Extraordinary

Federal Republic of Nigeria Official Gazette

No. 32 **Lagos - 23rd February, 2021** **Vol. 108**

Government Notice No. 36

The following is published as supplement to this *Gazette* :

Printed and Published by The Federal Government Printer. Lagos. Nigeria
FGP 78/022021/1.250

Annual Subscription from 1st January, 2021 is Local : ₦45,000.00 Overseas : ₦60,500.00 [Surface Mail] ₦75,000.00 [Second Class Air Mail]. Present issue ₦3,000 per copy. Subscribers who wish to obtain *Gazette* after 1st January should apply to the Federal Government Printer. Lagos for amended Subscriptions.

NUCLEAR SAFETY AND RADIATION PROTECTION ACT
(No. 19 of 1995)

NIGERIAN SAFETY OF RESEARCH REACTORS REGULATIONS, 2021

ARRANGEMENT OF REGULATIONS

Regulation :

S. I. No. 20 of 2021

NIGERIAN SAFETY AND RADIATION PROTECTION ACT
(No. 19 of 1995)

NIGERIAN SAFETY OF RESEARCH REACTOR REGULATIONS, 2021

[11*th Day of January*, 2021] Commencement.

In exercise of the powers conferred on it by section 47 of the Nuclear Safety and Radiation Protection Act No.19 of 1995 ad of all other powers enabling it in that behalf, the Nigerian Nuclear Regulatory Authority, with the approval of the President, makes the following Regulations—

PART I—OBJECTIVE AND APPLICATION

Objectives.

1. The objectives of these Regulations are to—

(*a*) provide a basis for safety and safety assessment for all stages in the lifetime of a research reactor ; and

(*b*) establish requirements for integrated management system and administrative process including responsibilities of the Authority and Operating organization.

Scope of application.

2. These Regulations establishes requirements for—

(*a*) all important areas of safety of research reactor, including critical assembly facilities with particular emphasis on requirements for site evaluation, design and construction, commissioning, operation, utilization and modification, extended shutdown and decommissioning ; and

(*b*) administrative processes including responsibilities of the Authority and the operating organization.

Graded approach.

3.—(1) The scope, extent and detail of the safety analysis shall follow a graded approach.

(2) The factors to be considered in the application of certain requirements established in these Regulations using a graded approach include—

(*a*) the reactor power ;

(*b*) the source term ;

(*c*) the amount and enrichment of fissile and fissionable material ;

(*d*) spent fuel elements, high pressure systems, heating systems and the storage of flammables, which may affect the safety of the reactor ;

(*e*) the type of fuel elements ;

(*f*) the type and the mass of moderator, reflector and coolant ;

(*g*) the amount of reactivity that can be introduced and its rate of introduction, reactivity control and inherent additional safety features ;

(*h*) the quality of the containment structure or other means of confinement ;

(*i*) the utilization of the reactor (experimental devices, tests and reactor physics experiments) ;

(*j*) siting ; and

(*k*) proximity to population groups.

(3) The operating organization shall be responsible for submitting to the Authority for review and approval of the justification for grading the application of these requirements.

PART II—GENERAL REPONSIBILITIES

Responsibilities of the Authority.

4.—(1) In discharging its responsibility for protecting people and the environment from the harmful effects of ionizing radiations and for ensuring the safety of facilities and activities that give rise to radiation risks, the Authority shall regulate and control research reactor safety by means of assessment, authorization, inspection and enforcement.

(2) The licensing process shall be in the following stages—

(*a*) site evaluation ;

(*b*) design and construction ;

(*c*) commissioning ;

(*d*) operation including utilization and modification ;

(*e*) decommissioning ; and

(*f*) release from regulatory control.

(3) The responsibilities of the Authority in regulating the safety of Research reactor shall include—

(*a*) issuing of authorizations for facilities and activities on the basis of documented safety demonstration ;

(*b*) establishing or adopting safety principles and regulations ;

(*c*) organizing public hearing in respect to siting or site evaluation activities in relation to research reactor in Nigeria ;

(*d*) reviewing, assessing and approving safety documents, including the safety analysis report, operational limits and conditions document, and emergency plan ;

(*e*) ensuring control of operational safety of research reactor through licensing and inspections ;

(*f*) ensuring that only suitably qualified and experienced persons hold posts that can affect safety through the licensing of reactor operating personnel ;

(*g*) conducting inspections to ensure compliance with the license conditions, the operational limits and conditions and applicable regulations, codes and standards ;

(*h*) reviewing information concerning safety related events, such as violation of safety limits, non-compliance with limiting conditions for safe operation, and personnel exposure or radioactive discharge beyond specified limits ;

(*g*) reviewing and approving planned modifications and experiments which may have a significant effect on the safety of the research reactor ;

(*h*) reviewing and approving planned modifications and experiments which may have a major effect on the safety of the research reactor and are beyond the scope of the existing limits and conditions and the Safety Analysis Report (SAR) ;

(*i*) enforcing regulations, including conditions attached to the licence and any necessary corrective actions ; and

(*j*) ensuring that a safety culture, including good practices and attitudes in the conduct of operations, is maintained by the reactor management and the operating organization.

(4) In order to achieve the common objective of safe operation the—

(*a*) relationship between the Authority and the operating organization shall be based on mutual understanding, respect and confidence ; and

(*b*) appropriate formal and informal lines of communication shall be established with the operating organization.

Review and assessment by the Authority.

5.—(1) A review and assessment of information usually in the form of a SAR submitted by the operating organization in support of its license application, shall be performed by the Authority to determine whether the proposed facility can be sited, constructed, commissioned, operated, utilized, modified and decommissioned without undue radiological risks to the personnel at the site, the public and the environment.

(2) The review and assessment shall be performed in accordance with the potential magnitude of the hazard associated with the research reactor, using a graded approach.

(3) The Authority shall liaise with the operating organization throughout the entire process of regulatory supervision of the installation, particularly the schedule for the submission of safety documents for review and assessment.

(4) The Authority shall ensure that the SAR submitted by the operating organization gives a detailed description of the reactor site, the reactor, experimental devices and all other facilities and activities with safety significance.

Inspection and enforcement.

6.—(1) The Authority shall conduct inspections to confirm compliance with the conditions set out in the authorizations and regulations and shall also take into account, as necessary, the activities of suppliers of services and products to the operating organization.

(2) The authority shall where necessary apply enforcement action in the event of deviations from, or non-compliance with regulatory requirements and conditions specified in the authorizations.

(3) The enforcement action referred to in sub regulation (2) of this regulation may include suspension or revocation of the authorization.

Responsibilities of the operating organization.

7.—(1) The operating organization shall be responsible for the safety of the research reactor throughout its lifetime, from the beginning of the project for site evaluation, design and construction, through to commissioning, operation, utilization, modification and decommissioning and this responsibility shall not be delegated.

(2) The operating organization shall establish an appropriate management structure for the research reactor and provide for all necessary infrastructures for the conduct of research reactor operations.

(3) The operating organization shall ensure that adequate provision is made for all functions relating to the safe operation and utilization of the research reactor.

(4) A system for reviewing and reporting abnormal occurrences shall be established.

(5) The operating organization shall establish the functions and responsibilities for the key positions in the organization for research reactor operation.

(6) The operating organization shall define the qualifications and experiences necessary for personnel performing duties that may affect safety, provided that—

(*a*) training and retraining programme shall be established, implemented and kept up to date and periodically reviewed to verify its effectiveness ;

(*b*) suitably qualified personnel shall be selected and given the necessary training and instruction to enable them perform their duties ; and

(*c*) individuals performing certain functions important to safety shall be required to hold a formal license issued by the Authority.

(7) The operating organizations shall establish and implement a radiation protection program to ensure that all activities involving radiation exposure or potential exposure are planned, supervised and executed to achieve the aims described in the Nigerian Basic Ionizing Regulations, 2003.

(8) The operating organization shall prepare and issue specifications and procedures, in particular for the procurement, loading, utilization, unloading, storage, movement and testing of fuel, core components and other fresh or irradiated fissile material.

(9) The operating organization shall consider decommissioning at all stages of the Research reactor lifetime as required in Part VIII of these Regulations.

(10) The operating organization shall prepare periodic summary reports on matters relating to safety and shall submit these reports to the safety committee and the Authority.

(11) The operating organization shall ensure that—

(*a*) the design enables the research reactor to be operated safely and the research reactor is constructed in accordance with the approved design ;

(*b*) an adequate SAR as described in these Regulations is prepared and kept up to date ;

(*c*) the commissioning process demonstrates that the design requirements have been met and that the research reactor can be operated in accordance with the design assumptions ;

(*d*) emergency procedures are established and implemented ;

(*e*) physical protection program is developed and implemented ;

(*f*) radioactive waste management program is developed and implemented ;

(*g*) fire protection program is developed and implemented ;

(*h*) the research reactor is being operated and maintained in accordance with the safety requirements by suitably qualified and experienced personnel ;

(*i*) adequate facilities and services are available during operations ;

(*j*) information on reportable events, including any assessments of such events and the corrective actions intended, is timely submitted to the Authority ;

(*k*) safety culture is fostered in the organization to ensure that the attitudes of personnel and the actions and interactions of all individuals and organizations are conducive for safe operation ;

(*l*) integrated management system is established and implemented ;

(*m*) the research reactor management is provided with sufficient authority and resources to enable it fulfil its duties effectively ;

(*n*) the research reactor is operated and maintained in accordance with the OLCs and operating procedures ;

(*o*) the fissile and radioactive materials that are utilized or generated are controlled ; and

(*p*) operational experience, including information on operating experience at similar research reactor, is carefully examined for any precursor signs of tendencies adverse to safety, so that corrective actions can be taken before serious adverse conditions arise and recurrences can be prevented.

(12) The operating organization shall establish an ageing management programme as part of integrated management system.

(13) The operating organization shall develop and make available acceptance criteria to the Authority for approval.

(14) The criteria referred to in sub regulation (13) of this regulation shall be developed on the basis of suitable principles for safe design and operations and in line with IAEA Safety Standards.

(15) The operating organization shall—

(*a*) establish and implement safety policies and ensure that safety matters are given the highest priority ;

(*b*) clearly define responsibilities and accountabilities with corresponding lines of authority and communication ;

(*c*) ensure that it has sufficient staff with appropriate education and training at all levels ;

(*d*) develop and strictly adhere to sound procedures for all activities that may affect safety, ensuring that managers and supervisors promote and support good safety practices while correcting poor safety practices ;

(*e*) review, monitor and audit all safety related matters on a regular basis, implementing appropriate corrective actions where necessary ; and

(*f*) be committed to safety culture on the basis of a statement of safety policy and safety objectives which is prepared, disseminated and understood by all staff.

(16) The operating organization shall control and prevent the proliferation of nuclear weapons in relation to the procurement, transport, use, handling and storage of nuclear material and shall further ensure the fulfilment of the national obligations as contained in the Safeguards Agreement between IAEA and Nigeria (INFCIRC/358) as well as the Additional Protocol.

Safety Analysis Report (SAR).

8.—(1) The SAR shall be prepared by the operating organization for the justification of the site and design and shall be the basis for the safe operation of the research reactor.

(2) The SAR shall be updated during the operational lifetime of the reactor on the basis of the experience and knowledge gained to reflect the as-built state of the facility and in accordance with regulatory requirements for license extension, periodic safety review and authorization of modifications important to safety.

(3) The SAR shall—

(*a*) give a detailed description of the research reactor site, the research reactor, experimental devices and all other facilities and activities with safety significance ;

(*b*) provide a detailed description of the general safety principles and criteria applied to the design for the protection of the research reactor. the operating personnel, other on-site personnel, the public and the environment ;

(*c*) analyze the potential hazards associated with the operation of the research reactor ; and

(*d*) include safety analyses of accident sequences and shall describe the safety features incorporated in the design to avoid or minimize the likelihood of occurrences of accidents, or mitigate their consequences through design and operating procedures.

(4) The safety analyses in the SAR shall—

(*a*) form the basis for establishing OLCs for the research reactor ;

(*b*) provide details of how the operating organization intends to organize and conduct operations and the integrated management system for all stages of research reactor's life, including design and construction ; and

(*c*) provide details of the emergency plan of the research reactor.

(5) The SAR shall include additional information as prescribed in relevant legislation and by the Authority.

(6) The level of detail of the information to be presented in the SAR shall be determined in accordance with the type, characteristics design, power, utilization and site of the research reactor.

(7) The SAR shall cite the technical literature in the form of references that may be necessary for a thorough review and assessment process.

(8) The references shall be readily available to the Authority and shall not be subject to any classification or limitation that would prevent its adequate review and assessment.

Interaction between the Authority and the operating organization.

9.—(1) The operating organization shall demonstrate to the Authority that its responsibility for safety at all stages in the lifetime of the reactor will be discharged.

(2) Where a change of stage is initiated by the operating organization, it shall submit a detailed demonstration, which shall include an adequate safety analysis for review and assessment by the Authority before the project is authorized to progress to the next stage.

(3) The operating organization shall—

(*a*) submit in a timely manner any information requested by the Authority ;

(*b*) be responsible for making arrangements with the vendors to ensure the availability of any information requested by the Authority ; and

Trustworthiness of Personnel.

(*c*) avail the Authority of any new information on the research reactor and any change to information previously submitted.

(4) The format and content of documents submitted to the Authority by the operating organization in support of a license application shall be as prescribed by the Authority, provided that the Authority may request additional information depending on the review of the submission.

PART III—INTEGRATED MANAGEMENT SYSTEM

Establishment of integrated management system.

10.—(1) The operating organization for a research reactor facility shall establish, implement, assess and continuously improve an integrated management system.

(2) The operating organization shall establish and implement an integrated management system for research reactor for the stages of site evaluation, design, construction, commissioning, operation, utilization, modification and decommissioning in a safe manner and within the limits and conditions that are specified in the OLCs and established in the authorization.

(3) The activities for site investigation, which are usually initiated long before the establishment of a project, shall be covered by the integrated management system.

(4) The extent of the detailed integrated management system required for a particular research reactor or facility shall be governed by the potential for hazard of the research reactor and the utilization programme shall meet the requirements of the Authority.

(5) The integrated management system shall include all the elements of management to ensure that processes and activities important to safety are established and conducted coherently with relevant requirements, including those relating to leadership, protection of health, human performance, emergency preparedness and response, protection of the environment, security and quality.

(6) The documentation of the integrated management system shall be reviewed and approved by the operating organization and shall be submitted to the Authority for review and assessment.

(7) The provisions of the integrated management system shall comprise—

(*a*) management responsibility ;

(*b*) resource management ; and

(*c*) process implementation and measurement, assessment, evaluation and improvement.

Management responsibility.

11.—(1) Management shall provide and demonstrate support for the effective implementation of the integrated management system in all work areas.

(2) The integrated management system shall include provisions to ensure that processes and activities important to safety are controlled and performed in a manner that ensure effective communication and clear assignment of responsibilities.

Resource management.

12.—(1) The operating organization shall ensure that the resources essential to the implementation of strategy and the achievement of the organization's objectives are identified and made available.

(2) The integrated management system shall ensure that—

(*a*) suppliers, manufacturers and designers of systems, structures and components important to safety have an effective integrated management system in place ;

(*b*) external personnel (including suppliers and experimenters) are adequately trained and qualified and are performing their activities under the same controls and to the same standards as the reactor personnel ; and

(*c*) the equipment, tools, materials, hardware and software necessary to conduct the work in a safe manner are determined, provided, checked, verified and maintained.

Process implementation.

13.—(1) The integrated management system shall include process implementation provisions to ensure that reactor design including subsequent changes, modifications or safety improvements, construction, commissioning, operation and utilization activities, and decommissioning are performed in accordance with established codes, standards, specifications, procedures and administrative controls.

(2) Items and services important to safety shall be specified and controlled to ensure their proper use, maintenance and configuration.

(3) During the manufacturing and construction of systems, structures and component of the research reactor, including its associated experimental facilities and devices and modification projects, processes shall be established to ensure that the relevant regulations and safety requirements are met and that the construction work is properly implemented.

(4) As part of the integrated management system—

(*a*) processes for utilization and modifications shall be established on the basis of their safety significance ; and

(*b*) relevant procedures describing the processes shall be put into effect by the operating organization early in the reactor operation phase.

(5) The integrated management system shall ensure that items and services under procurement meet established requirements and perform as specified.

(6) Suppliers shall be evaluated and selected on the basis of specified criteria.

(7) Requirements for reporting deviations from procurement specifications shall be specified in the procurement documents.

(8) Evidence that purchased items and services meet procurement specifications shall be made available for verification before the items are used or the services are provided.

Assessment and improvement.

14.—(1) The effectiveness of the integrated management system shall be periodically assessed through audits and weaknesses in processes and shall be identified and corrected.

(2) The operating organization shall evaluate the results of the audits referred to in sub-regulation (1) of this regulation and determine and implement the necessary actions for continuous improvements.

(3) Independent assessments shall be conducted on behalf of the management to measure the effectiveness of management processes and the adequacy of work performed, to monitor the quality of items and services and to promote improvements.

(3) A person conducting an independent assessment shall not be directly involved in the work being assessed.

Verification of safety.

15.—(1) A comprehensive safety assessment shall be carried out by the operating organization to confirm that the design meets the safety requirements set out at the beginning of the design process.

(2) The safety assessment referred to in sub-regulation (1) of this regulation shall be continued throughout all the stages in the lifetime of the reactor and it shall be conducted in accordance with the potential magnitudes and nature of the hazard associated with the particular facility or activity.

(3) The operating organization shall carry out self-assessment and peer reviews mainly for the purpose of identifying and solving problems concerning safety and for improving safety.

(4) The operating organization for a research reactor facility shall establish and maintain a system for the control of records and reports.

(5) The operating organization shall retain all essential information concerning the design, construction, commissioning, current configuration and operation throughout the lifetime of the reactor.

(6) Administrative procedures consistent with the integrated management system shall be developed for the generation, collection, retention, and archiving of records and reports.

(7) Records of non-compliance and the measures taken to return the research reactor to compliance shall be prepared and retained and shall be submitted to the Authority.

(8) The arrangements made for storing and maintaining records and reports shall be in accordance with the management system.

(9) The operating organization shall prepare and submit to the Authority an annual report of its operation not later than 31st March of each year.

(10) The annual report shall contain records of activities that took place in the preceding year, which include—

(*a*) operational record ;
(*b*) core management ;
(*c*) maintenance ;
(*d*) modification ;

(*e*) utilization including irradiation of samples ;

(*f*) radiation monitoring and control ;

(*g*) personnel dose record ;

(*h*) waste disposal ;

(*i*) events ;

(*j*) emergency drills ; and

(*k*) update on reactor management and operational staff.

(11) The operating organization shall periodically, as the Authority may request, reassess the following—

(*a*) reviewing the design basis of the reactor facility as described in the safety analysis report ; and

(*b*) assessment of the impact of events that are beyond the design basis of the facility including assessment of any consequential loss of the basic safety functions and the relevance of the mitigatory actions to be taken, in order to identify the need for safety improvements in both technical and organizational aspects.

PART IV— SITE EVALUATION

Initial evaluation and selection of a Site.

16.—(1) The main safety objective in evaluating the site for a research reactor is the protection of the public and the environment against the radiological consequences of normal and accidental releases of radioactive material.

(2) The site evaluation shall establish the boundaries of the site area under the control of the operating organization, and its legal rights within the area.

(3) Any activities that are unrelated to the operation of the research reactor but which will be permitted within these boundaries shall be evaluated and justified.

(4) In the evaluation of the suitability of a particular site for a research reactor, the characteristics of the site which may affect aspects of the safety of the research reactor, shall be investigated and assessed by the operating organization.

(5) The objective of the assessment shall be to demonstrate how these site characteristics will influence the design criteria and operating criteria for the facility and to demonstrate the adequacy of the site characteristics in terms of effects on safety.

(6) In the evaluation of the suitability of a site for a research reactor, the following aspects shall be considered—

(*a*) the effects of external events that may occur in the region of the site, which could be natural or human-induced ;

(*b*) the characteristics of the site and its environment that could influence the transfer of released radioactive material to humans ;

(*c*) the population density and population distribution and other characteristics in the vicinity of the site relevant to possible emergency measures and the need to evaluate the risks to individuals and the population ;

(*d*) the capability for an ultimate heat sink at the site ; and

(*e*) any other nuclear facilities at the site.

(7) Where the site evaluation for the factors mentioned in sub-regulation (6) of this regulation, including their foreseeable evolution, indicates that the site is unacceptable and these deficiencies of the site cannot be compensated for by means of design features, site protection measures or administrative procedures, the site shall be deemed unsuitable.

(8) In the evaluation of a site for possible radiological consequences in the region for operational states and for accident conditions at the reactor that could lead to emergency measures being taken, appropriate estimates shall be made of expected and potential releases of radioactive material, and the design of the installation and its safety features shall be taken into account, provided that, these estimates shall be confirmed once the design and its safety features have been established.

(9) A proposed site shall be adequately investigated and assessed with regard to all the characteristics that could affect safety in natural and human induced events.

(10) Prehistoric, historical and instrumental information and records, as applicable, of the occurrences and severity of important natural phenomena or human induced events or activities shall be collected for the region and carefully analyzed for reliability, accuracy and completeness.

(11) The environmental characteristics in the region that may be affected by potential radiological consequences of radioactive releases from the reactor in operational states and accident conditions shall be investigated, observed and monitored throughout the lifetime of the research reactor.

(12) The hazards associated with external events and combinations of events that are to be considered in the design of the reactor shall be determined.

(13) The combination of external events with anticipated operational occurrences or Design Bases Accident (DBA) conditions shall be considered for those cases in which an anticipated operational occurrence or a DBA condition is caused by the external event and where there is need to consider long lasting external events (such as flooding) or long post-event recovery time.

(14) Information and records, as applicable, of the occurrences and severity of important natural phenomena and the worst combination of low probability but high consequence events that may result to design extension conditions shall be collected for the region and carefully analysed.

(15) In the analysis of the suitability of the site, consideration shall be given to matters such as storage and transport of fresh fuel, spent fuel and radioactive waste.

(16) The reliability of electrical power at the site shall be considered during siting and throughout the lifetime of the research reactor.

(17) The potential for interaction between nuclear and non-nuclear effluents, such as the action of heat or chemicals on radioactive material in liquid effluents, shall be considered.

(18) For each proposed site the potential radiological consequences shall be evaluated for people in the region when the reactor is in operational states and in accident conditions, including states that could lead to emergency measures being taken in accordance with the provisions of the Nigerian Basic Ionizing Regulations, 2003.

(19) The region in which the research reactor is proposed to be sited shall be studied to evaluate the present and projected population distributions, which may influence the possible consequences of radioactive releases for individuals and the population as a whole.

(20) Prior to the commencement of construction of the research reactor, it shall be confirmed that no major problems are to be anticipated in the development of an off-site emergency plan.

(21) The site evaluation shall be documented and presented in sufficient detail to permit an independent review by the Authority, this shall constitute the first part of the development of the SAR for the research reactor.

Evaluation of external events

17.—(1) The seismological and geological conditions in the region shall be evaluated.

(2) The geotechnical and engineering properties of the proposed site shall be evaluated and this shall include information on slope instability, soil liquefaction, collapse, subsidence or uplift of the site surface, behaviour of foundation materials, other important natural phenomena and extreme conditions.

(3) The potential for slope instability (such as landslides and rock slides) that could affect the safety of the research reactor shall be evaluated for the site and its vicinity.

(4) The potential shall be evaluated for—

(*a*) collapse, subsidence or uplift of the site surface ; and

(*b*) for liquefaction of the subsurface materials at the proposed site.

(5) The geotechnical characteristics of the subsurface materials and their uncertainties shall be investigated and a soil profile for the site shall be produced in a form suitable for design purposes.

(6) The historical data shall be collected and evaluated on phenomena that have the potential to affect the safety of the research reactor, such as volcanism, strong winds, the frequency and severity of lightning strikes, sandstorms, severe precipitation, hail, extreme dust and harmattan haze.

(7) The hazard due to earthquake induced ground motion shall be assessed for the site with account taken of the seismic-tectonic characteristics of the region and specific site conditions.

(8) Where there is evidence for surface faulting or there is inadequate evidence that surface faulting has not occurred in the region, this phenomenon shall be investigated by the applicant and where the fault is capable, the site shall be deemed unsuitable unless a detailed analysis proves that engineering solutions would be practicable.

(9) The meteorological phenomena like wind, precipitation, high and low temperatures and storm surges shall be documented for an appropriate period of time to evaluate their possible extreme values, provided that the output of the site evaluation shall be described in a suitable way for design purposes.

(10) The potential for tornadoes or tropical cyclones and associated missiles shall be evaluated for the region of interest, together with the hazard posed by these phenomena.

(11) The region shall be assessed to determine the potential for flooding due to one or more natural causes such as runoff resulting from precipitation, high tide, storm surge, seismic activities or tsunamis and wind waves that may affect the safety of the research reactor.

(12) Information relating to upstream water control structures shall be analyzed to determine whether the research reactor would be able to withstand the effects resulting from the failure of one or more of the upstream structures and safety related equipment shall be protected from possible dam failure.

(13) The potential for aircraft crashes shall be evaluated, including impacts, fire and explosions on the site, with account taken of present and future characteristics for air traffic, the locations and types of airports, and aircraft characteristics, including aircraft with special permission to fly over or close to the facility such as fire fighting aircraft and helicopters.

(14) The activities in the region that involve the handling, processing, transport and storage of chemicals with potential for causing explosions or the production of gas clouds capable of deflagration or detonation shall be identified.

(15) The vicinity of the site shall be investigated for any facilities where inflammable, toxic, corrosive or radioactive material that could affect safety may be stored, processed, transported or otherwise handled.

(16) A meteorological description of the region, including the basic meteorological parameters and phenomena, shall be prepared, provided that, data for at least one representative year shall be presented, together with any other data that may be available from other sources.

(17) A description shall be prepared of the surface hydrological characteristics of the region, including the main characteristics of water bodies, both natural and artificial, and data on water uses in the region, and evaluation shall be performed on possible impact of the contamination of surface water on the critical group.

(18) A description of the groundwater hydrology of the region shall be prepared, including the main characteristics of the water bearing formations, their interactions with surface waters and data on the uses of groundwater in the region, and evaluation shall be performed on the possible impact of the contamination of groundwater on the critical group.

(19) The distribution of the population within the region shall be determined and in particular, information shall be collected on the distributions of present and projected populations, including both resident and transient populations, in the vicinity of the site, and the information shall be kept up to date over the lifetime of the research reactor, provided that the population distribution shall be used in the evaluation of possible impacts on the public of any releases of radioactive material on the site.

(20) The uses of land and water bodies in the region shall be identified so as to assess the possible regional effects of the proposed research reactor, and in particular for the purpose of preparing emergency plans.

(21) Before the commissioning of the research reactor, the ambient radioactivity of the atmosphere, hydrosphere, lithosphere and biota shall be determined for the vicinity of the site, as necessary, to permit the subsequent evaluation of the effects of the research reactor on radioactivity in the environment.

(22) The characteristics of natural and human induced hazards as well as the demographic, meteorological and hydrological conditions of relevance to the research reactor shall be monitored throughout its lifetime, commencing not later than the start of construction and continuing through to decommissioning.

PART V—DESIGN

General requirements for design.

18.—(1) The Research reactor shall be designed in such a way that the safety objectives are achieved.

(2) The design of the reactor shall consider any associated facilities that may affect safety, including the effects of the reactor as designed on the associated facilities and the implications of the design in all the stages of the reactor's lifetime.

(3) The design of the facility and its safety systems shall consider the different modes of operation planned for the reactor.

(4) The operating organization shall maintain close liaison with the reactor designer to ensure orderly arrangement, preparation, presentation and submission of design documents for use in the preparation of the SAR.

(5) The design shall—

(*a*) provide for successive verifiable physical barriers to the release of radioactive material from the reactor. ;

(*b*) use conservative margins, and the manufacturing and construction shall be in accordance with quality rules applied to the nuclear industry so as to provide assurance that failures and deviations from normal operation are minimized and that accidents are prevented as far as is practicable ;

(*c*) provide for the control of reactor behaviour by means of inherent and engineered features, such that failures and deviations from normal operation requiring actuation of safety systems are minimized or excluded to the extent possible ;

(*d*) provide for automatic actuation of safety systems, such that failures and deviations from normal operation that exceed the capability of control systems can be controlled with a high level of confidence, and the need for operator actions in the early phase of these failures or deviations from normal operation is minimized ;

(*e*) provide for systems, structures and components and procedures to control the course of, and as far as practicable, to limit the consequences of failures and deviations from normal operation that exceed the capability of safety systems ; and

(*f*) provide multiple means for ensuring that each of the fundamental safety function is performed.

Defence in depth.

19.—(1) The design of a research reactor shall satisfy defence in depth to provide graded protection against various reactor transients, including transients resulting from equipment failure and human error and from internal or external events that could lead to a Design Basis Accident (DBA), provided that the levels of defence in depth shall be independent as far as is practicable.

(2) Application of the defence in depth concept shall provide several levels of defence that are aimed at preventing consequences of accidents that could lead to harmful effects on people and the environment and for the mitigation of consequences in the event that prevention fails.

(3) Application of the defence in depth in the design shall include the consideration of the following aspects—

(*a*) application of the single failure criterion by ensuring the fulfilment of each of the fundamental safety functions ; and

(*b*) the use of on-site and off-site emergency plans aimed at mitigating the consequences for the public and the environment in the event of a substantial release of radioactive effluents to the environment.

Safety functions.

20.—(1) The design shall ensure the fulfilment of the following fundamental safety functions for a research reactor for all states of the facility—

(*a*) control of reactivity ;

(*b*) removal of heat from the reactor and from the fuel storage; and

(*c*) confinement of the radioactive material and control of radioactive releases.

(2) A systematic approach shall be taken in identifying those items important to safety that are necessary to fulfil the fundamental safety functions and defining the conditions and inherent features that contribute to or affect fulfilling the fundamental safety functions for all states of the facility.

(3) Means of monitoring the status of the reactor facility shall be provided for ensuring that the fundamental safety functions are fulfilled.

(4) In the design of the safety systems, the single failure criterion shall be applied, and provisions shall be included to facilitate regular inspection, testing and maintenance.

Acceptance criteria and design rules.

21. Acceptance criteria shall be established for design by the operating organization for operational states and for DBAs and in particular, the DBAs considered in the design of the research reactor and selected design extension conditions shall be identified for the purposes of establishing acceptance criteria.

Classification of Structure, Systems and Components (SSCs).

22.—(1) Structures, Systems, and Components (SSCs) and software for instrumentation and control that are important to safety shall first be identified and then classified according to their function and their significance for safety and the basis of the safety classification of the SSCs, including software, shall be stated and the design requirements shall be applied in accordance with their safety classification.

(2) The method for classifying the safety significance of items important to safety shall be based primarily on deterministic methods and complemented where appropriate, by probabilistic methods.

(3) The design shall ensure that any interference between items important to safety are prevented, and any failure of items important to safety in a system in a lower safety class shall not propagate to a system in a higher safety class.

(4) Equipment that performs multiple functions shall be classified in a safety class that is consistent with the most important function performed by the equipment.

Codes and standards.

23.—(1) The codes and standards applicable to SSCs shall be identified and their use shall be in accordance with their classification, provided that codes and standards used shall be relevant to the nuclear industry.

(2) In the case of SSCs for which there are no appropriate established codes or standards—

(*a*) an approach derived from existing codes or standards for similar equipment shall be applied ; or

(*b*) in the absence of such codes and standards, the results of experience, tests, analysis or a combination of these may be applied and this results based approach shall be justified.

Design basis.

24.—(1) The design basis for each item important to safety shall be systematically justified and documented and the documentation shall provide the necessary information for the operating organization to operate the reactor safely.

(2) All the challenges that the reactor may be expected to face during its operational lifetime and which may arise from postulated initiating events at all levels of defence-in-depth shall be taken into account in the design.

(3) The demands imposed on the design of the reactor by these challenges and conditions shall determine the design basis of the research reactor facility and the capabilities that the research reactor facility will need in order to withstand these challenges without authorized limits being exceeded shall be specified in the design basis.

Postulated Initiating Events (PIEs) and DBAs.

25.—(1) The design of the research reactor shall apply a systematic approach to identifying a comprehensive set of postulated initiating events such that all foreseeable events with the potential for serious consequences and all foreseeable events with significant frequency of occurrence are anticipated and are considered in the design.

(2) Postulated initiating events shall be selected appropriately for the purpose of safety analysis, provided that the postulated initiating events selected shall cover all credible accidents that may affect the safety of the research reactor and in particular, the DBAs shall be identified.

(3) The postulated initiating events used for developing the performance requirements for the items important to safety in the overall safety assessment and the detailed analysis of the reactor facility shall be grouped into a specified number of representative event sequences that identify bounding cases and that provide the basis for the design and the operational limits for items important to safety.

(4) A technically supported justification shall be provided for exclusion from the design of any initiating event that is identified in accordance with the comprehensive set of postulated initiating events.

(5) Where prompt and reliable action is necessary in response to a postulated initiating event, provision shall be made in the design for automatic safety actions for the necessary actuation of safety systems, to prevent progression to more severe reactor conditions.

(6) The operator actions that are necessary to diagnose the state of the reactor following a postulated initiating event and to put it into a stable long term shutdown condition in a timely manner shall be facilitated by the provision of adequate instrumentation to monitor the status of the reactor, and adequate means for the manual operation of equipment.

Internal and external hazards for a research reactor.

26.—(1) All foreseeable internal and external hazards for a research reactor, including the potential for human induced events directly or indirectly to affect the safety of the research reactor shall be identified and their effects, both individually and in credible combinations, shall be evaluated.

(2) An analysis of the postulated initiating events shall be made to establish all those internal events that could affect the safety of the research reactor facility.

(3) The potential for internal hazards such as fire, flooding, missile generation, pipe whip, jet impact or the release of fluid from failed systems or from other installations on the site shall be taken into account in the design of the research reactor facility.

(4) Appropriate preventive and mitigation measures shall be taken to ensure that nuclear safety is not compromised.

(5) Interrelationship between external and internal events shall also be considered in the design where appropriate.

(6) The design basis for natural and human induced external events shall be determined and shall also ensure, where appropriate, that automatic shutdown system of the reactor is actuated if a threshold is exceeded and the events to be considered shall include those that have been identified in the site evaluation.

(7) Items important to safety shall be designed and located consistent with other safety requirements to minimize the possible harmful consequences of external events, including failure of non-safety related items.

(8) The design shall provide for an adequate margin to protect items important to safety against levels of external hazards more severe than those selected for the design basis taking into account the site hazard evaluation.

Fires and explosions.

27.—(1) The fundamental safety functions as well as monitoring the status of the facility shall not be compromised by fires or explosions.

(2) SSCs important to safety shall be designed and located subject to compliance with other safety requirements to minimize the effects of fires and explosions.

(3) A fire hazard analysis and an explosion hazard analysis shall be carried out for the research reactor facility to determine the necessary ratings of the fire barriers and means of passive protection and physical separation against fires and explosions.

(4) The design shall include provisions to prevent or limit the formation of explosive atmospheres.

(5) Fire detection systems and fire-fighting systems of the necessary capability shall be provided and the fire-fighting systems shall be automatically initiated where necessary.

(6) Fire-fighting systems shall be designed and located to ensure that their rupture or spurious or inadvertent operation would not significantly impair the capability of SSCs important to safety, and would not simultaneously affect redundant safety groups thereby render ineffective the measures taken to comply with the single failure criterion.

Design limits of parameters.

28. The design limits for all relevant parameters shall be specified for each operational state of the reactor and for accident conditions by the operating organization.

Design for operational states.

29.—(1) The research reactor shall be designed to operate safely within predefined ranges of values for various parameters, and subject to requirements and constraints in all operational states, while meeting the radiation protection objective.

(2) The design shall be such as to facilitate the setting of a practicable set of OLCs for reactor operation.

Design for accident conditions.

30.—(1) Where prompt reliable action is required in response to postulated initiating events, the design of the reactor shall include means of automatically initiating the operation of the necessary safety systems.

(2) The items important to safety shall be designed to withstand the effects of extreme loading and environmental conditions such as extremes of temperature, humidity and radiation levels arising from DBAs.

(3) The design shall incorporate provisions, including a negative power coefficient for bringing the reactor into a stable long term condition.

(4) The design shall identify the equipment to be used in the management of severe accidents.

Engineered safety features.

31.—(1) The Operating organization shall perform safety analysis to determine the necessity for engineered safety features and the accidents to cope with by these systems shall be specified and analyses shall be provided to demonstrate that the systems fulfil the requirements.

(2) The design basis and the various modes of operation of an engineered safety feature shall be determined in detail, including automatic and manual operations.

(3) The design of items important to safety shall ensure that the equipment can be qualified, procured, installed, commissioned, operated and maintained to be capable of withstanding all conditions specified in the design basis for the items.

(4) Maximum authorized unavailability limits for operation of the research reactor shall be established for certain safety systems or components to ensure the required reliability in the performance of safety function.

(5) The following measures shall be used, if necessary in combination, to achieve and maintain the required reliability in accordance with the important functions to be performed by the SSCs—

(*a*) redundancy and the single failure criterion ;

(*b*) diversity ;

(*c*) independence ; and

(*d*) fail-safe design.

Redundancy and the single failure criterion.

32.—(1) The single failure criterion shall be applied to each safety system incorporated in the design of the research reactor.

(2) The design shall take due account of the failure of a component, unless it has been justified in the single failure analysis with a high level of confidence that a failure of that component is very unlikely and that its function would remain unaffected by the postulated initiating event.

(3) The principle of redundancy shall be applied as an important design principle for improving the reliability of systems important to safety and the design shall ensure, on the basis of analysis, that no single failure could result in a loss of the capability of a system to perform its intended safety function.

(4) Multiple sets of equipment that cannot be tested individually shall not be considered redundant.

(5) The degree of redundancy adopted shall reflect the potential for undetected failures that could degrade reliability.

Diversity.

33. The principle of diversity shall be applied to enhance reliability and to reduce the potential for common cause failures.

Independence.

34. The principle of independence shall be applied, as appropriate, to enhance the reliability of systems, in particular with respect to common cause failures.

Fail-safe design.

35.—(1) The principle of fail-safe design shall be considered and shall, where appropriate, be adopted in the design of systems and components important to safety.

(2) Systems at research reactor facilities shall be designed to pass into a safe state, with no necessity for any action to be initiated, if a system or component fails.

Design for commissioning.

36.—(1) The design shall include features as necessary to facilitate the commissioning process for the reactor facility.

(2) The design shall specify commissioning requirements including data to be recorded and retained.

Provision for inspection, testing and maintenance.

37.—(1) The design of the reactor shall include design features to allow for appropriate functional testing and inspection including routine in-service inspection of items important to safety to ensure that systems will perform their safety functions with the required reliability.

(2) Where it is not practicable to provide adequate accessibility of a component for testing, the possibility of its undetected failure shall be taken into account in the safety analysis.

(3) The design, including the layout of the reactor shall be such that these activities are facilitated and can be performed without undue exposure to radiation of the operating personnel.

Design for emergency planning.

38.—(1) The inclusion of specific design features for facilitating emergency planning shall be considered, depending on the potential hazard derived from the reactor, and the need for such design features may be determined by means of analyses of design extension conditions.

(2) The research reactor facility shall be provided with a sufficient number of safe escape routes, clearly and durably marked with reliable emergency lighting, ventilation and other building services essential to their safe use.

(3) Suitable alarm systems and means of communication shall be provided so that all persons present at the reactor facility and on the site can be warned and instructed, in operational states and in accident conditions.

Design for de-commissioning.

39. In the design of the research reactor and its experimental facilities and any modifications of them, consideration shall be given to facilitating its decommissioning.

Design for radiation protection.

40. Provision shall be made in the design for ensuring that doses to operating personnel, reactor users and the public are maintained below the prescribed dose limits and kept as low as reasonably achievable, and that the relevant dose constraints are taken into consideration.

Design for nuclear security.

41.—(1) Provision shall be made in the design for nuclear security consistent with any regulation on physical protection of nuclear material and nuclear facilities made pursuant to the Act.

(2) The interfaces between safety and security and for accounting for, and control of nuclear material for a research reactor facility shall be addressed in an integrated manner throughout the lifetime of the reactor.

(3) Safety measures and security measures shall be established and implemented in such a manner that they do not compromise one another.

Human factors and ergonomic considerations.

42. Systematic consideration of human factors, including the human–machine interface, shall be included at an early stage in the design process for a Research reactor facility, including its experimental facilities, and shall be continued throughout the entire design process.

Provision for utilization and modification.

43.—(1) The design for a research reactor facility shall include provisions for the safe utilization and modification of the research reactor to ensure that the configuration of the reactor is known at all times.

(2) Every proposed modification to an experiment or to the research reactor that may have a major significance for safety shall be designed in accordance with the same principles applied for the Research reactor itself.

Selection and ageing of materials.

44.—(1) The design for a research reactor shall take due account of ageing and wear out effects in all operational states for which a component is credited, including testing, maintenance, operational states during and following a postulated initiating event.

(2) Appropriate margins shall be provided in the design to take account of relevant ageing effects and potential ageing related degradation so as to ensure the capability of all items important to safety to perform their safety functions.

(3) Provisions shall also be made in the design for the necessary monitoring, testing, sampling and inspection for the detection, assessment, prevention and mitigation of ageing effects.

Provision for extended shutdown.

45. In the design of the research reactor facility, consideration shall be given to ensuring the safety of the facility during extended shutdown.

Safety analysis.

46.—(1) A safety analysis of the design for the research reactor shall be conducted in which methods of both deterministic analysis and complementary probabilistic analysis as appropriate shall be applied to enable the challenges to safety in all plant states to be evaluated and assessed.

(2) The safety analysis shall include analyses of the response of the reactor to a range of postulated initiating events, and these analysis shall be used as the basis for the design of items important to safety and the selection of the OLCs for the reactor and emergency planning.

Reactor core and reactivity control system.

47.—(1) Reactor core components and fuel elements and assemblies shall be designed to maintain their structural integrity, and to withstand satisfactorily the conditions in the reactor core in all operational states and in design basis accident conditions and where appropriate design extension conditions.

(2) There shall be provisions in the design to monitor the integrity of the fuel.

(3) Where possible, the design of the reactor core shall make use of inherent safety characteristics to minimize the consequences of transient and accident conditions.

(4) The design of a research reactor shall provide adequate means to control the reactivity.

Reactor shutdown system.

48.—(1) There shall be provided a means for a research reactor to ensure that there is a capability to shut down the reactor in operational states and in accident conditions, and that the shutdown condition can be maintained for a long period of time, with margins, even for the most reactive conditions of the reactor core.

(2) Capability to initiate manual reactor shutdown in all operational states and in accident conditions shall be provided in the design.

Reactor protection system.

49.—(1) A protection system shall be provided for a research reactor to initiate automatic actions to actuate the safety systems necessary for achieving and maintaining a safe state for the full range of postulated initiating events.

(2) The reactor protection system shall be independent of other systems and in addition, a manual reactor trip signal shall be provided as an input to the reactor protection system.

(3) The design of the reactor protection system shall be such that no single failure could result in the loss of automatic protective actions.

(4) All components of the reactor protection system shall be designed to ensure that they can be functionally tested.

(5) Where a computer based system is intended to be used in a reactor protection system, the following requirements shall apply—

(*a*) hardware and software of high quality and best practices shall be used ;

(*b*) the whole development process, including control, testing and commissioning of the design changes, shall be systematically documented and reviewable ; and

(*c*) to confirm the reliability of the computer based systems, an assessment of the computer based systems shall be undertaken by expert personnel who are independent of the designers and the suppliers.

(6) Where the necessary integrity of a computer based system that is intended for use in a reactor protection system cannot be demonstrated with a high level of confidence, diverse means of ensuring fulfilment of the protection functions shall be provided.

Reactor coolant system and related systems.

50.—(1) The reactor coolant system shall be designed and constructed to provide adequate cooling to the reactor core with a satisfactory and established margin.

(2) Systems containing reactor coolant shall be designed to facilitate pre-service and in-service inspection and testing.

(3) Where the primary cooling system is not designed for cooling the core after shutdown, a reliable separate system shall be provided for the removal of residual heat.

(4) For reactor systems that use flappers or equivalent systems for the transition from forced to natural circulation cooling, or for operation with natural circulation cooling, and for which this mode is part of the safety system or is considered an engineered safety feature, the single failure criterion shall be applied.

(5) The instrumentation to verify the functioning of flappers or equivalent systems and to provide signals to the reactor protection system shall be provided.

(6) The reactor coolant system shall be designed and constructed to provide long term, reliable heat transfer from the fuel to the ultimate heat sink.

(7) Where two fluid systems operating at different pressures are interconnected—

(*a*) the systems shall both be designed to withstand the higher pressure ; or

(*b*) provision shall be made to prevent the design pressure of the system operating at the lower pressure from being exceeded, on the assumption that a single failure occurs.

(8) Provision shall be made in the design—

(*a*) to monitor and control the properties of the reactor coolant and the moderator, and to remove radioactive substances from the coolant ; and

(*b*) for controlling the volume, temperature and pressure of the reactor coolant to ensure that specified design limits are not exceeded in any operational state of the facility, with due account taken of volumetric changes and leakage.

Emergency core cooling system.

51. The design of the research reactor shall make provision for emergency core cooling system as may be required, and the accidents to cope with by these systems shall be identified and analyses shall be performed to demonstrate that the systems fulfil the requirements.

Means of confinement.

52.—(1) The means of confinement shall be provided for a research reactor to ensure or contribute to the fulfilment of the following safety functions.

(*a*) confinement of radioactive substances in operational states and in accident conditions ;

(*b*) protection of the reactor against natural external events and human induced events ; and

(*c*) radiation shielding in normal operation states and in accident conditions.

(2) Coverings and coatings for structures and components performing the function of confinement, shall be such as to ensure their safety functions and to minimize interference with other safety functions in the event of their deterioration.

(3) A containment structure for research reactor that have greater potential hazards associated with them shall ensure that in design basis accident conditions, any release of radioactive material would be kept below authorized limits and that, in design extension conditions, such release would be kept below acceptable limits.

Experimental devices.

53.—(1) Experimental devices for a research reactor shall be designed so that they will not adversely affect the safety of the reactor in any operational states or accident conditions.

(2) Pursuant to the provisions of sub-regulation (1) of this regulation, experimental devices shall be designed so that neither its operation nor their failure shall—

(*a*)result in an unacceptable change in reactivity for the reactor ;

(*b*) affect operation of the reactor protection system ;

(*c*) reduce the cooling capacity ;

(*d*) compromise confinement ; or

(*e*) lead to an unacceptable radiation exposure.

(3) Where necessary, for the safety of the reactor and the safety of the experiment, the design shall provide appropriate monitoring of the parameters for experiments in the reactor control room and shall include specific safety features, if necessary, for the reactor systems, for the experimental devices and for any other related facility.

Instrumentation and control.

54.—(1) Instrumentation shall be provided for a research reactor facility for monitoring the values of all the main variables that can affect the performance of the fundamental safety functions, the main process variables that are necessary for its safe and reliable operation, to determine the status of the facility under accident conditions and for making decisions for accident management.

(2) An appropriate and reliable control systems shall be provided at the facility to maintain and limit the relevant process variables within the specified operating ranges.

(3) For computer based digital instrumentation and control systems, verification, validation and testing of software shall be provided.

(4) An audio and visual alarm systems shall be provided for early indication of changes in the operating conditions of the reactor that could affect its safety.

(5) Instrumentation and control systems for items important to safety at a research reactor facility shall be designed for high functional reliability and periodic testability commensurate with the safety functions to be performed.

Radiation protection systems.

55.—(1) Equipment shall be provided at a research reactor facility to ensure that there is adequate radiation monitoring in operational states and accident conditions.

(2) The design of radiation protection systems shall include—

(*a*) stationary dose rate meters for monitoring the local radiation dose rate at places routinely occupied by operating personnel and at other places such as beam tube areas where changes in radiation levels may occur ;

(*b*) stationary dose rate meters to indicate the general radiation levels at appropriate locations in the event of anticipated operational occurrences, DBAs and, as practicable, design extension conditions ;

(*c*) monitors for measuring the activity of radioactive substances in the atmosphere in those areas routinely occupied by personnel and where the levels of airborne activity may be expected to be such as to require protective measures ;

(*d*) stationary equipment and laboratories for determining the concentrations of selected radionuclides in fluid process systems and in gas and liquid samples taken from the research reactor facility or the environment in operational states, DBAs and, as practicable, design extension conditions ;

(*e*) stationary equipment for monitoring effluents prior to or during their discharge to the environment ;

(*f*) devices for measuring radioactive surface contamination ;

(*g*) installations and equipment needed for measuring doses to, and contamination of personnel ; and

(*h*) radiation monitoring at gates and other possible points of exit from the facility for radioactive material being removed from the reactor building without permission or by unnoticed contamination.

(3) Where necessary, arrangements shall be made to assess exposures and other radiological impacts to determine the radiological consequences of the facility in the vicinity.

Fuel handling and storage systems.

56.—(1) The design for a research reactor facility shall include provisions for the safe handling and storage of fresh and irradiated fuel and core components.

(2) The design shall include provisions for safely storing a sufficient number of spent fuel elements and irradiated core components in accordance with the programmes for core management and for removing or replacing fuel elements and core components.

(3) The design shall include provisions to unload the core safely at all times.

(4) Where applicable, the implications of the storage of irradiated fuel over an extended period of time shall be considered in the design.

(5) The handling and storage systems for fresh and irradiated fuel shall be designed to—

(*a*) prevent inadvertent criticality ;

(*b*) permit periodic inspection and testing ;

(*c*) minimize the probability of loss of or damage to the nuclear fuel ;

(*d*) prevent the inadvertent dropping of heavy objects on the nuclear fuel ;

(*e*) permit the storage of suspected or damaged fuel elements ;

(*f*) provide for radiation protection ;

(*g*) provide a means for controlling the chemistry and activity of the storage medium ;

(*h*) prevent unacceptable levels of stress in the fuel elements ; and

(*i*) identify individual fuel elements.

(6) Handling and storage systems for irradiated fuel shall be designed to permit adequate heat removal in operational states and in accident conditions.

Electrical power supply systems.

57.—(1) The design for a research reactor facility shall include reliable normal electrical power supply systems and shall consider reliable emergency electrical power supply systems.

(2) Reliable electrical power supplies for essential functions shall be available in normal operational states and in accident conditions.

(3) The design shall consider the provision of uninterruptible power supplies for those safety systems that require continuous energy supply such as the reactor protection system and radiation monitoring.

(4) In the design basis for emergency power supply, due account shall be taken of the postulated initiating events and the associated safety functions to be performed, to determine the requirements for capability, availability, duration of the required power supply, capacity and continuity.

Radioactive waste systems.

58.—(1) The design of a research reactor facility and its associated experimental facilities shall include provisions to minimize generation of radioactive waste.

(2) Systems shall be provided for treating solid, liquid and gaseous radioactive waste to keep the amounts and concentrations of radioactive releases as low as reasonably achievable and below authorized limits on discharges.

(3) Suitable means such as shielding and decay systems to reduce the exposure of personnel and radioactive releases to the environment shall be considered in the design.

(4) Proper means of measuring discharges to the environment such as sampling and monitoring of discharges of radioactive effluents shall be provided in the design.

(5) Provisions shall be made in the design, for the handling, collection, processing, storage, removal from the site and disposal of radioactive waste and to keep the amounts and concentrations of radioactive releases as low as reasonably achievable and below authorized limits.

(6) Where liquid radioactive waste is to be handled, provision shall be made for the detection of leakage and the recovery of waste.

(7) Systems shall be provided for the handling and storage of solid or concentrated radioactive waste expected to be generated by the facility on the site.

Buildings and structures.

59.—(1) The buildings and structures important to safety of research reactor shall be designed to keep radiation levels and radioactive releases on and off the site as low as reasonably achievable and below authorized limits for all operational states, design basis accidents and as far as practicable for design extension conditions

(2) The buildings and structures important to safety shall be designed for all operational states, DBAs and, as far as practicable, design extension conditions.

(3) The required leak tightness of the reactor building or of other buildings and structures containing radioactive material and the requirements for the ventilation system shall be determined in accordance with the safety analysis of the reactor and its utilization.

Auxiliary systems.

60.—(1) The design of supporting systems and auxiliary systems for a research reactor shall be such as to ensure that the performance of these systems is consistent with the safety significance of the system or component that they serve at the research reactor.

(2) The design shall ensure that failure of any auxiliary system, irrespective of its importance to safety, shall not jeopardize the safety of the reactor.

(3) Adequate measures shall be considered in the design and implemented to prevent the release of radioactive material to the environment.

Specific auxiliary systems.

61.—(1) Fire protection systems for a research reactor facility, including fire detection systems and fire extinguishing systems, fire containment barriers and smoke control systems, shall be provided throughout the research reactor facility, with due account taken of the results of the fire hazard analysis.

(2) The fire protection systems installed at the research reactor facility shall be capable of dealing safely with fire events of the various types that are postulated.

(3) Fire extinguishing systems shall, where appropriate, be capable of automatic actuation.

(4) Fire extinguishing systems shall be designed and located to ensure that their rupture or spurious or inadvertent operation would not impair the capability of items important to safety and would not endanger persons.

(5) Fire detection systems shall be designed to provide prompt information on the location and spread of fires that start in the reactor facility at any time.

(6) Fire detection systems and fire extinguishing systems that are necessary to protect against a possible fire following a postulated initiating event shall be appropriately qualified to resist the effects of the postulated initiating event.

(7) Non-combustible or fire retardant and heat resistant materials shall be used where practicable throughout the facility in locations such as the means of confinement and the control rooms.

Lighting systems for a research reactor facility.

62. The design shall provide for adequate lighting in all operational areas of a research reactor facility for operational states and in accident conditions.

Lifting equipment for a research reactor facility.

63.—(1) Equipment shall be provided for lifting and lowering items important to safety at a research reactor facility, and for lifting and lowering other items in the proximity of items important to safety.

(2) The lifting equipment shall be designed so that—

(*a*) measures are taken to prevent the lifting of excessive loads ;

(*b*) conservative design measures are applied to prevent any unintentional dropping of loads that could affect items important to safety or could cause radiological hazard like spent fuel cask ;

(*c*) the facility layout permits safe movement of the lifting equipment and of items being transported ; and

(*d*) such equipment for use in areas where items important to safety are located is seismically qualified.

Air conditioning systems and ventilation systems for a research reactor facility.

64.—(1) Systems for air conditioning, air heating, air cooling and ventilation for a research reactor facility shall be provided as appropriate in areas at the facility to maintain the required environmental conditions.

(2) Systems shall be provided for the ventilation of buildings at the reactor facility with appropriate capability for the conditioning and cleaning of air to—

(*a*) prevent unacceptable dispersion of airborne radioactive substances within the facility ;

(*b*) reduce the concentration of airborne radioactive substances to levels compatible with the need for access by personnel to the area ;

(*c*) keep the levels of airborne radioactive substances in the reactor facility below authorized limits and as low as reasonably achievable ;

(*d*) ventilate rooms containing inert gases or noxious gases without impairing the capability to control radioactive effluents ; and

(*e*) maintain the required efficiency of the filtration system and to control releases of gaseous radioactive material to the environment and maintain them below the authorized limits on discharges and to keep them as low as reasonably achievable.

Compressed air systems for a research reactor facility.

65. The design basis for any compressed air system at a research reactor facility that serves an item important to safety at the facility shall specify the quality, flow rate and cleanness of the air to be provided.

PART VI—OPERATION

Structure of the operating organization.

66.—(1) The operating organization shall establish an appropriate management structure for the research reactor and shall provide for all necessary infrastructures for the conduct of reactor operations, provided that the organization for reactor operation shall include the reactor manager and the operating personnel.

(2) The operating organization shall clearly establish lines of authority and communications between the reactor manager, operating personnel, safety committee, radiation protection group, maintenance groups, quality assurance personnel and experimenters.

(3) The operating organization shall determine the staff positions that require a licence or certificate and shall provide for adequate training in accordance with the requirements prescribed by the Authority.

(4) The reactor manager, the shift supervisors, reactor operators and individuals performing functions important to safety shall hold a licence issued by the Authority.

(5) The operating organization shall ensure that adequate measures are in place to provide protection against radiological hazards arising from utilization and modification projects for the research reactor.

(6) The number and the qualification of operating personnel required are dependent upon power level, duty cycle and utilization of the reactor.

(7) The operating personnel shall comprise a reactor manager, shift supervisors as required, operators as required, maintenance personnel and radiation protection personnel.

(8) The reactor manager, shift supervisors and reactor operators shall hold a reactor operators license issued by the Authority.

(9) The operating organization for a research reactor facility shall assign direct responsibility and authority for the safe operation of the reactor to the reactor manager.

(10) The number and qualification of operating personnel shall be defined following a graded approach.

Reactor manager.

67.—(1) The reactor manager shall have the overall responsibility for all aspects of operation, training, inspection, periodic testing and maintenance, utilization and modification of the research reactor.

(2) The reactor manager shall—

(*a*) have the direct responsibility and necessary authority for the safe operation of the research reactor ;

(*b*) clearly document the duties, responsibilities, the necessary experience and the training requirements of operating personnel, and their lines of

communication, including the duties, responsibilities and line of communication of other personnel involved in the operation or use of research reactor such as technical support personnel and experimenters ;

(*c*) specify the minimum staffing requirements for the various disciplines required to ensure safe operational states of the research reactor, including—

(*i*) number of personnel and the duties for which they are required to be authorized,

(*ii*) identification of the shift supervisor at all times, and

(*iii*) the availability of the staff required to deal with accident ;

(*d*) be responsible for ensuring that the staff selected for research reactor operation are given the training and retraining necessary for the safe and efficient operation of the research reactor and that this training and retraining is appropriately evaluated, provided that, there is adequate training in the procedures to be followed in both operational states and accident conditions ;

(*e*) ensure the presence of independent radiation protection personnel and training of the operating personnel, including technical support personnel and experimenters in radiation protection ;

(*f*) prepare in advance, detailed programme for the operation and experimental use of research reactor, subject to the verification by the reactor safety committee ;

(*g*) be responsible for, and make arrangements for all the activities associated with core management and fuel handling and the handling of any other fissile material ;

(*h*) periodically review the operation of the research reactor, including experiments and take appropriate corrective actions in regard of any problem identified ; and

(*i*) seek the advice of the safety committee or call upon advisers to review important safety issues arising in the commissioning, operation, inspection, periodic testing, maintenance and modification of the research reactor and experiments.

Operating personnel.

68.—(1) The operating personnel shall operate the facility in accordance with the approved Operational Limits and Conditions (OLCs), provided that every licensed reactor operator shall have authority to shut down the reactor in the interest of safety.

(2) Where there is need to run the reactor on a shift basis, the shift teams shall be headed by authorized shift supervisors, who shall report to the Reactor Manager.

(3) A shift team shall comprise of a shift supervisor, one or more authorized Reactor Operators and adequate number of technical support staff.

(4) The shift supervisor shall head his own shift team and shall be responsible for ensuring that direct operations are performed according to the approved OLCs and operating procedures.

(5) In the event of emergencies and transients, the shift supervisor shall be assisted by the safety engineer who has at least a shift supervisor's qualifications.

Maintenance personnel.

69.—(1) A maintenance group shall be established by the licensee to implement the programmes for inspection, periodic testing and maintenance.

(2) The maintenance group shall be headed by a maintenance manager who shall ensure that facility preventive and corrective maintenance are discharged in compliance with the technical specifications, approved procedures and instructions.

(3) Maintenance, periodic testing and inspections shall be conducted to ensure that systems, structures and components are able to function in accordance with the design intents and with requirements in compliance with the OLCs, provided that, the term "maintenance" under this sub-regulation covers both preventive and corrective actions.

(4) There shall be an approved programme for the maintenance, periodic testing and inspection of the reactor equipment, especially of all items important to safety based on the SAR.

(5) The maintenance, periodic testing and inspection programme shall be reviewed at regular interval to incorporate lessons learned from experience.

(6) All maintenance, periodic testing and inspection of systems or items important to safety shall be performed according to written and approved procedures.

(7) Equipment and items used for maintenance and periodic testing shall be identified and controlled to ensure their proper use.

(8) A system of work permits in accordance with the requirement of the management system shall be used for maintenance, periodic testing and inspection activities.

(9) There shall be a clearly defined procedure of review and approval for the performance of work.

(10) The head of maintenance shall assess the results of maintenance, periodic testing and inspection and the resumption of operation shall be subject to the approval of the reactor manager.

(11) The Authority shall be informed of any non-compliance that is significant to safety.

Radiation protection personnel.

70.—(1) A radiation protection group shall be established to prepare and implement a radiation protection programme and to advise the reactor management and the operating organization on matters relating to radiation protection.

(2) The radiation protection officers shall be assigned to the reactor facility and shall report independently.

Additional support personnel.

71. The operating organization shall make provision for additional technical personnel as may be required

Safety Committees.

72.—(1) One or more reactor advisory groups or safety committees internal to the operating organization but independent from the reactor management shall be established to advise the operating organization on—

(*a*) relevant aspects of the safety of the reactor and the safety of its utilization ; and

(*b*) the safety assessment of design, commissioning and operational issues.

(2) The reactor manager may also constitute advisory committees to advise the reactor management.

(3) The functions, authority, composition and terms of reference of such committees shall be documented and submitted to the Authority.

(4) The list of items required to be reviewed by the safety committee shall be established.

(5) The reactor safety committee shall—

(*a*) give decision on the safety issues submitted by the reactor manager ; and

(*b*) review the adequacy and safety of proposed experiments and modifications and provide the reactor manager with recommendations for action.

(6) The reactor manager shall, irrespective of the decision of the reactor safety committee, have the authority to refuse or delay the performance of an experiment or a modification that he considers not safe and refer such a proposal to his immediate higher authority for additional review.

Training. retraining and qualification.

73.—(1) The operating organization shall ensure that all activities that affect safety are performed by suitably qualified and competent persons.

(2) The operating organization shall clearly define the requirements for qualification and competence to ensure that personnel performing safety related functions are capable of safely performing their duties, provided that certain operating positions may require formal authorization or a licence.

(3) in order to enhance the knowledge and abilities of personnel, regular training and retraining programmes shall be established for the operating personnel,

including the reactor manager, the shift supervisors, reactor operators, the radiation protection staff, maintenance personnel, quality assurance personnel and others working at research reactor facility.

(4) The training programme shall—

(*a*) include provision for periodic confirmation of the competence of personnel and for refresher training on a regular basis ;

(*b*) in case of refresher training, it shall include retraining provision for personnel who have had extended absence from their authorized duties ; and

(*c*) emphasize the importance of safety in all aspects of reactor operation and promote safety culture.

(5) Procedures shall be put in place for the validation of the training to verify its effectiveness and the qualification of the staff, and training register shall be maintained.

Operational Limits and Conditions (OLCs).

74.—(1) The OLCs shall be developed for ensuring that the reactor is being operated in accordance with the design assumptions and intent, and in accordance with its licence conditions.

(2) The OLCs shall form an important part of the basis for the authorization of the operating organization to operate the research reactor facility.

(3) The facility shall be operated within the operational limits and conditions to prevent situations that could lead to anticipated operational occurrences or accident conditions, and to mitigate the consequences of such events if they do occur.

(4) The OLCs shall be used to provide the framework for the safe operation of the research reactor and shall be prepared for each stage in the lifetime of the reactor, provided that, the operating staff shall adhere to the OLCs throughout the lifetime of the reactor.

(5) The OLCs shall reflect the provisions made in the final design as described in the SAR.

(6) The set of OLCs important to reactor safety, including safety limits, safety systems settings, limiting conditions for safe operation, requirements for surveillance, testing and maintenance and administrative requirements shall be established and submitted to the Authority for review and assessment and approval before the commencement of operation.

(7) The OLCs shall be adequately selected, clearly established and appropriately substantiated by clearly stating the objective of each OLC, its applicability and specification.

(8) The selection of and the values for the OLCs shall be based on the SAR, on the reactor design or on aspects relating to the conduct of operations,

and shall be demonstrably consistent with the SAR, which reflects the present status of the reactor, provided that, in the case of research reactor on extended shutdown, OLCs shall be modified as appropriate.

Safety limits.

75.—(1) Safety limits shall be set to protect the integrity of the physical barriers that protect against the uncontrolled release of radioactive material.

(2) Safety limits shall be established by means of a conservative approach that ensures that all the uncertainties of the safety analyses are taken into account.

Safety system settings.

76.—(1) Safety system settings shall be defined so that the safety limits are not exceeded.

(2) Safety system settings shall be established for all operational states of the reactor, provided that, in determining a safety system setting, the process uncertainties and measurement uncertainties, response of instrumentation and uncertainties in calculations shall be taken into account.

Limiting conditions for safe operation.

77.—(1) Limiting conditions for safe operation shall be established to ensure that there are acceptable margins between normal operating values and the safety system settings.

(2) Limiting conditions for safe operations shall include limits on operating parameters, requirements relating to minimum operable equipment and minimal staffing levels, and prescribed actions to be taken by operating personnel to preserve the settings of the safety system.

Requirements for maintenance, periodic testing and inspection.

78.—(1) Requirements shall be established for the frequency and scope of inspection, periodic testing and maintenance, operability checks and calibrations of all items important to safety to ensure compliance with safety system settings and limiting conditions for safe operation.

(2) The requirements for maintenance, surveillance, periodic testing and inspection shall include a specification that clearly states the applicability, the frequency of performance and the acceptable deviation, provided that, in order to provide operational flexibility, the specification concerning frequency shall state the average intervals with a maximum that is not to be exceeded.

(3) Following maintenance or repair, equipment shall be inspected and, where necessary, recalibrated, tested and shown to be adequate for its purpose.

Administrative requirements.

79.—(1) The OLCs shall include administrative requirements or controls concerning organizational structure and the responsibilities for key positions in the safe operation of the reactor, staffing, the training and retraining of facility personnel, review and audit procedures, modifications, experiments, records and reports, and required actions following a violation of an OLC.

(2) The OLCs shall include safety related procedures, which shall be reviewed by the safety committee and shall be subject to approval by the Authority.

(3) The OLCs and SAR shall, where necessary, be reviewed and amended, on the basis of the result of commissioning tests and the justification of each of the OLCs shall be substantiated by means of a written indication of the reason for its adoption and any relevant background information.

(4) Any operation on the handling of the reactor core components shall be carried out during working hour.

Experiments and utilization.

80.—(1) Requirements for the safe utilization of experimental devices and requirements for deciding which devices and experiments are to be referred to the Authority shall be included in the OLCs.

(2) OLCs and limiting conditions for safe operations shall be prepared for the device and incorporated as appropriate into the OLCs of the research reactor.

Deviations from operational limits and conditions.

81.—(1) In the event that the operation of the reactor deviates from one or more OLCs, corrective actions shall be taken and the Authority shall be notified.

(2) Actions shall be prescribed to be taken by the operating staff within an allowed time if a limiting condition for safe operation is violated.

(3) The reactor management shall conduct an investigation on the cause and consequences of such violation and shall take appropriate actions to prevent a recurrence, provided that the report of the investigation shall be submitted to the Authority.

(4) If a safety limits is exceeded, the reactor shall be shut down and maintained in a safe condition and inspections of challenged items important to safety shall be performed.

(5) Pursuant to the circumstances referred to in sub-regulation (4) of this regulation, the Authority shall be promptly notified, an investigation of the cause shall be carried out by the operating organization and a report shall be submitted to the Authority for assessment before the reactor is returned to operation.

Periodic safety review for research reactors - objective.

82.—(1) The operating organization shall have the prime responsibility for performing the periodic safety review which shall be submitted to the Authority.

(2) In order to apply the principles for the verification of safety, the operating organization shall carry out comprehensive periodic reviews of operational issues and safety related activities.

(3) On the basis of the results of the periodic safety review, the operating organization shall implement any necessary corrective actions and shall consider making justified modifications to enhance safety.

(4) The operating organization shall report to the Authority as required, in a timely manner, the confirmed findings of the periodic safety review that have implications for safety.

(5) The review shall be made periodically, at least every ten years depending on the size of the facility.

(6) The scope of the review shall be clearly defined and justified.

(7) The review shall use an up to date systematic and documented methodology.

PART VII—COMMISSIONING AND USE OF RESEARCH REACTOR

Commissioning programme.

83.—(1) The operating organization for a research reactor facility shall ensure that a commissioning programme for the research reactor is established and implemented.

(2) An adequate commissioning programme shall be prepared for the testing of reactor components and systems after their construction or modification to demonstrate that they are in accordance with the design objective and meet the performance criteria, and the commissioning programme shall cover the full range of facility conditions required in the design.

(3) The commissioning programme shall establish the organization and responsibilities for commissioning, commissioning stages, suitable testing of SSCs on the basis of their importance to safety, test schedule, commissioning procedures and reports, methods of review and verification, treatment of deficiencies and deviations, and requirements for documentation.

(4) Experimental devices shall be given adequate consideration during the commissioning of the reactor.

(5) The detailed commissioning programme shall be submitted to the safety committee and the Authority and shall be subjected to an appropriate review and assessment before being implemented.

Commissioning tests and stages.

84.—(1) Commissioning tests shall be arranged in functional groups and in a logical sequence, provided that this sequence includes pre-operational tests, initial criticality tests, low power tests and power ascension and power tests.

(2) A test sequence shall not proceed unless the required previous steps have been successfully completed.

(3) The commissioning programme shall be divided into stages which shall be arranged according to the following sequences—

(*a*) stage A - tests prior to fuel loading ;

(*b*) stage B - fuel loading tests, initial criticality tests and low power tests ; and

(*c*) stage C - power ascension tests and power tests.

Commissioning procedures and reports.

85.—(1) Procedures shall be prepared, reviewed and approved for each commissioning test prior to the commencement of the tests.

(2) Commissioning activities shall be performed in accordance with approved written procedures and where necessary, the procedures shall include hold points for the notification and involvement of the safety committee, outside agencies, manufacturers and the Authority.

(3) The commissioning programme shall include provisions and procedures for audits, reviews and verifications intended to ensure that the programme has been conducted as planned and that its objectives have been fully achieved, provided that, provisions shall be included for resolving any deviation or deficiency that is discovered during the commissioning tests.

(4) Commissioning procedures covering the scope, sequence and expected results of these tests shall be prepared in appropriate detail and in accordance with the quality assurance requirements.

(5) A commissioning report including the results of all commissioning tests shall be maintained throughout the lifetime of the facility.

Operating procedures.

86.—(1) A comprehensive operating procedures for the research reactor and its associated facilities shall be developed for normal operation, anticipated operational occurrences and accident conditions, in accordance with the policy of the operating organization and the requirements of the Authority.

(2) An operating procedures shall be developed for all safety related operations that may be conducted over the entire lifetime of the facility by the operating organization including—

(*a*) commissioning ;

(*b*) operation in normal operational states ;

(*c*) the maintenance of major components or systems that could affect reactor safety ;

(*d*) periodic inspections, calibrations and tests of SSCs that are essential for the safe operation of the reactor ;

(*e*) radiation protection activities ;

(*f*) the review and approval process for operation and maintenance and the conduct of irradiations and experiments that could affect reactor safety or the reactivity of the core ;

(*g*) the reactor operator's response to anticipated operational occurrences and DBAs and, to the extent feasible, to design extension conditions ;

(*h*) emergencies ;

(*i*) handling of radioactive waste and monitoring and control of radioactive releases ;

(*j*) utilization ;

(*k*) modifications ; and

(*l*) integrated management system.

(3) An operating procedures shall be consistent with and useful in the observance of the OLCs.

(4) The operating procedures shall be reviewed and updated periodically on the basis of the lessons learned in using the procedure or, if the need arises, in accordance with predetermined internal procedures, provided that these procedures shall be available as relevant for the particular operation of the reactor.

(5) All personnel involved in the operation and use of the reactor shall be adequately trained in the use of these procedures according to their assigned duties.

(6) When activities that are not covered by existing procedures are planned, an appropriate procedure shall be prepared and reviewed and shall be subject to appropriate approval before the commencement of the operation, and additional training of relevant staff in these procedures shall be provided.

Inspection, periodic testing and maintenance.

87.—(1) The operating organization for a research reactor facility shall ensure that effective programme for inspection, periodic testing and maintenance are established and implemented.

(2) Inspection, periodic testing and maintenance shall be conducted to ensure that SSCs are able to function in accordance with the design intent and requirements, in compliance with the OLCs and in accordance with the long term safety of the reactor.

(3) The inspection, periodic testing and maintenance programmes shall be reviewed at regular intervals to incorporate lessons learned from experience.

(4) All maintenance, periodic testing and inspection of systems or items important to safety shall be performed by following approved written procedures, and the procedures shall specify the measures to be taken for any changes from the normal reactor configuration which shall include provisions for the restoration of the normal configuration on the completion of the activity.

(5) The operating organization shall establish a system of work permit in accordance with the integrated management system requirements for inspection, periodic testing and maintenance, including appropriate procedures for checking off before and after the conduct of the work, with a clearly defined structure of review and approval for the performance of the work, and the procedures shall include acceptance criteria.

(6) Non-routine inspections or corrective maintenance of systems or items important to safety shall be performed in accordance with a specially prepared plan and procedures and an in-service inspection conducted for safety purposes and on a programmatic basis shall be performed in a similar manner.

(7) Equipment and items used for periodic testing and maintenance shall be identified and controlled to ensure their proper use.

(8) Maintenance shall not be performed in such a way as to result in either deliberate or unintentional design changes to the system being maintained and where a maintenance activity requires a design change, procedures for the implementation of a modification shall be followed.

(9) The results of inspection, periodic testing and maintenance shall be assessed by properly qualified personnel, who shall verify that the activities have been accomplished as specified in the appropriate procedure and shall verify compliance with the OLCs.

(10) The safety committee and Authority shall be informed of any non-compliance that is significant to safety, and the resumption of operation shall be subject to internal review system based on the integrated management system.

Core management and fuel handling.

88.—(1) Core management and fuel handling procedures for a research reactor facility shall be established to ensure compliance with OLCs and consistency with the utilization programme.

(2) Core management activities shall ensure safe operational cores.

(3) Core management and fuel handling shall be part of the integrated management system for a research reactor and shall be put into effect by the operating organization early in the research reactor project and the operational aspects of core management and the fuel handling activities at the reactor site shall be the direct responsibility of the reactor manager.

(4) The operating organization shall develop a fuel handling programme which shall include receipt, transfer, inspection and storage, in line with administratively controlled procedures and engineering practices design.

(5) A programme for refueling shall be implemented by means of approved procedures which specify in details the sequence of the operations to be carried out.

(6) OLCs shall be established and procedures shall be prepared for dealing with failures of fuel elements and control rods so as to minimize the amounts of radioactive products released.

(7) Where a failure of fuel is detected, the reactor shall be shut down and the failed fuel shall be identified, unloaded from the core and isolated, and the failed fuel shall be stored in a manner that prevents release of radioactive material.

(8) Procurement of new fuel assemblies shall be in conformance with the integrated management system.

(9) The packaging and transport of fuel assemblies with fresh and irradiated fuel shall be carried out in accordance with national and international requirements.

(10) Adequate storage shall be available on-site for the storage of irradiated fuel and approved procedures shall be used to ensure that the irradiated fuel assemblies are stored only in configurations that have been assessed and approved.

(11) A comprehensive record system shall be maintained in compliance with the management system to cover core management, handling and storage of fuel and core components, and the record system shall be kept throughout the life time of a Research reactor.

Fire safety.

89.—(1) The operating organization for a research reactor facility shall make arrangements for ensuring fire safety.

(2) The reactor shall have a chief fire officer who has received training relative to his position and under whose authority the rest of the trained fire protection organization operates.

(3) The arrangements for ensuring fire safety made by the operating organization shall include—

(*a*) adequate management for fire safety ;

(*b*) preventing fire outbreak ;

(*c*) detecting and quickly extinguishing any fire toutbreak ;

(*d*) providing protection from fire for structures, systems and components that are necessary to shut down the reactor safely ; and

(*e*) preventing the spread of those fires that have not been extinguished.

(4) In the arrangements for fire-fighting, special attention shall be given to cases for which there is risk of release of radioactive material in a fire.

(5) A comprehensive fire hazard analysis shall be developed for the research reactor and associated facilities and shall be periodically reviewed and updated.

Emergency planning.

90.—(1) The operating organization for a research reactor facility shall prepare emergency arrangements for preparedness for, and response to, a nuclear or radiological emergency.

(2) The emergency arrangements shall be commensurate with the hazards assessed and the potential consequences of an emergency should it occur.

(3) Emergency arrangements shall cover the capability of maintaining protection and safety in the event of an emergency, mitigating the consequences of accidents if they do occur; protection of site personnel, the public and the environment, and communicating with the public in a timely manner.

(4) The operating organization shall develop emergency arrangements that include emergency plans and procedures for on-site preparedness and response to an emergency in relation to the research reactor under its responsibility and shall demonstrate to, and provide, the Authority with an assurance that emergency arrangements provide for an effective response on the site.

(5) The on-site emergency arrangements shall be coordinated with those of off-site response organizations with responsibilities in emergency preparedness and response, as relevant.

(6) The emergency plan and procedures shall be reviewed at specified periods and shall be amended as necessary to ensure that lessons learned are incorporated.

(7) All personnel involved in responding to an emergency in relation to the research reactor shall be qualified, trained and retrained periodically according to their assigned duties and shall be fit for the intended duty.

(8) The emergency response shall include persons with up to date knowledge of the operations of the research reactor and all persons on the site shall receive instructions on the steps to take in an emergency, including a prominently display of instructions.

(9) Exercises shall be conducted at least once in a year and shall involve, to the extent practicable, all those persons with duties in responding to the emergency, provided that the results of the exercise shall be reviewed and, where necessary, the lessons learned shall be incorporated into revisions of the emergency plan.

(10) Facilities, instruments, tools, equipment, documentation and communication systems to be used in emergencies shall be kept available and maintained in such conditions that is unlikely that they would be affected or made unavailable by the accidents postulated to happen and these capabilities shall be tested periodically.

Physical protection.

91. Appropriate measures shall be taken by the operating organization in accordance with national laws and regulations to prevent unauthorized actions including acts of sabotage, unauthorized access that could jeopardize safety of research reactor and their associated facilities and respond to such actions should they occur.

Utilization and modification of the research reactor.

92.—(1) The operating organization for a research reactor facility shall establish and implement a programme to manage utilizations and modifications of the reactor.

(2) The operating organization shall be responsible for ensuring the following—

(*a*) safety analyses of the proposed utilization or modification are conducted to ascertain whether all applicable safety requirements and provisions have been satisfied ;

(*b*) the relevant safety documentation for the experiment or modification are prepared and submitted to the Authority for approval ;

(*c*) the disposition path of any materials irradiated in the experiment is defined and approved ;

(*d*) all personnel who will be involved in making a proposed modification or in conducting the proposed utilization are suitably trained, qualified and experienced for the task ; and

(*e*) all documents affected by the experiment or modification that relate to the safety characteristics of the reactor, such as the safety analysis reports, the operational limits and conditions and the relevant procedures for operation, maintenance and emergencies, are updated as necessary, prior to the new utilization or to the commissioning of the modification.

(3) All utilization and modification projects shall be subjected to a screening process in order to determine their safety implication and the related safety category of the experiment or modification, and the screening process shall be documented and selection of the safety category shall be justified.

(4) The operating organization shall be responsible for all safety aspects of the preparation and performance of a modification or experiment.

(5) Utilization and modification projects having major safety significance shall be subject to safety analyses and procedures for design, construction and commissioning that are equivalent to those for the reactor itself.

(6) In implementing utilization and modification projects for research reactor, the radiation exposure of the workers and other personnel at the facility shall be kept as low as reasonably achievable.

(7) The reactor manager shall establish a procedure in accordance with accepted engineering practice, for the review and approval of proposals for experiments and modifications and for the control of their performance.

(8) Temporary modifications shall be limited in time and number to minimize the cumulative safety significance.

(9) The use and handling of experimental devices shall be controlled by means of written procedures, and the possible effects on the reactor, particularly changes in reactivity, shall be taken into account in these procedures.

(10) Any modifications made to experimental devices shall be subject to the same procedures for design, operation and approval as were followed for the original experimental device.

Ageing management for a research reactor.

93.—(1) The operating organization for a research reactor facility shall ensure that an effective ageing management programme is implemented to manage the ageing of items important to safety so that the required safety functions of SSCs are fulfilled over the entire operating lifetime of the research reactor.

(2) The ageing management programme shall be coordinated with, and be consistent with other relevant programmes, including the programme for in-service inspections, periodic safety review and maintenance.

(3) A systematic approach shall be taken to provide for the development, implementation and continuous improvement of ageing management programmes.

(4) For a new research reactor project, ageing management shall be established earlier on in the design stage and the system shall cover all items, services and processes important to safety including a means of establishing control over ageing management activities.

(5) The operating organization shall plan and perform ageing management activities, and their results recorded, in accordance with approved procedures and instructions which shall be included in the documentation for ageing management.

(6) The operating organization shall provide adequate resources to implement an ageing management programme.

Radiation protection programme.

94.—(1) The operating organization shall develop and implement an operational radiation protection programme.

(2) The radiation protection programme shall be subject to the requirements of the Nigerian Basic Ionizing Radiation Regulations, 2003 and shall be approved by the Authority.

Radiation protection personnel.

95.—(1) The radiation protection programme shall include the appointment of qualified personnel with responsibility for radiation protection, knowledgeable about the radiological aspects of the design and operation of the reactor.

(2) The persons appointed pursuant to sub-regulation (1) of this regulation shall work in cooperation with the group that operates the reactor, but they shall have reporting lines to the operating organization that are independent of the reactor management.

(3) A qualified expert shall be identified and shall be available to the reactor manager for the purpose of advising on the observance of the radiation protection programme and its compliance with the requirements established in the Nigerian Basic Ionizing Radiation Regulations, 2003 and shall have access to the managers in the operating organization who have the authority to establish and enforce operational procedures.

(4) All personnel at the facility shall be individually responsible for putting into practice the measures for exposure control in their areas of activity that are specified in the radiation protection programme and particular emphasis shall be given to training all the facility's personnel to ensure that they are fully aware of both the radiological hazards and the protective measures available.

(5) Special attention shall be paid to the possibility that the personnel at the research reactor facility may include persons not permanently working there such as experimenters, trainees, visitors and contractors.

Reference levels.

96.—(1) The operating organization shall set reference levels for doses and dose rates and reference levels for radioactive releases that are below the authorized limits on releases, and where the reference levels are exceeded, the

operating organization shall investigate the matter for the purpose of taking corrective action.

(2) The Authority shall be informed in accordance with the requirements if the applicable dose limits for occupational or public exposure or the authorized limits for radioactive releases are exceeded.

Control of occupational exposure.

97. All personnel who may be occupationally exposed to radiation at significant levels shall have their doses measured, recorded and assessed as required by the Authority and the records shall be made available to the reactor manager and the Authority.

Radioactive waste management.

98.—(1) The operating organization for a research reactor facility shall establish and implement a programme for the management of radioactive waste.

(2) The reactor and its experimental devices shall be operated to minimize the production of radioactive waste of all kinds, to ensure that releases of radioactive material to the environment are kept as low as reasonably achievable and to facilitate the handling and disposal of waste.

(3) Arrangements shall be put in place for the management of solid, liquid and gaseous radioactive waste in the research reactor facility and its ultimate removal from the facility and all activities concerning radioactive effluents and waste shall be conducted in accordance with the integrated management system.

(4) Releases of radioactive effluents shall be monitored and the results recorded in order to verify compliance with the applicable regulatory requirements and reported periodically to the Authority.

(5) Written procedures shall be followed for the handling, collection, processing, storage and disposal of radioactive waste and these activities shall be carried out in accordance with the requirements of the Authority as provided for in the Radioactive Waste Management Regulations.

(6) An appropriate record of the quantities, types and characteristics of the radioactive waste stored and disposed of or removed from the reactor site shall be kept.

Extended shutdown.

99.—(1) Where an extended shutdown is planned or occurs, the operating organization for a research reactor facility shall establish and implement arrangements to ensure safe management, planning, effective performance and control of work activities during extended shutdown.

(2) The operating organization shall take appropriate measures during an extended shutdown to ensure that materials and components do not seriously degrade.

(3) The operating organization shall be responsible for issuing programmes and procedures to manage extended shutdown and for the provision of adequate resources for ensuring safety during extended shut down operations.

(4) The operating organization shall take the necessary decisions as soon as possible to reduce the period of extended shutdown to a minimum.

(5) During a period of extended shutdown, the operating organization shall ensure continued compliance with the licence conditions such as for the physical protection of the fuel, emergency planning and for the qualification of the operating staff.

(6) The operating organization shall ensure that necessary tests are carried out before putting back the reactor to operation after the period of shut down and the results of these tests meet relevant pre-determined conditions.

(7) The operating organization shall not put the reactor into operation after a shutdown until it has made available to the Authority the results of such tests carried out and relevant authorization obtained from the Authority.

Feedback of operating experience for a research reactor facility.

100. The operating organization for a research reactor facility shall establish a programme to learn from events at the reactor facility and events in other research reactor and from the nuclear industry

PART VIII—DECOMMISSIONING

De-commissioning process.

101.—(1) A decommissioning plan shall be prepared and kept up to date during the lifetime of the research reactor.

(2) The decommissioning plan shall be submitted for review by the safety committee and approval by the Authority at the stage of conception and initial authorization of the research reactor.

(3) Prior to decommissioning, the operating organization shall prepare a detailed plan to ensure safety throughout decommissioning activities.

(4) All operational activities at the research reactor including inspection, periodic testing and maintenance, modification and experiments, shall be conducted in a way that will facilitate their decommissioning, and the documentation of the reactor shall be kept up to date.

(5) The operating organization shall be responsible for financial provisions for decommissioning including establishing a mechanism to provide and ensure adequate financial resources for safe and timely decommissioning, provided that this assurance shall be provided before authorization to operate the facility.

(6) In the operational stage of the research reactor, the operating organization shall become familiar with decommissioning projects at similar research reactor to facilitate the assessment of the complexity and costs of the ultimate decommissioning of its own research reactor.

(7) The decommissioning plan shall include an evaluation of one or more approaches to decommissioning that are appropriate for the reactor concerned and are in compliance with the requirements of the Authority.

(8) The decommissioning plan shall include all the steps that lead to the ultimate completion of decommissioning and an operating organization shall periodically review the decommissioning plan throughout the operating life of the research reactor based on change in technology and utilization.

(9) Full details shall be retained of the design requirements and of information relating to the site and its final design and construction, such as the 'baseline' radiological characterization, as-built drawings relating to the facility's layout, piping and cable penetrations, as necessary information for decommissioning.

(10) All aspects of the facility's operation that are important in relation to decommissioning shall be reviewed including any unintentional contamination whose clean-up has been deferred until the reactor's decommissioning, and any modifications that may not have been fully documented.

(11) In developing the decommissioning plan, occurrences at the reactor over any period of extended shutdown period shall be taken into consideration.

(12) All activities conducted during the decommissioning process shall be subject to the integrated management system.

(13) Procedures for handling, dismantling and disposal of experimental devices and other irradiated equipment that require storage and eventual disposal shall be established in advance, or as early as possible if the equipment concerned has already been constructed and these procedures are not in place.

(14) The responsibility of the operating organization shall be terminated at the end of decommissioning of the facility only with the approval of the Authority.

PART IX—OFFENCES AND PENALTIES

Offences and penalties.

102.—(1) A person who contravenes any of the provisions of these Regulations commits an offence and is liable on conviction to the penalties stipulated under the Act and any other extant law or guidelines made pursuant to the Act.

(2) Notwithstanding the provisions of sub-regulation (1) of this regulation, the Authority may impose penalties such as administrative fine, suspension, revocation of authorization, sealing of facility or any combination of these.

PART X—MISCELLANEOUS

Interpretation.

103. In these Regulations—

"*acceptable limit*" means a limit acceptable to the Authority ;

"*accident conditions*" means deviations from normal operation more severe than anticipated operational occurrences, including design basis accidents and severe accidents ;

"*Act*" means Nuclear Safety and Radiation Protection Act No.19 of 1995;

"*activities*" include the production, use, import and export of radiation sources for industrial, research and medical purposes, the transport of radioactive materials, the mining and processing of radioactive ores and closeout of associated facilities, clean-up of sites affected by residues from past activities and radioactive waste management activities such as the discharge of effluents ;

"*anticipated operational occurrence*" means an operational process deviating from normal operation which is expected to occur at least once during the operating lifetime of a facility but which, in view of appropriate design provisions, does not cause any significant damage to items important to safety or lead to accident conditions ;

"*applicant*" means a legal person who applies to the Authority for authorization to undertake specified activities ;

"*audit*" means activities carried out to determine that requirements are met and that processes are adequate and effective, and to encourage managers to implement improvements, including safety improvements ;

"*Authority*" means Nigerian Nuclear Regulatory Authority (NNRA) established under section 1 of the Nuclear Safety and Radiation Protection Act 19 of 1995 ;

"*authorization*" means the granting by the Authority of written permission for an operator to perform specified activities which may include licensing, certification, registration, and any activities ;

"*authorized limit*" means a limit on a measurable quantity established or formally accepted by the Authority ;

"*commissioning*" means the process during which systems and components of facilities and activities having been constructed, are made operational and verified to be in accordance with the design and to have met the required performance criteria ;

"*common cause failure*" means failure of two or more structures, systems or components due to a single specific event or cause ;

"*confinement*" means prevention or control of releases of radioactive material to the environment in operation or in accidents ;

"*containment*" means methods or physical structures designed to prevent or control the release and dispersion of radioactive substances ;

"*controlled area*" means a defined area in which specific protection measures and safety provisions are or could be required for controlling normal exposures or preventing the spread of contamination during normal working conditions, and preventing or limiting the extent of potential exposures ;

"*critical Assembly*" means an assembly containing fissile material intended to sustain a controlled fission chain reaction at a low power level, used to investigate reactor core geometry and composition ;

"*critical group*" means a group of members of the public which is reasonably homogeneous with respect to its exposure for a given radiation source and is

typical of individuals receiving the highest effective dose or equivalent dose from the given source ;

"*decommissioning*" means all administrative and technical steps other than disposal facility, taken to allow the removal of some or all of the regulatory controls from a facility ;

"*design basis*" means the range of conditions and events taken explicitly into account in the design of a facility, according to established criteria, such that the facility can withstand them without exceeding authorized limits by the planned operation of safety systems;

"*Design Basis Accident (DBA)*" means accident conditions against which a nuclear facility is designed according to established design criteria, and for which the damage to the fuel and the release of radioactive material are kept within authorized limits ;

"*design extension conditions*" means postulated accident conditions that are not considered for design basis accidents, but that are considered in the design process of the facility in accordance with best estimate methodology, and for which releases of radioactive material are kept within acceptable limits ;

"*disposal*" means emplacement of waste in an appropriate facility without the intention of retrieval ;

"*diversity*" means the presence of two or more redundant systems or components to perform an identified function, where the different systems or components have different attributes so as to reduce the possibility of common cause failure ;

"*dose limit*" means the value of the effective dose or the equivalent dose to individuals from controlled practices that shall not be exceeded ;

"*engineered safety features*" means safety systems that are provided mainly to limit or to mitigate the consequences of anticipated operational occurrences and DBAs ;

"*events*" means any occurrence unintended by the operator, including operating error, equipment failure or other mishap, and deliberate action on the part of others, the consequences or potential consequences of which are not negligible from the point of view of protection or safety ;

"*extended shutdown*" means the state in which the reactor has been shut down and for which there are no approved plans and no committed resources in place to resume operation or enter decommissioning ;

"*facilities*" means facilities including nuclear facilities, irradiation installations, mining and milling facilities, waste management facilities and any other place where radioactive materials are produced, processed, used, handled, stored or disposed of or where radiation generators are installed on such a scale that consideration of protection and safety is required ;

"*failure*" means inability of a structure, system or component to function within acceptance criteria ;

"*flapper*" means a passive valve that opens when the flow (pressure) is below a set value to allow for a creation of natural circulation in the event of loss of forced flow ;

"*fuel assembly*" means a set of fuel elements and associated components which are loaded into and subsequently removed from a reactor core as a single unit ;

"*fuel element*" means a rod or other form of nuclear fuel, its cladding and any associated components necessary to form a structural entity ;

"*fuel handling*" means the movement, storage, transfer, packaging and transport of fresh and irradiated fuel ;

"*graded approach*" means a process or method in which the stringency of the control measures and conditions to be applied is commensurate, to the extent practicable, with the likelihood and possible consequences of, and the level of risk associated with, a loss of control for a system of control, such as a regulatory system or a safety system ;

"*IAEA*" means International Atomic Energy Agency ;

"*in-service inspection*" means inspection of structures, systems and components undertaken over the operating lifetime by or on behalf of the operating organization for the purpose of identifying age related degradation or conditions that, if not addressed, might lead to the failure of structures, systems or components ;

"*integrated management system*" means a single coherent management system in which all constituents of an organization are integrated to enable the organization's objectives to be achieved ;

"*investigation level*" means the value of a quantity such as effective dose, intake, or contamination per unit area or volume at or above which an investigation shall be conducted ;

"*licence*" means a legal document issued by the Authority granting authorization to perform specified activities related to a facility or activity ;

"*licensee*" means the holder of a current licence ;

"*limit*" means the value of a quantity used in certain specified activities or circumstances shall not be exceeded ;

"*maintenance*" means the organized activity, both administrative and technical, of keeping structures, systems and components in good operating condition, including both preventive and corrective aspects ;

"*modification*" means the alteration of a system, component or structure in such a way that it no longer meets all the requirements set for earlier designs ;

"*monitoring*" means continuous or periodic measurement of radiological or other parameters or determination of the status of a system, and sampling may be involved as a preliminary step to measurement ;

"*normal operation*" means operation within specified operational limits and conditions ;

"*nuclear safety*" means the achievement of proper operating conditions, prevention of accidents or mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation hazards ;

"*nuclear security*" means the prevention and detection of, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities ;

"*Operational Limits and Conditions* (*OLCs*)" means a set of rules setting forth parameter limits, the functional capability and the performance levels of equipment and personnel approved by the Authority for safe operation of an authorized facility ;

"*operating organization*" means the organization authorized by the regulatory authority to operate a facility ;

"*operational states* (or *operating conditions*)" means states defined under normal operation and anticipated operational occurrences ;

"*operations area*" means a geographical area that contains an authorized facility, and enclosed by a physical barrier to prevent unauthorized access and by means of which the management of the authorized facility can exercise direct authority ;

"*peer reviews*" means a review conducted by a team of independent experts with technical competence and experience in the areas of evaluation ;

"*periodic testing*" means inspections, operability checks and calibrations carried out on parameter values, structures, systems and components to verify compliance with operational limits and conditions and to ensure adequacy of the safety status of the reactor ;

"*Postulated Initiating Event* (PIE)" means an event identified during design as capable of leading to anticipated operational occurrences or accident conditions ;

"*preventive maintenance*" means actions that detect, preclude or mitigate degradation of a functional structure, system or component to sustain or extend its useful life by controlling degradation and failures to an acceptable level ;

"*protection* (or *radiation protection*)" means the protection of people from the effects of exposure to ionizing radiation, and the means for achieving this ;

"*protection system*" means a system which monitors the operation of a reactor and which, on sensing an abnormal condition, automatically initiates actions to prevent an unsafe or potentially unsafe condition, and the 'system' in this case encompasses all electrical and mechanical devices and circuitry, from sensors to actuation device input terminals ;

"*protective action*" means an intervention intended to avoid or reduce doses to members of the public in emergencies or situations of chronic exposure ;

"*qualified expert*" means an individual who, by virtue of certification by appropriate boards or societies, professional licences or academic qualifications and experience, is duly recognized as having expertise in a relevant field of specialization ;

"*quality assurance*" means planned and systematic actions necessary to provide adequate confidence that an item, process or service will satisfy given requirements for quality, for example, those specified in the licence ;

"*recording level*" means a level of dose, exposure or intake specified by the Authority at or above which values of dose, exposure or intake received by workers are to be entered in their individual exposure records ;

"*redundancy*" means provision of alternative identical or diverse structures, systems or components, so that anyone can perform the required function regardless of the state of operation or failure of any other ;

"*reference level*" means an action level, intervention level, investigation level or recording level ;

"*repair*" means action on a non-conforming product to make it acceptable for its intended use ;

"*repetitive experiment*" means an experiment that had been approved earlier and has only minor changes compared with the original design that would not affect the originally performed safety analyses ;

"*research reactor*" means a nuclear reactor used mainly for the generation and utilization of neutron flux and ionizing radiation for research and other purposes, including experimental facilities associated with the reactor and storage, handling and treatment facilities for radioactive materials on the same site that are directly related to safe operation of the research reactor, including the facilities commonly known as critical assemblies ;

"*Safety Analysis Report* (SAR)" means a document provided by the applicant to the Authority containing information concerning the facility, its design, safety analysis and provisions to minimize the risk to the public, the operating personnel and the environment ;

"*safety actuation system*" means the collection of equipment required to accomplish the necessary safety actions when initiated by the protection system ;

"*safety culture*" means the assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance ;

"*safety function*" means a specific purpose that shall be accomplished for safety ;

"*safety group*" means the assembly of equipment designated to perform all actions required for a particular postulated initiating event to ensure that the limits specified in the design basis for anticipated operational occurrences and design basis accidents are not exceeded ;

"*safety limits*" means limits on operational parameters within which an authorized facility has been shown to be safe, and safety limits are operational limits and conditions beyond those for normal operation ;

"*safety related item*" means an item important to safety which is not part of a safety system ;

"*safety system*" means a system important to safety, provided to ensure the safe shutdown of the reactor or residual heat removal from the core, or to limit the consequences of anticipated operational occurrences and design basis accidents, safety systems consist of the protection system, the safety actuation systems and the safety system support features ;

"*safety system settings*" means the levels at which protective devices are automatically actuated in the event of anticipated operational occurrences or accident conditions, to prevent safety limits being exceeded ;

"*safety system support features*" means the collection of equipment that provides services such as cooling, lubrication and energy supply required by the protection system and the safety actuation systems ;

"*self-assessment*" means routine and continuing process conducted by management at all levels to evaluate the effectiveness of performance in all areas of their responsibility including review, surveillance and discrete checks, which are focused on preventing, or identifying and correcting management problems that hinder the achievement of the organization's objectives, particularly safety objectives ;

"*severe accident*" means accident conditions more severe than a design basis accident and involving significant core degradation ;

"*single failure criterion*" means a criterion (or requirement) applied to a system such that it shall be capable of performing its task in the presence of any single failure ;

"*single failure*" means a failure which results in the loss of capability of a component to perform its intended safety function, and any consequential failure which result from it ;

"*site area*" means a geographical area that contains an authorized facility, and within which the management of the authorized facility may directly initiate emergency actions and this area is often identical to the operations area, except in situations (e.g. research reactor, irradiation installations) where the authorized facility is on a site where other activities are being carried out beyond the operations area, but where the management of the authorized facility can be given some degree of authority over the whole site area and site boundary is the boundary of the site area ;

"siting" means the process of selecting a suitable site for a facility, including appropriate assessment and definition of the related design bases ;

"*source term*" means the amount and isotopic composition of material released (or postulated to be released) from a facility ;

"*Structures Systems and Components (SSCs)*" means a general term encompassing all of the elements (items) of a facility or activity which contribute to protection and safety, except human factors ; and

"*supervised area*" means a defined area not designated as a controlled area but for which occupational exposure conditions are kept under review, even though specific protection measures and safety provisions are not normally needed.

104. These Regulations may be cited as the Nigerian Safety of Research Reactor Regulations, 2021. Citation.

MADE at Abuja this 11th day of January, 2021.

MUHAMMADU BUHARI
President of the Federal Republic of Nigeria
and Minister of Petroleum Resources