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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 PLANT SYSTEMS, STURCTURES AND COMPONENTS

## 1 GENERAL

The safety criteria that are adhered to in the design of nuclear power plants /1/ require that systems, structures and components important to safety be designed, manufactured and erected such that their quality level and the inspections and tests needed for ascertaining the quality level are commensurate with the importance to safety that the item has. To make possible the consistent implementation of this principle, the systems, structures and components of a nuclear power plant are assigned to three Safety Classes, Classes 1, 2 and 3, and to Class EYT (non-nuclear). Items with the greatest safety significance are placed in Safety Class 1.

The safety classification provides one starting point for the design, manufacture, installation, inspection, testing, operation, maintenance and quality assurance of each item. This does not, however, imply that there is always a direct interdependence between the Safety Class and the technical requirements to be set for the item. Other factors to be considered, besides the Safety

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Class, when establishing technical requirements are the loading and ambient conditions of the item, accessibility for testing, inspection, maintenance and repairs during operation, and, most importantly, the factors that are essential to the safety function. In some cases, the desired structural and functional reliability is attained primarily through careful design, in other cases it is necessary to emphasize the importance of manufacture and quality control.

The Institute of Radiation Protection (IRP) utilizes the safety classfication in establishing inspection procedures. The interdependence between safety classification and inspection measures is dealt with in detail in various YVL Guides.

## 2. SCOPE OF CLASSIFICATION

For classification, the nuclear power plant is divided into structural or operational units called systems. The division shall be such that every structure or component under the supervision of the IRP is included in some system. For example, a system may comprise a section of the reactor coolant pressure boundary, an auxiliary process or a control circuit performing a specific function, a building or a part of it, or a number of separate components serving the same purpose. Each system is given a safety Class or assigned to Class EYT.

Systems of Safety Classes 1, 2 and 3 are subdivided into structures and components. Further, those structures and components of Class EYT that are supervised by the IRP are specified. An item that forms a clearly definable entity from the standpoint of manufacture, installation and quality control is regarded as one structure or com-

ponent. Each structure and component is given a Safety Class or assigned to Class EYT. As a general rule, a structure or component belongs to the same Safety Class as the system in which it is included, provided that it is needed in performing the safety function of the system. Less important parts of the system may be assigned to a lower Safety Class or to Class EYT.

## 3. CLASSIFICATION DOCUMENT

Compilation of the classification document shall be begun as early as possible at the design stage and the document shall be amended 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 commencement of construction, the classification document may, with respect to the system involved, be approved in the form corresponding with the effective premilinary plans.

The classification document shall include

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

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

System-specific lists of structures and components are compiled on systems of Safety Classes 1, 2 and 3. Structures and components are provided with designations which

have the system designation as the first part,and their Safety Class is given. In the same fashion, those structures and components of Class EYT systems that are supervised by the IRP are catalogued. Besides the 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 inspection class, if their meaning to each structure and component type has been defined. Further,the list may contain

- references to standards or other instructions to be applied to certain structures and components
- a note stating whether a stress analysis in accordance with Guide YVL 3.5 is planned.

The drawings of the buildings shall be furnished with marks that can be used to explain the locations of the structures and components. It is sufficient to specify only the building in which they are located, if the whole building is homogeneous in regard to radiation level, 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 a component is located is specified. The classification of the buildings is presented in the drawings.

The process, instrumentation and electricial diagrams shall show system boundaries and the location of classfied components within the systems. The classification of piping is presented in the process system diagram.

As the design of the plant proceeds to details, it may become necessary to supplement and modify the classification document. Therefore it is recommended that the docu-

ment be compiled in such a format that it can be easily up-dated using revised sheets.

The final classification document, as approved by the IRP, shall be submitted to the IRP at least in ten copies at the time when the design of systems is essentially completed and the procurement of components commences.

## 4. CLASSIFICATION INSTRUCTIONS

The safety classification system is dependent on the structure of the nuclear power plant and the functions assigned to its systems. Therefore the IRP will not set forth binding classification requirements. 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.

Before going into actual classification, the concept 'reactor coolant pressure boundary' will be defined.

### Reactor Coolant Pressure Boundary

The reactor coolant pressure boundary of a nuclear power plant equipped with a pressurized water reactor or a boiling water reactor includes all pressure containing parts, such as pressure vessels, piping, pumps, and valves which are a part of the reactor coolant system, or connected to the reactor coolant system, up to and including:

- the outermost containment isolation valve in a pipeline that penetrates the primary reactor containment,

- the second of two valves closed during normal reactor operation in a pipeline that does not penetrate the primary reactor containment,

- the safety or relief valve of the reactor coolant system.

In a nuclear power plant furnished with a boiling water reactor, it is considered that the reactor coolant system extends to the outer isolation valves of the main steam and feedwater pipelines.

The limit valves of the reactor coolant pressure boundary are regarded as a part of the reactor coolant pressure boundary.

Safety Class 1

Systems covered by items a) and b) below as well as structures and components that are part of the systems and necessary for their safety functions, are assigned to Safety Class 1:

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

- small pipes (inner diameter not more than 20 mm)

- parts which are connected to the reactor coolant system through a passive flow-limiting device

and which, if ruptured, do not cause a leak greater than that caused by the rupture of a 20 mm pipe

- parts that, in the event of failure, can be isolated from the reactor coolant system by two automatically closing valves: closing time shall be short enough to allow for normal reactor shutdown and cooldown.

b) The reactor protection instrumentation designed to start the reactor scram when some pre-set safety limit is exceeded.

Safety Class 2

Systems covered by items a)...p) below, as well as structures and components that are part of the systems and necessary for their safety functions, are assigned to Safety Class 2, provided that the system or its part is not regarded as belonging to Safety Class 1:

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

b) The following parts of steam and feedwater systems:

- at a PWR plant, the part inside the reactor containment up to the outermost isolation valves

- at a PWR plant, the part of the emergency feed water system that is bounded by the emergency feed water pumps and the steam generatos

- at a BWR plant, those parts of the steam system that are located between the isolation valves and the next shut-off valves outside the reactor containment.

c) The residual heat removal system used for recirculation of reactor coolant.

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

e) The systems and components needed for the reactor scram.

f) The following reactor containment systems designed to function after an accident used as a design basis:

- spray system
- other cooling systems
- systems which prevent the formation of an explosive mixture of hydrogen and oxygen (e.g combustion and blending systems of hydrogen).

g) The systems needed in case of loss-of-coolant situations. These systems include:

- at a PWR plant, pressurized safety injection water tanks, HP and LP safety injection systems

- at a BWR plant, reactor core spray system and auxiliary feedwater system.

h) The boron system needed for shutting down

the reactor or keeping it in a sub-critical condition in a design basis accident.

i) The supporting structures of the reactor coolant pressure boundary.

j) The reactor containment including personnel and material hatches, penetrations, isolation valves, and other structures affecting its structure and function.

k) Structures, such as emergency restraints and missile shields, which protect components in Safety Class 1.

l) The inner structures of the reactor pressure vessel that support the reactor core and are important to its coolability.

m) Storage racks for fresh and spent fuel.

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

o) Electrical components and distribution systems necessary for the fulfilment of the safety functions of systems in Safety Classes 1 and 2.

p) Electrical power sources assuring electricity 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 the Class 2 system is made up by

- a passive device limiting the flow to such an extent that the functional capability of the system in Class 2 is not lost even if the other system should suffer a failure; examples of such flow-limiting devices are a small pipe connection (see guide YVL 3.3), throttle or shaft gasket

- one valve that is normally closed

- the outermost of two normally open shut-off valves, both of which can be closed so fast that the functional capability of the class 2 system is not lost even if the other system of a lower Safety Class 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 flow direction is towards 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, small-diameter piping (see guide YVL 3.3, section 1.1) and such structures and components of a Class 2 system that are not essential to the main function of the system may be assigned to a lower Safety

Class.

However, the boundaries of Safety Class 2 defined above are not applied to the sections of the reactor coolant pressure boundary mentioned in item a) but they have been given separate boundaries in connection with the reactor coolant pressure boundary.

Safety Class 3

Systems covered by items a)...p) below, as well as structures and components that are part of the systems and necessary for their safety functions, are assigned to Safety Class 3, provided that the system or its part is not regarded as belonging to a higher Safety Class:

a) The boron system from the borated water storage tank onward.

b) Those parts of the reactor coolant make-up and letdown water systems that are not placed in Safety Class 2.

c) Those parts of the emergency feed water system of a PWR plant that are not placed in Safety Class 2.

d) Systems needed for the cooling and pressure relief of the reactor coolant pressure boundary.

e) The cooling systems necessary for the removal of
- reactor residual heat
- spent fuel residual heat
- heat generated by Class 2 components
- heat generated by the systems themselves

into the ultimate heat sink, provided that they do not belong to the higher Safety Classes.

f) Sealing water, pressurized air, lubricating, fuel and other such systems necessary for the start-up or operation of systems in Safety Classes 2 and 3.

g) Systems treating liquids or gases containing radioactive substances if 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 systems of liquid wastes
- radioactive gas treatment systems.

h) The ventilation and air cleanup systems whose function significantly reduces the releases of radioactive materials or that in some other way are necessary for ensuring the safety of the plant in normal operation and in accident conditions. Such systems are:

- reactor building ventilation
- ventilation of the active rooms in the auxiliary building
- spent fuel storage ventilation
- waste building ventilation
- control room emergency ventilation
- ventilation systems necessary for maintaining

the ambient conditions required by components in Safety Classes 1, 2 or 3.

i) The reactor pressure vessel internals that do not belong to Safety Class 2.

j) Nuclear fuel treatment and inspection systems whose malfunction can endanger the integrity of the fuel.

k) The following hoisting and transporting equipment

- those parts of the control rod drives that are not placed in Safety Classes 1 or 2
- containment main crane
- equipment needed for lifting and moving nuclear fuel.

l) Storages of spent fuel and liquid wastes, including pools and tanks.

m) Buildings and structures designed to

- protect or support components in Safety Classes 2 or 3. The failure of the buildings or structures could endanger the integrity of these components
- protect workers to assure the maintenance of functions important to safety in accident conditions.

n) The concrete structures inside the reactor containment, unless placed in Safety Class 2.

o) Instrumentation systems performing the following functions:
- instrumentation systems needed in accident conditions (unless placed in Safety Classess 1 or 2)
- radiation monitoring systems needed in accident conditions
- instrumentation needed for the safe shutdown of the plant (including auxiliary control room)
- control of hydrogen and oxygen concentrations inside the containment
- control of leaks in the reactor coolant pressure boundary
- control of radioactive releases
- radiation control of rooms
- in-core instrumentation
- control of the reactor condition during fuel loading
- alarm system for warning persons at the plant site of imminent danger.

p) Electrical components and distribution systems needed for the safety function of Class 3 systems.

In case a system in Safety Class 3 containing liquid or gas is connected to a system of lower safety rating, or contains small-diameter piping or components not essential to the main function of the system, the boundaries of Class 3 can be determined in the same way as the boundaries of Class 2 in a similar situation.

Class EYT

All the systems of a nuclear power plant not assigned to Safety Classes 1,2 or 3 are placed in Class EYT. The

EYT systems covered by items a)...h) below shall be included in the classification document:

a) Systems incorporating components regarded as pressure vessels. If these systems contain liquids or gases considered to be dangerous, their components are supervised as components in safety Class 3.

b) Systems that contain, or may contain, radioactive substances in such concentrations as to preclude free release of the contents into the environment, or systems containing liquids or gases considered to be dangerous for some other reason.

c) Instrumentation systems performing the following functions:

- environmental radiation monitoring
- monitoring of meteorological conditions in the environment
- the main control systems of the plant
- the reactor control and power reduction system and the reactor set-back system as far as they are not required to operate in accident conditions
- control of vibrations and loose parts in the reactor coolant pressure boundary
- control of the fuel and waste storages, such as measurement of the pool levels and coolant temperatures.

d) Power supply systems associated with the power plant process, unless placed in Safety Classes 1, 2 or 3.

e) Fire detection and extinguishing systems as well as systems designed to contain the spreading of fires. The fire-suppression systems that must be capable of performing their function also in case of a single failure shall be regarded as safety systems and placed in Safety Class 3.

f) Service platforms, stairs, ladders and rails made of steel, unless they support components of a higher Safety Class.

g) Structures that function as radiation shields and are not placed in higher Safety Classes.

h) Systems associated with industrial security (physical protection).

## 5 REFERENCES

1. YVL 1.0 Safety Criteria for Design of Nuclear Power Plants, 1.12.1982

2. IAEA: Safety Series No 50-SG-D1, 1979, Safety Functions and Component Classification for BWR, PWR and PTR.