Power Plants

USNRC Regulatory Guide 1.73
Qualification Tests of Electric Valve Operators Installed Inside Containment of Nuclear Plants

IEEE Standard 317
Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations

IEEE Standard 323
General Guide for Qualifying Class 1E Electric Equipment for Nuclear Power Generating Stations

IEEE Standard 334
Standard for Type Test of Continuous Duty Class 1E Motors for Nuclear Power Generating Stations

IEEE Standard 382
Trial-Use Guide for the Type Test of Class 1 Electric Valve Operators for Nuclear Power Generating Stations

IEEE Standard 383
Standard for Type Test of Class 1E Electronic Cables, Field Splices, and Connections for Nuclear Power Generating Stations

The IRP may accept also other national and international standards as a basis for applicability and type tests.

The operating experience date shall describe the main applications of similar, previously fabricated components as well as the longest service period for components being used at nuclear power plants. Further, data on possible malfuctions and actions taken to eliminate them shall be presented as well.

3.3
Quality Control Programme

The quality control programme comprises

- inspection and testing plan
- inspection and testing instuctions

The inspection and testing plan contains the quality control measures taken at the factory in the course of fabrication, prior to the issue of dispatch permission. The organization performing each activity, and potential supervising organization, shall be specified in the plan.

The IRP requires that functional tests be conducted on components of Safety Class 1 (such as electronics cards, relays and sensors). Additionally, the IRP requires that part of the tests be supervised or repeated by an agency independent of the manufacturer,

purchaser, vendor or licensee applicant before the components are taken into service. A less extensive test will suffice for components of Safety Class 2.

Inspection and testing instructions shall be presented for each activity mentioned in the inspection and testing plan. The instructions shall specify the method and extent of the inspections and tests, including requirements and reporting. As for details, reference can be made to applicable standards.

4 SUPERVISION DURING FABRICATION

The IRP will request, when deemed appropriate, the licensee to arrange inspection tours to factories fabricating EI components of Safety Classes 1, 2, or 3. The purpose of the visists is to attend to the fabrication methods and the quality assurance activity in site and follow the inspections and tests conducted during fabrication.

For inspection tours, the IRP shall be kept informed of the progress of fabrication.

5 STRUCTURAL INSPECTION OF COMPONENTS

The licensee applicant does not request a structural inspection; instead, the IRP conducts the inspection, when deemed necessary, on the same components as the pre-inspection. The structural inspection is conducted on suitable component groups and should, preferably, be administered at the fabrication site.

The structural inspection consists of

- visual examination of components
- examination of quality control findings and records documented during fabrication
- attendance to dispatch tests or examination of their resultant documentation and records

In addition, unless already done, the structural inspection includes examination of type test programmes and results, and the factory quality assurance programme.

For some components the IRP may deem it appropriate to combine the supervisory stages described in section 4 with those presented above.

6 SUPERVISION DURING INSTALLATION

The IRP monitors EI systems and components of all Safety Classes during installation by observing installation inspections and tests (such as inspections of background wiring of electronics cubicles, comparisons of electronic circuits with diagrams, calibrations and linearity cheeks of sensors and transmitters, logic checks of logic circuits, preoperational tests of rotating devices and inservice takings of electric power distribution centers) by studying installation techniques, by examining instructions for tests conducted during installation and by observing the quality assurance activities of the installation parties (installation organization, vendor and power company). To facilitate the supervision the IRP shall be informed, in the beginning of the installation stage of the respective tasks and fields of responsibility of each party, of the comprehensiveness of the testing programmes used in the installation tests, of the procedures adhered to in documenting the installation activities as well as of the extent of the installation inspection conducted after completed installation.

The IRP requires that a quality assurance procedure conforming to standard

IEEE Standard 336
Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment During the Construction of Nuclear Power Generating Stations

is adhered to during installation and installation inspections.

During the installation phase, the IRP shall be kept informed on a regular basis of the progress of installations and of expected inspections.

7 SUPERVISION OF PREOPERATIONAL TESTING

The Institute of Radiation Protection supervises the preoperational testing of nuclear power plants, by examining the general plans for preoperational testing included in the preliminary and final Safety Analysis Reports, inspecting preoperational testing programmes, following the performance of tests at the facility and inspecting reports on preoperational testing. The supervision of the preoperational testing is explained in more detail in Guide YVL 2.5.

The requirements set forth in guides

USNRC Regulatory Guide 1.41
Preoperational Testing of Redundant On-Site Electric Power Systems to Verify Proper Load Group Assignment

USNRC Regulatory Guide 1.68
Initial Test Programs for Water-Cooled Reactor Power Plants

shall be taken into account when planning, performing and reporting preoperational testing.

8
REVISIONS AND MODIFICATIONS

Revisions and modifications of EI systems and components are subject to similar control as the initial construction.

All modifications of EI systems of Safety Classes 1, 2, and 3 shall have formal acceptance by the IRP prior to commencement of the work. The Final Safety Analysis Report shall be updated following the modifications. The Safety Analysis Report shall also be updated when modifications are made on other EI systems covered by the report.

The new components introduced as a result of a modification shall be subjected to preinspection and structural inspection to the extent determined by the Safety Class of the components involved. Similarly, the IRP conducts supervision of components during fabrication and installation as described above.

If such components (e.g. relays, electronics cards, transmitters, switches) are used in the modification as have already, in connection with the original system, been subjected to preinspection or structural inspection, this will be taken into account when the extent of the inspection is determined.

The modified part of the system shall undergo pre-operational testing following the same principles as applied to the original system in accordance with Guide YVL 2.5. The purpose of the pre-operational testing is to assure that the parts of the system which directly, or indirectly, are affected by the modification function as designed. The IRP may deem it appropriate to conduct the preoperational testing in connection with the periodic testing of the system.

9 SUPERVISION DURING OPERATION

The IRP supervises the service, maintenance and periodic testing of EI systems and components of Safety Classes 1, 2, and 3 during operation.

A general maintenance plan is presented in the Final Safety Analysis Report, in the section for the operation of the nuclear power plant. The following items are included in the quality assurance programme for operation and in the system-specific maintenance instructions: the organization performing maintenance operations and their work routines; frequency and content of regular maintenance operations; actions taken to repair faults detected between maintenance period and maintenance reporting.

The effect of the condition of EI systems on the operational and functional restrictions of the facility is defined in the Technical Specifications.

The framework for periodic testing of EI systems is presentend in the Technical Specifications. In addition, programmes for periodic testing and descriptions of test reporting shall be submitted to the IRP for approval.

Periodic testing shall satisfy the requirements of the quides.

USNRC Regulatory Guide 1.22 (Safety Guide 22)
Periodic Testing of Protection System
Actuation Functions

USNRC Regulatory Guide 1.108
Periodic Testing of Disesel Generator Used as Onsite Electric Power Systems at Nuclear Power Plants

IEEE Standard 338
Standard Criteria for the Periodic Testing of Nuclear Power Generating Station Class IE Power and Protection Systems

The IRP requires that the power company compile data on the most important events related to EI systems and components. Items to be recorded include the failure statistics and service lives of the components as well as the effect of the components on the availability of the facility. The IRP shall have access to the data.