COMMISSION OF THE EUROPEAN COMMUNITIES

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COMMUNICATION FROM THE COMMISSION TO THE COUNCIL

"Safety Principles for Light-Water-Reactor Nuclear Power Plants"

FOREWORD

The Council Resolution of 22 July 1975 on the technological problems of nuclear safety foresees the Community action in respect of the progressive harmonization of safety requirements and criteria to proceed in three stages.

The first stage is the exchange of information and the listing of the methodologies, criteria and standards applied in the different Member States. This has been largely completed, even though it is necessary to revise periodically the established inventories in order to take into account the evolutionary character of technological problems of nuclear safety.

The second stage consists in identifying the similarities and dissimilarities and in analysing reasons for their existence.

The aim of the third stage is the establishment of Recommendations pursuant to Article 124 second indent of the Euratom Treaty.

During the work relating to the first and second stages mentioned above conducted within the Working Group on safety of light water reactors "Methodology, criteria, codes and standards" with the active collaboration of the representatives from regulatory bodies, licensing authorities and/or associated safety and control organizations, utilities and equipment vendors, it appeared that any specific harmonization can only be based on a previous harmonization effort on the basic principles of safety, on which requirements and criteria depend.

A Task Force was set up, composed of experts from the national safety authorities and supported by the competent services of the Commission, to compile a set of basic safety principles and a scheme for subsequent requirements and criteria for light water reactor nuclear power plants, which may, in general, also be applied to other types of nuclear power stations.

The result of this task is given in the present document which was formally approved by the Commission and which is brought to the knowledge of the other Community institutions and the public.

With this document the Commission makes known the basic safety principles for light water reactor nuclear power plants in terms which can easily be understood and replies to the mounting emphasis and attention to safety by nuclear industry, regulatory bodies, and by the public at large.

These basic principles, constituting the fundamental and general safety principles, form an entity. Though general in nature, they shall make a contribution to the thinking in the Member States and the Community institutions on problems regarding light water reactor safety and in particular are intended to form the framework which can be used as reference for judgments that must be made in the safety evaluation process by regulatory bodies, licensing authorities, utilities, equipment vendors, architect engineers etc. to adopt a consistent and uniform approach.

This document will form the basis for further harmonization activities.

Introduction.

Most human activities present a potential hazard to the health and safety of individuals and of society as a whole. In general terms it can be said that the larger the potential consequences of a hazardous event the greater the effort of man and society to reduce the probability of the event and to limit its consequences.
The peaceful uses of nuclear energy have been developed from the beginning with special concern for protection against risks, that is with particular attention to the prevention of accidents and the limitation of adverse consequences.

Such concern could not fail to be of interest at Communinity level, and it can be found in different articles of the Euratom Treaty and also in the Council Resolution of July 22, 1975 on technological problems of nuclear safety. In the light of this resolution activities have been developed, in particular with respect to progressive harmonization of safety requirements and criteria.
In this context one can make the following observations :

- a harmonization of requirements and criteria, although possible at certain levels, is not practicable at all levels, because requirements and criteria often refer, for example, to a specific aspect of a protective function,which may be achieved in different ways;

- any harmonization can only be based on a previous effort of harmonization of fundamental principles of safety, on which the requirements and criteria depend;

- although the aim is to achieve an equivalent and satisfactory degree of protection of the population and of the environment, the way to obtain this degree of protection may differ from country to country.
The basic principles, however, must and can be common, as far as they reflect objectives but not the way to reach them.

The principles given herein are of a general nature and for the use of designers, operators and assessors.

The harmonization of safety principles, requirements and/or criteria, even though desirable, is not sufficient to guarantee the harmonization of the levels of safety. In addition the sole application of technical aspects does not guarantee the safety of a nuclear installation if it is not accompanied by complete and detailed assessments coupled with appropriate inspection and enforcement activities.

Nevertheless the harmonization of basic (fundamental and general safety) principles is the necessary starting point for any further harmonization.

Purpose and scope of the document.

The described principles in this document are divided into two categories. The first category gives the fundamental safety principles upon which the second category is based.

This second category gives the general safety principles to achieve the objectives as given in the first category i.e. to avoid accidents and to limit the radiological consequences of the operation of the nuclear power plant during all operational states and accident conditions.[1)]

The document includes a third part, giving a list of subjects in which safety requirements might be worked out in order to fulfill the general safety principles as given in the second part.

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1) See definitions in Appendix

From the introduction it will be clear that it is not the intention to impose the ways in which the objectives should be attained. Neither is it the intention to state the requirements which might be worked out at an appropriate time in an appropriate sequence since it is necessary to take into account the difficulties in harmonization.
The principles given in this document refer to LWR Nuclear Power Plants though they may, in general, be applied to other types of nuclear power plants.

Remark : The use of technical terms which are of special character or the meaning of which has to be specified was reduced to a minimum in this document. However, for certain expressions it seemed to be necessary to provide definitions (see appendix). Definitions were taken from the Codes of Practice of the IAEA* Safety Series 50.

PART I

Fundamental safety principles.

1. Nuclear power plants shall be sited, designed, constructed, tested, operated, and decommissioned so as to provide reasonable assurance there is no undue risk to the workers, the general public and the environment.

In this document only the radiological aspects related to human health will be considered; no guidance is given on environmental aspects such as protection of natural, agricultural and industrial environment and human habitat ; neither is specific reference made to site selection principles even though, in the complex area of siting, exchange of information is going on in the frame of Community activities.

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* IAEA = International Atomic Energy Agency - Vienna

The characteristic hazard of a nuclear power plant has its origin in the amount of radioactive products present in the plant.
Harm to man may arise from ionising radiations emitted from radioactive materials taken into the body by inhalation and by ingestion and also from external radiation.
Therefore

2. Measures shall be taken to ensure that radioactive materials which are present in the installations are confined in an appropriate manner.

3. The release of radioactive materials shall be as low as reasonably achievable.

4. Adequate steps shall be taken in the design, operation and decommissioning of the plant to ensure that all exposures to ionising radiations are as low as reasonably achievable.

The foregoing principles are primarily aimed at normal operation of the plant (including waste handling), but are also applicable to accident conditions.

During normal operation of a nuclear power plant some radiation exposure of site personnel and members of the public is unavoidable. Some discharge of radioactivity in gaseous or liquid form will take place and this results in an exposure pathway to the public. The doses from discharges of radioactivity during normal operation of a NPP can however be kept very low when appropriate provisions are applied.
In addition safe operation of the plant requires a proper level of supervision, including inspections, maintenance, waste treatment, and repairwork which give rise to radiation exposure to site personnel.

Consequently, the following protection principle applies, in agreement with the Euratom directive on radiation protection and with the recommendations of the I.C.R.P.* :

5. Individual doses shall always be kept within prescribed limits. In addition individual and collective doses to both site personnel and the general public shall be kept as low as reasonably achievable in all operational states of the nuclear power plant.

It is important to take into account the relationship between the dose to site personnel and that to the general public.

Note :

In order to determine whether a reduction in dose below the recommended limits is "reasonably achievable" it is necessary to consider on the one hand the increase in benefit from such a reduction and on the other the increase in cost (social and economical) involved in its achievement. According to the ICRP an optimum is obtained at a value of the collective dose such that the increase in cost of protection per unit dose equivalent balances the reduction of detriment per unit dose (ICRP 26, pa 74).
The application of the recommended optimization process is not at the stage where common quantitative limits for collective dose can be given.

The prevention of accidents and, since accidents might nevertheless occur, the mitigation of their consequences are both of fundamental importance. The more serious the potential consequences of accidents, the more stringent the requirements will be to prevent the faults leading to such accidents. Furthermore these accidents will require extensive protective measures to confine the radioactive products. This leads to the following principles :

6. All reasonably practicable steps shall be taken to prevent accidents.

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* International Commision on Radiological Protection *

7. All reasonably practicable steps shall be taken to minimize the radiological consequences to the general public of any accident, should it occur.

8. All reasonably practicable steps shall be taken to minimize the radiological consequences to site personnel of any accident, should it occur.

9. The more serious the potential consequences of an accident, the smaller should be the probability of its occurrence.

To guarantee that all practicable steps can be taken by the site personnel to get an accident situation under control and to carry out all necessary actions to limit the consequences of accidents, it is required that provisions are made to protect these personnel against excessive radiation doses.
Therefore

10. Provisions shall be made to prevent the exposure of site personnel reaching levels which hamper the actions necessary to mitigate the consequences of an accident.

Additional remarks concerning the above principles :

With respect to the implementation of the above principles 1, 3, 4 and 5 guidance is found in the Euratom Directive of the Council "Basic Safety Standards for the Health Protection of the general public and workers against the dangers of Ionizing Radiation",15 July 1980* and in the "Recommendations of the I.C.R.P.".

Dose limits for workers and the general public for controllable exposures are prescribed for instance in Articles 7 to 13 of the above mentioned Basic Safety Standards. In addition, Article 6 requires that exposures must be kept as low as reasonably achievable. The ICRP recommends for the ALARA principle an optimization process on the basis of a cost - benefit analysis.

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* O.J.. L246 - 17.09.80

Deriving from the ICRP recommendations it is advisable that already in the planning stage of nuclear plants the aspect of individual annual doses and site personnel dose distribution are taken into account.

Guidance on the implementation of principles 6, 7, 8 and 10 is given in Part II with special reference to a "defense in depth" concept. Concerning the probabilistic aspects that are connected with principle 9 the following can be stated :

Risk considerations combining probabilities of incident/accident situations and respective consequences, mainly radiological, have not been introduced generally into the licensing procedure. First approaches in this direction have, however, been made and an example in this respect derived from these approaches is given in the Appendix to Part I. The main emphasis of these approaches is aimed at categorizing events in regard to frequencies and consequences of events and fault sequences.
The scheme which is presented in this appendix only gives a general idea of categorizing events and fault sequences. Categorization in a more quantitative manner can be made up, when still more information on the frequency and consequences of these events and fault sequences is available.

APPENDIX to Part I.

1. Events (operational occurrences) with moderate frequency, any of which may occur in every nuclear power plant several times during plant life. Due to the presence of protective means in the plant, these events do not escalate into situations where the prescribed yearly dose limits (operational limits) are exceeded, although during short periods of time the normal exposure levels might be exceeded.

   Examples of postulated events are :
   - loss of normal feed water
   - partial loss of core coolant flow
   - total loss of load and/or turbine trip
   - loss of off-site power.

2. Events or fault sequences, anyone of which may occur during the life time of a particular plant. Due to the presence of protective means in the plant, these events or fault sequences are not expected to escalate into situations where external countermeasures to protect the public are necessary other than for instance on a precautionary basis a monitoring program (with respect to food stuffs), although the prescribed yearly dose limits for normal operation might be exceeded.

   An example of postulated event is :
   - loss of primary reactor coolant from a small ruptured pipe of such an extent as to prevent normal reactor shut down and cool down, assuming make up is provided by normal make up only.

3. Events or fault sequences not expected to occur during the life-time of a particular plant, but whose occurrence is nevertheless considered in the design.
   Due to the presence of protective means in the plant, these events or fault sequences are not expected to escalate into situations where extensive off-site countermeasures are required to protect the public.

   An example of postulated event is :
   . double ended break of a large pipe in the primary pressure boundary.

4. Hypothetical events or fault sequences with a very remote probability whose occurrence is not considered in the design. These situations might require extended countermeasures to protect the public, based on an emergency planning scheme.

PART II

General safety principles.

In order to protect man and his environment against the harmful effects of ionizing radiation, the nuclear power plant shall be designed, constructed, tested and operated according to a number of safety principles. It is of prime importance to minimize the release and prevent the escape of radioactive materials in all operational states and during accident conditions.

To achieve this safety objective a "Defense in depth" concept is usually employed. For example four different sometimes successive and mutually reinforcing echelons of defense are required to prevent a serious accident affecting the public.

- A first echelon of defense in depth emphasizes accident prevention It requires that the plant be soundly and conservatively designed, constructed and operated in accordance with stringent quality levels and engineering practices.
  The basic design must minimize the possibility of anticipated operational occurrences and accident conditions.

- A second echelon of defense is based on the assumption that failures or operating errors will occur during the service life of a nuclear power plant, despite the care taken to prevent them. Accordingly, specific systems are required to prevent or minimize damage from such failures. The aim here is to detect and intercept deviation from normal operating conditions in order to prevent minor incidents from escalating into major ones.

- A third echelon provides additional safety systems to protect the public against accidents. A number of accident sequences are selected as a basis for the incorporation of these additional safety systems required to mitigate the consequences of such events.

- A fourth echelon of defense, which is conceptually different from reactor design, is emergency preparedness; this relates to off-site as well as on-site planning. Emergency preparedness takes into account accident conditions which may lead to release of radioactive material that go beyond those of the events considered in the third echelon.

One technical way to implement a defense in depth concept is the preservation of a series of barriers preventing the escape of radioactive materials.
The three principal barriers are the following :

- The first barrier comprises the retaining ability of the fuel matrix and the fuel cladding. It is essential to ensure the integrity of this barrier; therefore reliable cooling of the core and reactivity control must be provided to limit the fuel and cladding temperature during normal operation, anticipated operational occurrences such as transients and in accident conditions. In addition, reliable means must be provided to remove residual heat after shut down to preserve the integrity of the fuel elements.

- The second barrier is the primary pressure boundary; within this barrier the heat production and the heat exchange take place. This barrier prevents the escape of any radioactive materials which are present in the cooling fluid. Loss of integrity of this barrier leads to a loss of coolant, which in turn might lead to a failure of the fuel cladding. Provisions are therefore necessary to limit the consequences of the failure of the second barrier.

- The third barrier is constituted by the containment system. Its main function is to mitigate the consequences of an escape of radioactive materials from the primary circuit and to limit the escape of these materials into the environment.

There are further aspects in connection with general safety principles.

The plant must be operated in such a manner that the process and systems parameters are kept within their operational limits. Any deviation from operating ranges should be detected and should lead to appropriate actions to keep process and system parameters within their safety limits.

It must be ensured that the reliability of the structures, systems and components is maintained at an adequate level throughout plant-life in accordance with the safety functions to be performed. This is achieved by proper design, construction and operation, and by ensuring at the design stage that adequate facilities are available for testing, inspection, maintenance and repair. Operating experience can provide an important source of safety guidance for NPP's and therefore the lessons learned from operation and accidental conditions should be fed back into the desing, construction and operation of nuclear power plants.

An appropriate quality assurance programme is required and the quality level must reflect the importance to safety of structures, systems and components.

Of great importance are also managerial and organizational aspects, including qualification and training of personnel.

The impact of the site characteristics and the activities carried out in the proximity on the safety of the plant shall also be considered. Adequate protection shall be provided against external impacts of natural or man made origin. Such impacts are earthquakes, floods, tornadoes, airplane crashes, explosions, fires etc.

Although the importance of emergency planning as an ultimate measure for the protection of the public against the effects of accidental releases is recognized, it will not be treated specifically in this document.

The foregoing considerations are expressed in the following general safety principles :

1. To implement the fundamental safety principle - that all practical steps shall be taken to prevent accidents and to minimize the radiological consequences of any accident should it occur - a "defense in depth" strategy shall be applied.
   This strategy leads to the following requirements :

- Design, construction and operation of the plant shall provide adequate safety margin in normal operation, prevent the occurrence of system malfunctions and minimize the sensitivity of the plant to failures, malfunction and maloperation.

- the plant shall be designed, constructed and operated so that off-normal conditions (such as anticipated operational occurrences) can be detected and minor incidents can be prevented from escalating.

- reliable features, as well as operational and organizational provisions must be available to cope with any credible internal or external event or credible combination of them. This requires that the plant can be safely shut down and kept shut down, the residual heat can be removed and the release of radioactive materials is limited.

- emergency plans (on site and off site) shall be provided.

2. A safety evaluation shall be performed in particular to demonstrate that the design, the construction and the operation of the plant will take place according to the defense in depth strategy. This evaluation shall be based on tests, experience and analysis taking into account uncertainties in data and analysis. The safety evaluation shall show which kind of events and combination of them, as well as their consequences, are taken into account.

3. Structures, systems and components important to safety shall be designed, fabricated, erected, inspected and tested to a quality level commensurate with the importance of the safety functions to be performed. Where codes and standards are used, they shall be identified and evaluated to determine their adequacy and shall be supplemented or modified if necessary.

   A quality assurance programme shall be established and implemented in order to provide adequate assurance that these structures, systems and components will satisfactorily perform their safety functions when required throughout their anticipated operational life in the plant.
   More in general there shall be a comprehensive quality assurance programme for the design, construction, commissioning, operation and decommissioning covering all activities which may have an influence on the safety of the NPP.

The reliability of a barrier or of a safety system shall be commensurate with the safety function it has to perform. Equipment outages, single failures, common mode failures, and consequential failures (e.g. from equipment failures) have to be taken into account. Suitable measures shall be taken to minimize the probability of occurrence of common mode failures. Other systems, structures or components that may influence the safety performance of these barriers, safety systems or the plant as a whole also shall be considered.
The requirements for safety system support features shall be consistent with those for the safety systems supplied.

All items important to safety shall be testable and maintainable commensurate with the safety function to be performed. If structures, systems or components important to safety cannot be tested to the extent desirable, adequate safety precautions shall be taken to compensate for possible undiscovered failures.
The effects of radiation and other environmental conditions shall be considered in this context.

In addition to the protection against internal events, including for instance loss of coolant, fire and explosion, turbine explosion etc., protection against external events, either natural (earthquakes, tornadoes, floods etc.) or man-made (aircraft crashes, chemical works accidents, mining operations etc.), has to be taken into account. A quantitative probabilistic approach of these external events and their consequences may be considered.

Interaction between the plant and the environment shall be taken into account. In this context, amongst others, off-site services, upon which the safety of the plant and protection of the plant personnel and the public may depend, shall be considered, for example ultimate heat sink, electricity supply and fire fighting services.

8. Structures, systems and components important to safety shall not be shared between nuclear power units on one site, unless it can be demonstrated that an accident condition in one unit will not affect the orderly shut down, cool down and residual heat removal of the other unit on the site, taking into account situations such as the loss of off-site electrical power.

9. In the interest of safety appropriate ergonomic principles shall be applied in the working areas and the working environment of the site personnel with due regard to the actions to be taken by these personnel during normal operation and during accident situations. In addition the possibility of errors by site personnel should be minimized by proper design and administrative measures.

10. Access to the safety and support systems shall be appropriately limited, bearing in mind the need to prevent unauthorized access and to guard against unintentional or intentional damage. The methods employed shall include appropriate combinations of physical protection and administrative measures.

11. The personnel must be sufficiently qualified and trained to perform the required tasks.

PART III

Subjects for safety requirements

1. Introduction

While Part II presents general safety principles, which have an overall importance for the NPP, Part III lists systematically the main keywords for safety requirements some of which might be developed at a later stage.

It is recognized that some requirements cover more than one of the phases of :

- siting,
- design,
- construction,
- commissioning,
- operation,
- decommissioning;

these requirements have a different character from those associated with the phases given above. They relate to the areas of :

- safety evaluations,
- quality assurance,
- radiological protection, including waste treatment,
- ergonomics,
- emergency planning.

For the specific phases of design, construction, commissioning, operation, decommissioning, general requirements should be developed related to every particular phase, followed by specific requirements related to the specific subjects of that phase.*

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* A figure is attached which shows in a diagrammatic form an outline of the proposed scheme for safety requirements.

Section 2 of this Part III gives a draft list of the subjects of general and specific requirements for the phases, and Section 3 lists the main topics to develop safety requirements for the areas.

2. Safety requirements for the phases.

2.1. SITING*

General requirements

- general criteria for site screening and site selection
- criteria for taking into account external events
- criteria for defining potential effects of the NPP on the region
- population considerations

Specific requirements for specific subjects

- floods
- geology ans seismology
- tornadoes
- air craft crashes
- chemical explosions and effects of dangerous gases
- dispersion of radioactive materials
- site-related radioecology aspects
- population distribution
- further site-related parameters.

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* According to Part I, at this stage, siting aspects are a matter of exchange of informations only.

2.2 DESIGN

General requirements

- safety classifications
- reliability aspects (probabilistic, deterministic; single failure criterion, diversity, physical separation, fail-safe behaviour)
- multiplant site
- decommissioning provisions.

Specific requirements for specific subjects

Structures, components and systems

- design against external events (natural and man-made)
- effects associated with equipment failures (e.g. missiles, pipe whip)
- protection against fire and explosions
- buildings (incl. containment)

Reactor core

- reactor design (incl., inherent safety)
- fuel elements
- reactor core control
- reactor internals

Reactor coolant system

- reactor coolant system overall design
- pressure boundary
- residual heat removal
- emergency core cooling
- auxiliaries for reactor coolant system (e.g. reactor coolant clean up)

Power conversion system

- steam generators
- turbine

Instrumentation and control

- instrumentation overall design
- control-room and supplementary control-points
- radiation monitoring and control of release of radioactive material
- incident instrumentation
- safety related instrumentation

Reactor protection system

- separation from control system

Electric power supply

- on-site power
- off-site power
- emergency power

Containment system

- overall design (e.g. leakage, testing, isolation)
- auxiliaries (e.g. heat removal system; atmosphere clean up system, containment internals)

Auxiliary systems

- fuel handling and storage
- ventilation systems
- fire protection systems
- further auxiliary systems

2.3 COMMISSIONING AND OPERATION

General requirements

- operation surveillance
- management organization
- operational limits and conditions
- recruitment, training and authorization of personnel

Specific requirements for specific subjects

Commissioning

- programme
- test procedures

Operation

- procedures (power operation, refuelling, shutting down, plant modifications, etc.)
- instructions (operating manual; records and reports, including incident reporting, etc.)

Maintenance, testing, examination and inspection

- programme
- procedures.

2.4 DECOMMISSIONING

At this stage, no requirement is given for this phase.

3. Safety requirements for the areas

3.1 SAFETY EVALUATIONS

Requirements

- Objectives
- Documentation (safety reports and supporting documents)
- Procedures
- Stages and topics
- Methodology
  - deterministic (single failure criteria, postulated initiating events
  - probabilistic (risk concept, fault tree, reliability...)

3.2 QUALITY ASSURANCE

Requirements

- Programmes
- Organization
- Control (document, design, procurement, material, process)
- Inspection
- Non-conformance
- Corrective actions
- Records
- Audits

3.3 RADIOLOGICAL PROTECTION, INCLUDING FUEL HANDLING AND WASTE TREATMENT

Requirements

- Radiological protection aspect related to siting
- Radiological protection in the design stage
- " " during operation
- Fuel handling and management
- Waste treatment

3.4 ERGONOMICS

Requirements

- Work-Environment (e.g. climate, lighting, noise and vibrations)
- Work-Area (e.g. design and arrangement of actuators and indicators)
- Plant regulations and organization of work.

3.5 EMERGENCY PLANNING

Requirements

- On-site planning
- Off-site planning
- Coordination of on-site and off-site responsabilities.

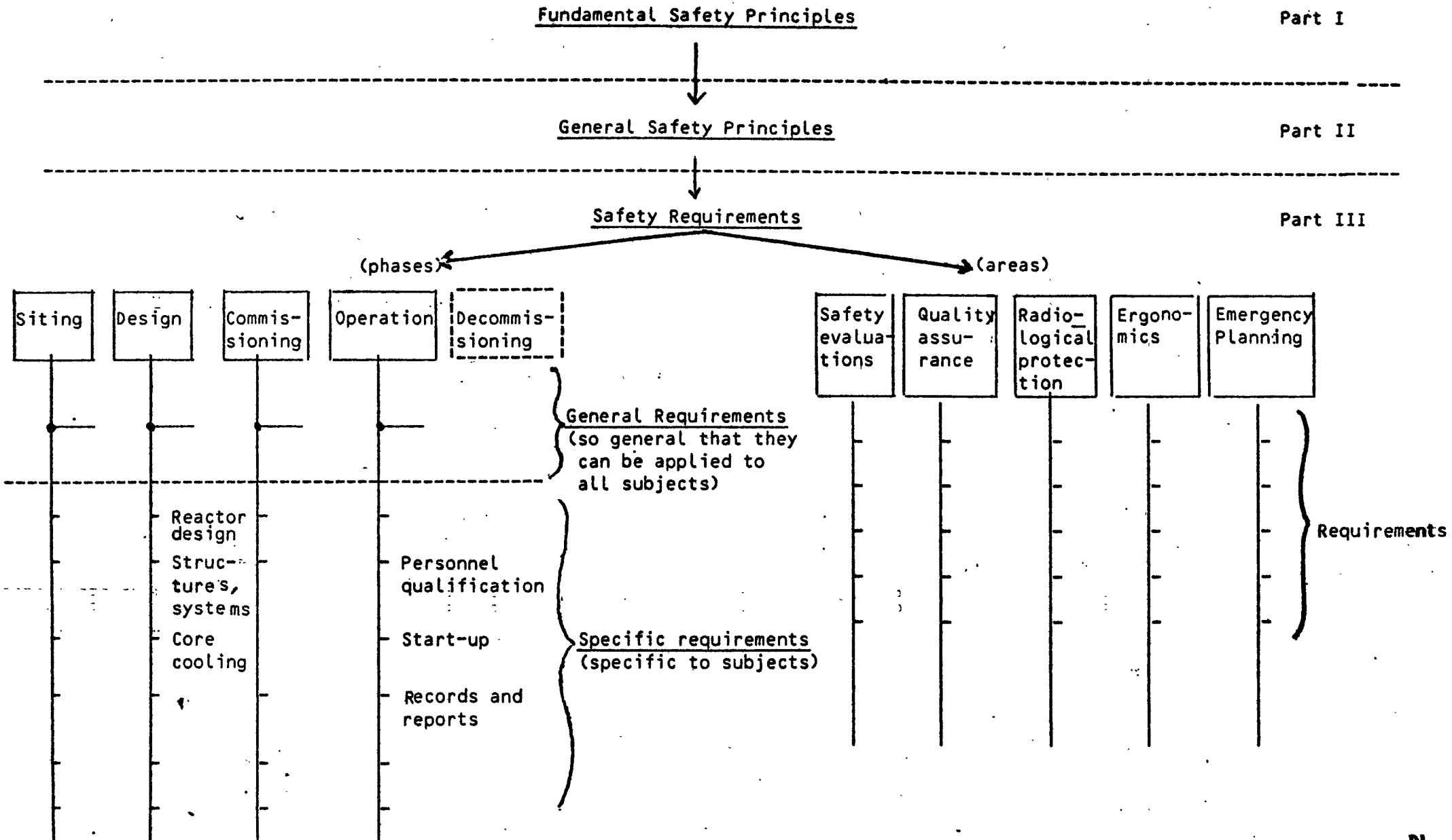

Figure - Scheme for safety requirements

APPENDIX

DEFINITIONS

The following definitions are taken from the Codes of Practice of the IAEA Safety Serie-50.

Accident conditions

Substantial deviations from Operational States which are expected to be infrequent, and which could lead to release of unacceptable quantities of radioactive materials if the relevant engineered safety features did not function as per design intent.

Anticipated Operational Occurrences

All operational processes deviating from Normal Operation which are expected to occur once or several times during the operating life of the plant and which, in view of appropriate design provisions, do not cause any significant damage to Items Important to Safety nor lead to Accident Conditions (see Operational States).

Items Important to Safety

The items which comprise :

(1) those structures, systems, and components whose malfunction or failure could lead to undue radiation exposure of the Site Personnel or members of the public*;

(2) those structures, systems and components which prevent Anticipated Operational Occurrences from leading to Accident Conditions;

(3) those features which are provided to mitigate the consequences of malfunction or failure of structures, systems or components.

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* This includes successive barriers set up against the release of radioactivity from nuclear facilities.

Normal Operation

Operation of a Nuclear Power Plant within specified Operational Limits and Conditions including shut-down, power operation, shutting down, starting up, maintenance, testing and refuelling (see Operational States).

Operation *

All activities performed to achieve, in a safe manner, the purpose for which the plant was constructed, including maintenance, refuelling, in-service inspection and other associated activities.

Operational Limits and Conditions

A set of rules which set forth parameter limits, the functional capability and the performance levels of equipment and personnel approved by the Regulatory Body for safe operation of the Nuclear Power Plant.

Operational States

The states defined under Normal Operation and Anticipated Operational Occurrences (see Normal Operation and Anticipated Operational occurrences).

Prescribed Limits **

Limits established or accepted by the Regulatory Body.

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* The terms Siting, Construction, Commissioning, Operation and Decopmmissioning are used to delineate the five major stages of the licensing process. Several of the stages may coexist for example, Construction and Commissioning, or Commissioning and Operation.

** The term "authorized limits" is sometimes used for this term.

Protection System

A system which encompasses all electrical and mechanical devices and circuity, from sensors to actuation device input terminals, involved in generating those signals associated with the protective function.

Protective System

A safety system designed and installed to act automatically to ensure that one or more Safety Limits are not violated.

Quality Assurance

Planned and systematic actions necessary to provide adequate confidence that an item or facility will perform satisfactorily in service.

Reliability

The probability that a device, system or facility will perform its intended function satisfactorily for a specified time under stated operating conditions.

Residual Heat

The sum of the heat originating from radioactive decay and shut-down fission and the heat stored in reactor-related structures and in heat transport media.

Safety Limits

Limits upon process variables within which the Operation of the Nuclear Power Plant has been shown to be safe.

Safety Systems

Systems important to Safety, provided to assure, in any condition, the safe shut-down of the reactor and the heat removal from the core, and/or to limit the consequences of Anticipated Operational Occurrences and Accident Conditions (see Anticipated Operational Occurrences and Accident Conditions).

Single Failure

A random failure which results in the loss of capability of a component to perform its intended safety functions. Consequential failures resulting from a single random occurrence are considered to be part of the single failure.

Site

The area containing the plant, defined by a boundary and under effective control of the Plant Management

Site Personnel

All persons working on the Site, either permanently or temporarily.