INSTITUTE OF RADIATION PROTECTION

GUIDE YVL 2.1
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In the event of any differences in interpretation of this guide the Finnish version shall take precedence over this translation

SAFETY CLASSIFICATION OF NUCLEAR POWER PLANT SYSTEMS, STRUCTURES AND COMPONENTS

1 GENERAL

The general design criteria for nuclear power plants require that systems, structures and components important to safety be designed, fabricated, erected, tested and inspected to a quality level commensurate with the safety functions to be performed. To make it possible to implement this principle consistently, the systems, structures and components of a nuclear power plant are assigned to Safety Classes 1, 2 and 3 and Class NNS (non-nuclear safety). Items with the greatest safety significance are classified as Class 1.

The safety classification system offers one point of departure when setting design, fabrication and quality assurance requirements for an item. This does not, however, imply that there always is such an interdependence between Safety Class and technical requirements. Other factors to be considered, beside Safety Class, when establishing technical requirements are the loading and ambient conditions of the item as well as possibilities for testing, inspection, maintenance and repairs during operation.
In some cases, the desired structural and functional reliability is attained through careful design, in other cases fabrication and quality control are of greater importance.

The Institute of Radiation Protection utilizes the classification system in establishing inspection procedures. The interdependence of safety classification on one hand and inspection measures on the other are dealt with in Guide YVL 2.2.

2 SCOPE OF CLASSIFICATION

For classification, the nuclear power plant is divided into structural or operational units called systems. The division shall be such as to assign every structure or component important to safety, or otherwise regulated by the IRP, to some system. A system may, for example, be composed of

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a portion of the reactor coolant pressure boundary, of an auxiliary process or control circuit performing a specific function, of a building or a part of it, or of a number of separate serving the same purpose. Each system is assigned to some Safety Class or classified as NNS.

Systems of Safety Class 1, 2 and 3 are subdivided into structures and components. Further, those NNS structures and components regulated by the IRP are specified. A structure or component is defined as an entity forming an a whole from the standpoint of fabrication, installation or quality control. Each structure and component is asigned to some Safety Class or classified as NNS. As a general principle, a structure or component belongs to the same Safety Class as the system in which it is incorporated, provided that it is necessary for the safety function of the system. Less important portions of a system may be placed in a lower Safety Class or classified as NNS.

3 CLASSIFICATION DOCUMENT

Preparation of the classification document shall be begun as early as possible at the design stage and amended accordingly as the design work progresses. Approval of the classification document is one precondition for an IRP endorsement of the application for a construction permit. However, if the detailed design of a system is carried out only after commencment of construction, the classification document may, with respect to the system involved, be approved in the form corresponding with the effective preliminary plans.

The classification document shall include

- a list of systems
- system-specific lists of structures and components
- main drawings of buildings
- process, instrumentation and electrical system diagrams

In the list of systems, the systems are arranged in groups and provided with letter or numerical symbols as well as with Safety Class designations.

System-specific lists of structures and components shall be compiled on Safety Class 1, 2 and 3 systems. Structures and components are provided with designations the first part of which consists of the system designation and their Safety Class is given. In the same fashion, the structures and components of Class NNS systems regulated by the IRP are catalogued. In additon to class, the list shall specify the location of the structure or component as well as the construction requirements by means of references and appropriate designations, such as design and testing class, if their practical significance to each structure and component type is determined. Further, the list may contain

- references to standards and other instructions to be applied to structures and components

- a note stating whether a stress analysis in accordance with Guide YVL 3.5 is planned

The main drawings of the buildings shall be furnished with markings indicating the location of each structure and component. It is sufficient to specify the building in which they are located, if the whole buildings is homogeneous in regard to radiation, accessibility, physical protection and separation of components and Safety Class. In case the building, with respect to some of the items listed above, is divided into zones, the zone where a structure or component is located is specified. The classification of buildings is presented in the main drawings.

Process, instrumentation and electrical diagrams shall give system boundaries and the location of classified components there in. Piping classification is presented in the process system diagram.

As the design of the facility proceeds to details, it may become necessary to supplement and modify the classification document. Therefore, it is recommended that the document be compiled in such a format that it can easily be up-dated using interleaves and correction sheets.

The final classification document, in the form approved by the IRP, shall be submitted to the IRP in a minimum of ten binded copies at the time when the design of systems is, in essential parts, completed and procurement of components commences.

4 CLASSIFICATION INSTRUCTIONS

In part, the safety classification system is determined by the structure of the facility and the functions assigned to various systems. Therefore the IRP will not set forth binding classification reguirements. Instead, details are dealt with on a plant-by-plant basis using the license applicant's proposals as a starting point. However, examples as precise as possible are provided in this guide to facilitate the classification process.

Prior to presentation of the actual classification, the concept of 'reactor coolant pressure boundary' shall be defined.

Reactor Coolant Pressure Boundary

Reactor coolant pressure boundary for pressurized water reactor and boiling water reactor includes all pressure containing parts, such as pressure vessels, pipings, pumps, and valves which are a part of reactor coolant system, or connected to the reactor coolant system, up to and including:

- the outermost containment isolation valve in system piping that penetrates the primary reactor containment,
- the second of two valves normally closed during normal reactor operation in system piping that does not penetrate primary reactor containment.
- the safety or relief valve of the reactor coolant system.

The limit valves of the reactor coolant pressure boundary are regarded as a part of the reactor coolant pressure boundary. In a nuclear power plant furnished with a boiling water reactor, the reactor coolant system is regarded to extend to the outer isolation valves of the main steam and feedwater pipelines.

Safety Class 1

Systems, structures and components covered by items a) and b) and necessary for the safety function of the systems are classified as Safety Class 1:

a) Those portion of the reactor coolant pressure boundary whose rupture would result in a leakage of such magnitude that it could not be compensated by the normal make-up systems functioning during normal operation of a nuclear power plant. In conformance with this principle, the following portions of the reactor coolant pressure boundary are excluded from Safety Class 1:

- small pipes; the size limit is determined by the pressure of the reactor coolant pressure boundary and the capacity of the make-up water system but 20 mm can be given as the maximum inner diameter.
- parts that are connected to the reactor coolant system through a passive flow-limiting device; examples of such devices are a small pipe branch, a throttle or shaft gasket.
- parts that, in the event of failure, can be isolated from the reactor coolant system by two automatically closing valves; closure time shall be short enough to allow for normal reactor shutdown and cooldown.

b) The trip and interlock instrumentation of the reactor designed to shut the reactor down when some pre-set safety limit is exceeded.

Safety Class 2

Systems, sturctures and components covered by the following items a) through q) and necessary for the safety function of the systems are, on the condition that they are not assigned to Safety Class 1, classified as Class 2:

a) Portions of the reactor coolant pressure boundary not assigned to Safety Class 1

b) The following portions of steam and feedwater systems:

- at a PWR plant, the part of system inside the containment up to the outermost isolation valves
- at a BWR plant, the parts located between isolation valves and the next shut-off valves outside containment

c) Residual heat removal system used for recirculation of reactor coolant

d) At a PWR plant, the part of make-up water system bounded by make-up water pumps and reactor coolant pressure boundary

e) At a BWR plant, the hydraulic scram system

f) The following reactor containment systems designed to function in design basis post-accident conditions:

- spray system
- other potential cooling systems
- air clean-up systems
- the system designed to prevent the formation of an explosive mixture of hydrogen and oxygen

Systems designed for emergency core cooling following a loss-of-coolant accident. Such systems include, for example

- at PWR plant, pressurized safety injection water tanks, high and low pressure safety injection systems
- at a BWR plant, reactor core spray system and auxiliary feedwater system

h) Boron system necessary for reactor shutdown or maintenance of a sub-critical condition in a design basis accident.

i) Support structure of the primary coolant system

j) Reactor containment including the following structures and components:

- personnel and material hatches
- penetrations
- isolation valves

k) Missile shields protecting the reactor containment or Class 1 and 2 components inside it

l) Emergency supports inside the containment designed to arrest the movement of a ruptured item

m) Reactor vessel internals

n) Storage racks for fresh and spent fuel

o) Instrumentation systems designed to accomplish containmetn isolation and/or to activate the engineered safety features mentioned under items f), g) and h).

p) Electrical components and distribution systems necessary for the fulfillment of the safety function of Class 2 systems

q) Electrical power sources assuring electricy supply to Class 2 components upon loss of offsite and generator power

In case a Class 2 system containing liquid or gas is connected to a system of a lower Safety Class, the boundary of Class 2 system is made up by

- a passive device limiting the flow to such extent that the functional capability of Class 2 system is not lost even if the other system should suffer a failure; examples of such flow-devices are a samll pipe branch, throttle or limiting shaft gasket

- one valve that is normally closed
- the outermost of the two normally open shut-off valves both of which can be closed so fast that the funtional capability of the Class 2 sytem is not lost even if the other system of a lower Safety Class rating should sustain a failure
- one normally open shut-off valve in a system whose safety function can be fulfilled by means of a redundant portion of the system even if the said valve could not be closed
- a check valve where the direction of flow is toward the Class 2 system
- a safety or relief valve

All components constituting the boundary of the Safety Class are included in Class 2.

On the same grounds, such structures and components of a Class 2 system that are nonessential to the central function of the system may be assigned to a lower Safety Class. Minimum flow and testing lines are examples of such parts.

The boundaries of Safety Class 2 defined above are not, however, applicable to the portions of the reactor coolant pressure boundary mentioned in item a)

Safety Class 3

Systems, structures and components covered by the following items a) through p) and necessary for the safety function of the system are, on the condition that they are not assigned to a higher Safety Class, classified as Class 3:

a) Boron system from borated water storage tank onward

b) Make-up and letdown water systems of a PWR primary coolant system extending form make-up water tanks to letdown water tanks

c) The safety injection system of a PWR plant

d) Cooling systems necessary for removal of

- reactor residual heat
- spent fuel residual heat
- heat produced by Class 2 components
- heat produced by these systems into the final heat sink

e) Sealing water, pressurized air, lubricating, fuel and other systems necessary for start-up or operation of Class 1, 2 and 3 systems

f) Systems containing radioactive materials or processing liquids or gases when their failure could result in a significant dose increase, as compared to normal conditions, to an employee or a member of the public. Such systems are

- reactor water cleanup system
- fuel pool water cleanup system
- processing and storage system of liquid wastes
- radioactive gas treatment system

If the main part of radioactive materials are concentrated in certain portions of the system, some of the components in the system may be classified as NNS.

g) Systems containing dangerous, though not radioactive, liguids or gases.

h) Ventilation systems serving

- the main control room
- the reactor building
- the spent fuel storage room
- the waste building

i) Ventilation systems necessary for maintaining the ambient conditions required by Class 1, 2 and 3 components.

j) The following hoisting and transporting equipment

- control rod drives
- fuel loading machine
- containment main crane
- crane of the spent fuel store

k) Liquid Waste storage building

l) Buildings and support structures designed to protect or support Class 2 and 3 components when their failure would endanger the integrity of these components.

m) Pools for storage of spent fuel

n) Emergency supports and missile shields outside the containment

o) Instrumentation system performing following functions:

- control of reactor condition during fuel loading
- radiation monitoring
- monitoring of radioactive releases
- direct control room alarm indicating a dangerous condition of some component or process parameter specified in the Technical Specifications
- warning individuals at the site of the plant of imminent danger

p) Electrical components and distribution systems necessary for the safety funtion of Class 3 systems

In case of a Safety Class 3 system containing liquid or gas is connected to a system of lower safety rating, the boundaries of Class 3 can be determined in the same way as the boundaries of Class 2 in a similiar situation.

Class NNS

All the systems of a nuclear power plant not assigned to Safety Class 1, 2 or 3 are classified as NNS. The NNS systems covered by items a)through d) below are regulated by the IRP and shall be included in the classification document:

a) Systems incorporating components regarded as pressure vessels

b) Systems that contain, or may contain, radioactive substances in such concentrations as to preclude free release of the contents into the environment

c) Instrumentation systems performing following functions:

- environmental radiation monitoring
- monitoring of meteorological conditions in the environment

d) Fire detection and extinguishing systems as well as systems designed to contain fires

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REFERENCES

1. General Principles for Design of Nuclear Power Plants, Institute of Radiation Protection January 27, 1976