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PART II

Statutory Notifications (S.R.O.)

GOVERNMENT OF PAKISTAN

PAKISTAN NUCLEAR REGULATORY AUTHORITY

NOTIFICATION

Islamabad, the 10th of February, 2012

S.R.O. 219(I)/2012. - In exercise of the powers conferred by sections 56 and 16(2)(a) of the Pakistan Nuclear Regulatory Authority Ordinance, 2001 (III of 2001), the Pakistan Nuclear Regulatory Authority is pleased to make and promulgate the following regulations:-

- 1. Short Title, Extent, Applicability and Commencement.** – (1) These regulations may be called "Regulations on the Safety of Nuclear Research Reactor(s) Operation – (PAK/923)".
- (2) These regulations extend to the whole of Pakistan.
- (3) These regulations are applicable to the research reactors.
- (4) These regulations shall come into force at once.

2. Definitions: - In these regulations, unless there is anything repugnant in the subject or context,

- (a) “accident” means any unintended event, including operating errors, equipment failures and other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection or safety;
- (b) “accident conditions” mean deviations from normal operation more severe than anticipated operational occurrences, including design basis accidents and severe accidents;
- (c) “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;
- (d) “assessment” means the process, and the result, of analyzing systematically and evaluating the hazards associated with sources and practices, and associated protection and safety measures;
- (e) “Authority” means the Pakistan Nuclear Regulatory Authority established under section 3 of Pakistan Nuclear Regulatory Authority Ordinance, 2001;
- (f) “authorization” means an authorization granted under section 20 or, as the case may be, sections 21, 22 or 23 of the Ordinance;
- (g) “authorized limit” means a limit on a measurable quantity, established or formally accepted by the Authority;
- (h) “beyond design basis accident” means accident condition more severe than a design basis accident;
- (i) “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;
- (j) “common cause failure” means failure of two or more structures, systems and components due to a single specific event or cause;
- (k) “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;

- (l) “design basis accident” means accident conditions against which a 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;
- (m) “dose limit” means the value of the effective dose or the equivalent dose to individuals from controlled practices that shall not exceed from the authorized limits;
- (n) “decommissioning” means administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility;
- (o) “disposal” means emplacement of waste in an appropriate facility without the intention of retrieval;
- (p) “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 including common mode failure;
- (j) “Executive Member” means full time member of the Authority appointed by Federal Government under section 4(1) of the Ordinance and so designated by general or specific order by the Chairman of the Authority;
- (k) “facility” means, for the purpose of this document, is the installation containing research reactor;
- (l) “fuel element” means a rod (or other form) of nuclear fuel, its cladding and any associated components necessary to form a structural entity;
- (m) “licence” means a legal document issued by the Authority granting authorization to perform specified activities related to a facility or activity;
- (n) “licensee” means the holder of a valid licence;
- (o) “maintenance” means the organized activity, both administrative and technical, of keeping structures, systems and components in good operating condition, including both preventive and corrective (or repair) aspects;
- (p) “monitoring” means the measurement of dose or contamination for reasons related to the assessment or control of exposure to radiation or radioactive substances, and the interpretation of the results;

- (q) “normal operation” means operation within specified operational limits and conditions;
- (r) “operational limits and conditions” 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;
- (s) “operational states” means the states defined under normal operation and anticipated operational occurrences;
- (t) “Ordinance” means the Pakistan Nuclear Regulatory Authority Ordinance, 2001 (III of 2001);
- (u) “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; the ‘system’ in this case encompasses all electrical and mechanical devices and circuitry, from sensors to actuation device input terminals;
- (v) “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, e.g. medical physics, radiation protection, occupational health, fire safety, quality assurance or any relevant engineering or safety specialty;
- (w) “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;
- (x) “radiation protection” means the protection of people from the effects of exposure to ionizing radiation, and the means for achieving this;
- (y) “radioactive waste” means waste that contains, or is contaminated with, radionuclides at concentrations or activities greater than clearance levels as established by the Authority;
- (z) “radioactive waste management” means all administrative and operational activities, , involved in the handling, pretreatment, treatment, conditioning, transport, storage and disposal of radioactive waste;

- (aa) “redundancy” provision of alternative (identical or diverse) structures, systems and components, so that anyone can perform the required function regardless of the state of operation or failure of any other;
- (bb) “research reactors” 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 related to safe operation of the research reactor. Facilities commonly known as critical assemblies are included;
- (cc) “research reactor management” means the operating organization of the relevant research reactor, authorized by the Authority to operate the reactor;
- (dd) “reactor operator” means a person authorized to carry out operations in the control room and in the field;
- (ee) “safety committee” means a group of experts from the operating organization convened to advise on the safety of operation of an authorized facility;
- (ff) “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;
- (gg) “safety limits” mean limits on operational parameters within which an authorized facility has been shown to be safe. Safety limits are operational limits and conditions beyond those for normal operation;
- (hh) “safety system” means a system important to safety, provided to ensure the safe shutdown of the reactor or the residual heat removal from the core, or to limit the consequences of anticipated operational occurrences and design basis accidents;
- (ii) “safety system settings” mean 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;
- (jj) “shift supervisor” means a person responsible and in charge of the operation shift;

- (kk) “severe accident” means accident conditions more severe than a design basis accident and involving significant core degradation;

3. Objective

The main objective of these regulations is to establish requirements on aspects relating to regulatory control, management of safety and basis for safety assessment for operation of research reactors.

4. Scope

These regulations establish requirements for the safety of research reactors, with particular emphasis on requirements for operation.

5. Interpretation

The decision of Chairman of the Authority regarding the interpretation of any word or phrase of these regulations or applicability of these regulations shall be final and binding on the licensee/applicant.

6. MANAGEMENT OF SAFETY CONSIDERATIONS

6.1 Safety Analysis Report (SAR)

(1) The safety analysis report shall be updated in accordance with applicable regulatory requirements during the life time of the reactor due to feed back of experience or when a significant modification in design is under taken

(2) The SAR shall give a detailed description of the research reactor site, the research reactor, experimental devices and all other facilities and activities with safety significance. It shall 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. It shall analyze the potential hazards associated with the operation of the research reactor. The SAR shall include safety analyses of accident sequences and shall describe the safety features incorporated in the design to avoid or to minimize the likelihood of occurrence of accidents, or to mitigate their consequences through design and operating procedures.

(3) The SAR shall form the basis for establishing the operational limits and conditions (OLCs) for the research reactor. It shall also provide details as to how the licensee intends to organize and conduct operations and as to the quality assurance programme for all stages of research reactor life, including design and construction. It shall also provide details of the emergency plan of the research reactor.

(4) The SAR shall include additional information as prescribed in national legislation and by the Authority. The level of detail of the information to be presented in the SAR shall be determined in accordance with the type, characteristics (its design, power and usage) and site of the research reactor.

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

6.2 *Interaction between the Authority and the Licensee*

(1) The licensee shall demonstrate to the Authority that its responsibility for safety at all stages in the lifetime of the research reactor will be discharged. Whenever a change of stage is initiated by the licensee, 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.

(2) The licensee shall submit to the Authority in a timely manner any information that it has requested. The licensee shall be responsible for making arrangements with the vendors to ensure the availability of any information that has been requested by the Authority. The licensee shall also be responsible for appraising the Authority of any new information on the research reactor and of any changes to information submitted previously.

(3) The format and content of documents submitted to the Authority by the licensee in support of a licence application shall be based on the requirements established in sub-section 6.1, clauses (1-5) of these regulations. The Authority may request additional information, depending on the Authority practices of the other countries.

7. QUALITY ASSURANCE

(1) The licensee shall establish and implement performance based quality assurance requirements for research reactors for the stages of site evaluation, design, construction, commissioning, operation, utilization, modification and decommissioning.

(2) The licensee shall develop quality assurance programmes for all the stages in the lifetime of a research reactor at a time consistent with the schedule for accomplishing stage related activities. In particular, activities for

site investigation, which are usually initiated long before the establishment of a project, shall be covered by a quality assurance programme.

(3) The graded approach shall be adopted so as to reflect planned and accepted differences in the application of specific quality assurance requirements to research reactors. The extent of the detailed quality assurance programme that is required for a particular research reactor or experiment shall be governed by the potential for hazard of the research reactor and the experiment and shall meet the requirements of the Authority.

(4) The quality assurance programme shall be reviewed and approved at the appropriate levels of management and shall be submitted to the Authority. The provisions of the programme shall be based on the following three functional principles:

- (a) Managers provide planning, direction, resources and support so as to achieve objectives;
- (b) Staff performs the work so as to achieve quality;
- (c) Independent assessments are made by staff in the licensee or by an outside agency so as to evaluate the effectiveness of the management processes and the performance of work.

7.1 Management

(1) Management of the licensee shall provide and demonstrate support for the effective implementation of the quality assurance programme in all work areas. The management aspects of the quality assurance programme shall include:

- (a) a statement of the policy of the organization on quality assurance;
- (b) the organizational structure;
- (c) the functional responsibilities;
- (d) requirements for training, qualification and certification;
- (e) levels of authority and interfaces for those who manage, perform and evaluate the adequacy of the work.

7.2 Performance

(1) At all stages in the lifetime of the research reactor, work shall be planned and performed in accordance with established codes, standards,

specifications, procedures and administrative controls. Items and services important to safety shall be specified and controlled to ensure their proper use, maintenance and configuration.

(2) It shall be ensured that items and services under procurement meet established requirements and perform as specified. Suppliers shall be evaluated and selected on the basis of specified criteria. Requirements for reporting deviations from procurement specifications shall be specified in the procurement documents. 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.

7.3 Assessment

(1) The management at all levels shall periodically assess the processes for which it is responsible to determine its effectiveness in achieving the objectives for nuclear safety. Weaknesses in processes shall be identified and corrected.

(2) 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. The persons conducting the independent assessments shall not include anyone directly involved in the work being assessed.

8. VERIFICATION OF SAFETY

8.1 Safety Committees

(1) One or more research reactor advisory groups or safety committees that are independent of the reactor manager shall be established to advise the licensee on:

- (a) relevant aspects of the safety of the research reactor and the safety of its utilization and
- (b) safety assessment of design, commissioning and operational issues.

(2) One of the committees shall also advise the reactor manager (as described in sub-section 11.5 of these regulations). Members of such a group or groups shall be experts in different fields associated with the operation and design of the research reactor. It may be advisable to include external experts (i.e. from outside the licensee) in such committees. Depending on the

complexity of the operations carried out at the research reactor, one of the advisory groups could be external to the licensee. The functions, authority, composition and terms of reference of such committees shall be documented and, if required, submitted to the Authority. The list of items that the safety committee is required to review shall also be established. Such a list shall include, among other things, the following data:

- (a) proposed changes in the OLCs in the licence for the facility;
- (b) proposed new tests, experiments, equipment, systems or procedures that have significance for safety;
- (c) proposed modifications to items important to safety and changes in experiments that have implications for safety;
- (d) violations of the OLCs, of the licence and of procedures that are significant to safety;
- (e) the design, including the chemical composition, of the nuclear fuel elements and the reactivity control elements;
- (f) events that are required to be reported or that have been reported to the Authority;
- (g) periodic reviews of the operational performance and safety performance of the facility;
- (h) reports on routine releases of radioactive material to the environment;
- (i) reports on radiation doses to the personnel at the facility and on any doses to the public.

9. DESIGN CONSIDERATIONS FOR SAFE OPERATION

9.1 Safety Functions

(1) The following three basic safety functions shall be met through appropriate design provisions and by applying administrative procedures over the lifetime of the research reactor:

- (a) shutting the research reactor and maintaining it in a safe shutdown state for all operational states or design basis accidents (DBAs);
- (b) providing for adequate removal of heat after shutdown, in particular from the core, including DBAs;

- (c) confining radioactive material in order to prevent or mitigate its unplanned release to the environment;

(2) In normal operation, the equipment needed to perform safety functions shall include the normal operating systems supplemented by other engineered safety features to perform their functions for anticipated operational occurrences and in DBAs.

9.2 Acceptance Criteria

Acceptance criteria shall be established for operational states and for DBAs. In particular, the DBAs considered in the design of the research reactor and selected or beyond design basis accidents (BDBAs) shall be identified for the purposes of establishing acceptance criteria. These acceptance criteria shall be reviewed and accepted by the Authority.

9.3 Postulated Initiating Events and DBAs

Postulated initiating events shall be selected appropriately for the purpose of analysis. It shall be shown that the set of postulated initiating events selected covers all credible accidents that may affect the safety of the research reactor. In particular, the DBAs shall be identified.

10. THE CONCEPT OF DEFENCE IN DEPTH

(1) The concept of defence in depth shall be applied to all safety activities, whether organizational or behavioural by ensuring that they are subject to overlapping provisions, so that if a failure were to occur, it would be detected and compensated for or corrected by appropriate measures. Application of the concept of defence in depth throughout design and operation shall provide a graded protection against a wide variety of transients, anticipated operational occurrences and accidents, including those resulting from equipment failure or human action within the research reactor, and events that originate outside the research reactor.

(2) Application of the concept of defence in depth in the design of a research reactor provides a series of levels of defence (inherent features, equipment and procedures) aimed at preventing accidents and ensuring appropriate protection in the event that prevention fails.

(3) The aim of the first level of defence is to prevent deviations from normal operation, and to prevent system failures. Attention shall be paid to the procedures involved in the in-service inspection, maintenance and testing, to the way the research reactor is operated and to how operational experience is utilized.

(4) The aim of the second level of defence is to detect and intercept deviations from normal operational states in order to prevent anticipated operational occurrences from escalating to accident conditions. This level necessitates the provision of operating procedures to prevent or minimize damage from such postulated initiating events (PIEs).

(5) For the third level of defence, it is assumed that, although very unlikely, the escalation of certain anticipated operational occurrences or PIEs may not be arrested by a preceding level and a more serious event may develop. Procedures are provided to control their consequences and to achieve stable and acceptable research reactor states following such events by the use of engineered safety features that are capable of leading the research reactor first to a controlled state, and subsequently to a safe shutdown state, and maintaining at least one barrier for the confinement of radioactive material.

(6) The aim of the fourth level of defence shall be to address events in which the design basis may be exceeded and to ensure that radioactive releases are kept as low as practicable. The most important objective of this level is the protection of the confinement function. This shall be achieved by complementary measures and procedures to prevent accident progression, and by mitigation of the consequences.

(7) The fifth and final level of defence shall be aimed at mitigation of the radiological consequences of potential releases of radioactive materials that may result from accident conditions. This requires the provision of an adequately equipped emergency control centre, and plans for the on-site and off-site emergency response.

11. ORGANIZATIONAL PROVISIONS.-

11.1 Structure and Responsibilities of the Licensee

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

(2) The licensee shall ensure that adequate provision is made for all functions relating to the safe operation and utilization of the research reactor, such as inspection, periodic testing and maintenance, radiation protection, quality assurance and relevant support services.

(3) The licensee shall have the overall responsibility for the safety of the research reactor, which shall not be delegated. The research reactor manager shall have the direct responsibility and the necessary authority for the safe operation of the research reactor. A system for reviewing and reporting abnormal occurrences shall be established.

(4) The licensee shall establish the functions and responsibilities for the key positions in the organization for research reactor operation. In particular, the licensee shall clearly establish lines of authority and communications between the research reactor manager, the safety committee(s), the radiation protection group, maintenance groups, the quality assurance personnel and the experimenters.

(5) The licensee shall define the qualifications and experiences necessary for personnel performing duties that may affect safety. Suitably qualified personnel shall be selected and given the necessary training and instruction to enable them to perform their duties correctly for the different operational states of the research reactor and in the event of an accident, in accordance with the appropriate operating or emergency procedures. Individuals performing certain functions important to safety shall be required to hold a formal licence issued by the Authority.

(6) The licensee shall establish and implement a radiation protection programme to ensure that all activities involving radiation exposure or potential exposure are planned, supervised, and executed to achieve the aims described in section 23 of these regulations. In particular, the licensee shall ensure that adequate measures are in place to provide protection against radiological hazards arising from utilization and modification projects for the research reactor (for details refer to section 22 of these regulations).

(7) The licensee shall have overall responsibility for the preparation and satisfactory completion of the commissioning programme pursuant to section 14 of these regulations.

(8) The licensee 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) In the operational stage of the research reactor, the licensee shall become familiar with decommissioning projects at similar research reactors to facilitate the assessment of the complexity and costs of the ultimate decommissioning of its own research reactor. Before decommissioning, the

licensee shall prepare a detailed plan to ensure safety throughout decommissioning.

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

(11) The licensee 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 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) a radiation protection programme is developed and implemented;
- (e) emergency procedures are established and implemented;
- (f) physical protection programme is developed and implemented;
- (g) radioactive waste management programme is developed and implemented;
- (h) fire protection programme is developed and implemented;
- (i) the research reactor is being operated and maintained in accordance with the safety requirements by suitably qualified and experienced personnel;
- (j) personnel with responsibilities relating to safe operation are adequately trained, and a training and retraining programme is established, implemented and kept up to date and periodically reviewed to verify its effectiveness; (as per section 12 of these regulations)
- (k) adequate facilities and services are available during operation;
- (l) information on reportable incidents, including any assessments of such events and the corrective actions intended, is submitted to the Authority;

- (m) 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 to safe operation;
- (n) quality assurance programme is established and implemented;
- (o) the research reactor management is provided with sufficient authority and resources to enable it to fulfill its duties effectively;
- (p) the research reactor is operated and maintained in accordance with the OLCs and operating procedures (for detailed requirements refer to sections 13 and 15 of these regulations);
- (q) the fissile and radioactive materials that are utilized or generated are controlled;
- (r) operational experience, including information on operating experience at similar research reactors, 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.

11.2 Operating Personnel

(1) The licensee shall assign direct responsibility and authority for the safe operation of the research reactor to the reactor manager. The primary duties of the reactor manager shall comprise the discharge of this responsibility. The reactor manager shall have overall responsibility for all aspects of operation, inspection, periodic testing and maintenance, and utilization and modification of the research reactor.

(2) The reactor manager shall clearly document the duties, the responsibilities, the necessary experience and the training requirements of operating personnel, and their lines of communication. The duties, responsibilities and line of communication of other personnel involved in the operation or use of research reactor (e.g. technical support personnel and experimenters) shall also be clearly defined and documented.

(3) The reactor manager shall specify the minimum staffing requirements for the various disciplines required to ensure safe operation for all operational states of the research reactor. These requirements include both the number of personnel and the duties for which they are required to be authorized. The shift supervisor shall be clearly identified at all times. The availability of the staff that would be required to deal with accident conditions shall also be specified.

- (4) The reactor manager shall 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. There shall be adequate training in the procedures to be followed in both operational states and accident conditions.
- (5) The presence of independent radiation protection personnel (as specified in sub-section 11.3 of these regulations) shall be ensured and the operating personnel, including technical support personnel and experimenters, shall be given suitable training in radiation protection.
- (6) The detailed programme for the operation and experimental use of the research reactor shall be prepared in advance and shall be subject to the approval of the reactor manager.
- (7) The reactor manager shall be responsible for and shall make arrangements for all the activities associated with core management and fuel handling and the handling of any other fissile material.
- (8) The reactor manager shall periodically review the operation of the research reactor, including experiments, and shall take appropriate corrective actions in regard of any problem identified. The reactor manager shall seek the advice of the safety committee or shall call upon advisers to review important safety issues arising in the commissioning, operation, inspection, periodic testing and maintenance, and modification of the research reactor and experiments.
- (9) The operating personnel shall operate the facility in accordance with the approved OLCs and operating procedures (for details, refer to sections 13 and 15 of these regulations). The number and the type of operating personnel required will depend on design aspects of the research reactor, such as the power level, the duty cycle and the utilization.
- (10) Every licensed reactor operator shall have the authority to shut down the research reactor in the interest of safety.
- (11) A maintenance group shall be established by the licensee to implement the programmes for inspection, periodic testing and maintenance (for details refer to section 16 of these regulations).
- (12) Criteria for licensing of research reactor operating personnel are given in Appendix-I of these regulations.

11.3 Radiation Protection Personnel

A radiation protection group shall be established to prepare and implement a radiation protection programme (as detailed in section 23 of these regulations) and to advise the research reactor management and licensee on matters relating to radiation protection.

11.4 Additional Support Personnel

(1) The licensee shall make provision for additional technical personnel such as training officers, safety officers and research reactor chemists.

(2) The licensee shall arrange for the provision of assistance by contractor personnel as required.

11.5 Safety Committee

(1) The safety committee advising the reactor manager shall provide judgments on the safety issues submitted by the research reactor manager. In particular, the safety committee shall review the adequacy and safety of proposed experiments and modifications and shall provide the reactor manager with recommendations for action.

(2) Notwithstanding the judgment of the safety committee, the reactor manager shall have the authority to refuse or delay the performance of an experiment or a modification that he or she considers is not safe and shall refer such a proposal to higher authority for additional review.

12. TRAINING, RETRAINING AND QUALIFICATION

(1) Training and retraining programmes shall be established for the operating personnel, including the reactor manager, the shift supervisors, the reactor operators, the radiation protection staff, the maintenance personnel, the quality assurance personnel and others working at the research reactor. Regular training and retraining shall be provided to enhance the knowledge and abilities of personnel continually.

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

13. OPERATIONAL LIMITS AND CONDITIONS (OLCs)

13.1 General

(1) A set of OLCs important to research reactor safety, including safety limits, safety system settings, limiting conditions for safe operation, requirements for inspection, periodic testing and maintenance and

administrative requirements, shall be established and submitted to the Authority for review and assessment.

(2) The OLCs shall be used to provide the framework for the safe operation of the research reactor. OLCs shall be prepared for each stage in the lifetime of the reactor (e.g. commissioning and operation). The operating staff shall adhere to the OLCs throughout the lifetime of the reactor.

(3) The OLCs shall be adequately selected, clearly established and appropriately substantiated (e.g. by clearly stating for each OLC its object, its applicability and its specification; i.e. its specified limit and its basis). The selection of and the values for the OLCs shall be based on the SAR, on the research 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 research reactor.

13.2 Safety Limits

(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 set on such important parameters as the temperature and other measured process variables that may affect the integrity of the barrier and which can be readily measured and controlled.

13.3 Safety System Settings

For each parameter for which a safety limit is required and for other important safety related parameters, there shall be a system that monitors the parameter and provides a signal that can be utilized in an automatic mode to prevent that parameter from exceeding the set limit. The point for this protective action that will provide the minimal acceptable safety margin is the safety system setting. This safety margin will allow for, among other things, behaviour in system transients, the equipment response time and inaccuracy of the measuring devices.

13.4 Limiting Conditions for Safe Operation

Limiting conditions for safe operation are conditions established to ensure that there are acceptable margins between normal operating values and the safety system settings. The setting of limiting conditions for safe operations is aimed at avoiding the undesirably frequent actuation of safety systems. 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.

13.5 Requirements for Inspection, Periodic Testing and Maintenance

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

13.6 Administrative Requirements

The OLCs shall include administrative requirements or controls concerning organizational structure and the responsibilities for key positions in the safe operation of the research 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.

13.7 Violations of OLCs

(1) In the event that the operation of the research reactor deviates from one or more OLCs, remedial 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. The reactor management shall conduct an investigation of the cause and the consequences and shall take appropriate actions to prevent a recurrence. The Authority shall be notified in due time.

(3) If a safety limit is not observed, the research reactor shall be shut down and maintained in a safe condition. Under such circumstances, the Authority shall be promptly notified, an investigation of the cause shall be carried out by the licensee and a report shall be submitted to the Authority for assessment before the research reactor is returned to operation.

14. COMMISSIONING

14.1 Commissioning Programme

- (1) An adequate commissioning programme shall be prepared for the testing of research 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.
- (2) The commissioning programme shall establish the organization and responsibilities for commissioning, the commissioning stages, the suitable testing of structures, systems and components (SSCs) on the basis of their importance to safety, the test schedule, the commissioning procedures and reports, the methods of review and verification, the treatment of deficiencies and deviations, and the requirements for documentation.
- (3) Experimental devices shall be given adequate consideration during the commissioning of the research reactor.
- (4) The 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.

14.2 Organization and Responsibilities

- (1) The licensee, designers and manufacturers shall be involved in the preparation and execution of the commissioning programme. The commissioning process shall involve cooperation between the licensee and the supplier to ensure an effective means of familiarizing the licensee with the characteristics of the particular research reactor.
- (2) Close liaison shall be maintained between the Authority and the licensee throughout the commissioning process. In particular, the results and analyses of tests directly affecting safety shall be made available to the safety committee and the Authority for review and approval as appropriate.

14.3 Commissioning Tests and Stages

Commissioning tests shall be arranged in functional groups and in a logical sequence. This sequence includes pre-operational tests, initial criticality tests, low power tests and power ascension and power tests. No test sequence shall proceed unless the required previous steps have been successfully completed. The commissioning programme shall therefore be divided into stages which are usually arranged according to the following sequences:

- (a) Stage A tests prior to fuel loading;
- (b) Stage B tests including fuel loading tests, initial criticality tests and low power tests;

- (c) Stage C tests including power ascension tests and power tests.

14.4 Commissioning Procedures and Reports

(1) Procedures shall be prepared, reviewed and approved for each commissioning stage prior to the commencement of tests for that stage. Commissioning activities shall be performed in accordance with approved written procedures. If necessary, the procedures shall include hold points for the notification and involvement of the safety committee, outside agencies, manufacturers and the Authority.

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

(3) Reports covering the scope, sequence and expected results of these tests shall be prepared in appropriate detail and in accordance with the quality assurance requirements. The reports shall cover:

- (a) the purpose of the tests and expected results;
- (b) the safety provisions required to be in force during the tests;
- (c) precautions and prerequisites;
- (d) the test procedures;
- (e) The test reports, including a summary of the data collected and their analysis, an evaluation of the results, the identification of deficiencies, if any, and any necessary corrective actions.

(4) The results of all commissioning tests, whether conducted by the licensee or a supplier, shall be made available to the licensee and shall be maintained for the lifetime of the research reactor.

15. OPERATING PROCEDURES

(1) Operating procedures shall be developed by the licensee for all safety related operations that may be conducted over the entire lifetime of the facility, including:

- (a) commissioning;
- (b) operation in all operational states and, where appropriate, the loading, unloading and movement within the research reactor of

- fuel elements and assemblies or other core and reflector components, including experimental devices;
- (c) the maintenance of major components or systems that could affect research reactor safety;
 - (d) periodic inspections, calibrations and tests of SSCs that are essential for the safe operation of the research 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 research reactor safety or the reactivity of the core;
 - (g) the reactor operator's response to anticipated operational occurrences and design basis accidents (DBAs) and, to the extent feasible, to beyond design basis accidents (BDBAs);
 - (h) emergencies;
 - (i) physical protection;
 - (j) handling of radioactive waste and monitoring and control of radioactive releases;
 - (k) inspection, periodic testing and maintenance, as required, of the research reactor and its auxiliary systems during extended periods of shutdown of the research reactor;
 - (l) utilization;
 - (m) modifications;
 - (n) activities of an administrative nature with a possible effect on safety (e.g. the control of visitors);
 - (o) quality assurance.
- (2) Operating procedures shall be developed by the reactor operating personnel, in co-operation whenever possible with the designer and manufacturer and with other staff of the licensee, including radiation protection staff. Operating procedures shall be consistent with and useful in the observance of the OLCs and shall be prepared in accordance with a general quality assurance procedure that governs the format, development, review and control of such procedures. They shall be reviewed independently (e.g. by the safety committee) and they shall be subject to the approval of the reactor

manager. The approved procedures shall be made available to the Authority if required.

(3) 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. They shall be available as relevant for the particular operation of the research reactor.

(4) All personnel involved in the operation and use of the research reactor shall be adequately trained in the use of relevant procedures.

(5) 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 operation is started. Additional training of relevant staff in these procedures shall be provided.

16. INSPECTION, PERIODIC TESTING AND MAINTENANCE

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

(2) The licensee shall establish documented programmes for inspection, periodic testing and maintenance based on the SAR for the research reactor equipment, especially all items important to safety. It shall be ensured by means of these programmes that the level of safety is not reduced during their execution.

(3) The inspection, periodic testing and maintenance programme shall be reviewed at regular intervals to incorporate lessons learned from experience. All inspection, periodic testing and maintenance of systems or items important to safety shall be performed by following approved, written procedures. The procedures shall specify the measures to be taken for any changes from the normal reactor configuration and shall include provisions for the restoration of the normal configuration on the completion of the activity.

(4) The licensee shall establish a system of work permits in accordance with the quality assurance requirements for inspection, periodic testing and maintenance, including appropriate procedures for checking off before and after the conduct of the work. There shall be a clearly defined structure of review and approval for the performance of the work. These procedures shall include acceptance criteria.

(5) 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. In-service inspections conducted for safety purposes and on a programmatic basis shall be performed in a similar manner.

(6) The decision to carry out maintenance work on installed equipment, to remove equipment from operation for maintenance purposes, or to reinstall equipment after maintenance:

- (a) shall be the overall responsibility of the reactor manager;
- (b) shall be in accordance with the objective of maintaining the level of safety of the research reactor as specified in the OLCs.

(7) The frequency of inspection, periodic testing and maintenance of individual SSCs shall be adjusted on the basis of experience and shall be such as to ensure adequate reliability.

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

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

(10) The results of inspection, periodic testing and maintenance shall be accessed 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.

(11) The Authority shall be informed of any non-conformance that is significant to safety. A maintenance assessment shall be made and the coordinator of maintenance activities shall review its results. The resumption of operation shall be subject to the approval of the coordinator of maintenance activities.

17. CORE MANAGEMENT AND FUEL HANDLING

(1) Core management shall be used to produce safe operational cores consistent with the needs of the experimental programme. The basic activities for core management are:

- (a) To determine by calculation, using validated methods and codes, the appropriate locations for fuel, reflectors, safety devices (such as neutron absorbing rods and valves for dumping

- the moderator and burnable poisons), experimental devices and moderators in the core;
- (b) To keep and update baseline information on the parameters for the fuel and core configurations;
 - (c) To procure fuel on the basis of specifications in accordance with the design intent and the requirements of the OLCs;
 - (d) To load the fuel following the procedures for fuel handling;
 - (e) To utilize (burn up) the research reactor core while ensuring the integrity of the fuel by maintaining the relevant parameters for the core configuration in accordance with the design intent and the assumptions as specified in the OLCs for the research reactor, and by detecting, identifying and unloading failed fuel;
 - (f) To unload the irradiated fuel when appropriate.
- (2) In addition to the above activities, other activities shall be undertaken in the core management programme to ensure the safe use of the fuel in the core or to facilitate the basic activities for core management, such as:
- (a) The assessment of the safety implications for any core component or material proposed for irradiation;
 - (b) The conduct of investigations into the causes of fuel failures and means of avoiding such failures;
 - (c) The assessment of the effects of irradiation on core components and core material.
- (3) Fuel handling comprises the movement, storage, transfer, packaging and transport of fresh and irradiated fuel. Applicable safety requirements shall be complied with in these processes.
- (4) Procedures shall be prepared for the handling of fuel elements and core components to ensure their quality, safety and physical protection and to avoid damage or degradation. In addition, 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. The integrity of the research reactor core and the fuel shall be continuously monitored by a cladding failure detection system, not necessarily on-line. If a failure of fuel is detected, an investigation shall be conducted to identify the failed fuel element. Authorized limits shall not be exceeded and if necessary the reactor shall be shut down and the failed fuel element shall be unloaded.

(5) The packaging and transport of fuel assemblies with fresh and irradiated fuel shall be carried out in accordance with PNRA regulations PAK/916.

(6) A comprehensive record system shall be maintained in compliance with the quality assurance programme to cover core management, handling activities for fuel and core components and fuel storage.

18. FIRE SAFETY

The licensee shall conduct periodic fire safety analyses. These analyses shall include: assessments of the vulnerability of safety systems to fire; modifications to the application of defence in depth; modifications to fire fighting capabilities; the control of inflammables; the control of ignition sources; inspection; maintenance; testing; and the readiness of personnel.

19. EMERGENCY PLANNING

(1) Emergency plans shall be prepared for a research reactor facility to cover all activities planned to be carried out in an emergency. Emergency procedures shall be prepared by the licensee, in accordance with the requirements of the Authority, and in co-operation, where necessary, with the appropriate governmental and local authorities or other bodies, to ensure the effective co-ordination of all site services and of external aid in an emergency. Emergency procedures shall be based on the accidents analyzed in the SAR as well as those additionally postulated for the purposes of emergency planning.

(2) The emergency plan and arrangements prepared by the licensee shall include:

- (a) the identification of the emergency organizations (for preparedness and response), including the authorities and responsibilities of key individuals;
- (b) the identification and classification of emergencies;
- (c) the conditions under which an emergency should be declared, a list of persons empowered to declare an emergency and a description of suitable warning procedures or devices;
- (d) the arrangements for initial and subsequent assessment, including environmental monitoring of the radiological conditions;

- (e) agreements with off-site agencies that will help in an emergency, including letters of agreement and details of contact points;
 - (f) protective measures for minimizing the exposure of persons to radiation and measures for ensuring the medical treatment of any casualties;
 - (g) guidance on limits on the doses due to exposure of personnel performing rescue missions or missions to mitigate the consequences of an emergency;
 - (h) action at the facility to limit the extent of any radioactive release and the spread of contamination;
 - (i) the chain of command and communication, clearly defining the responsibilities and duties of the persons and organizations concerned;
 - (j) provisions to ensure the reliability of communications between the emergency control centre and internal and external locations;
 - (k) a description of facilities, equipment and procedures for emergencies;
 - (l) the inventory of the equipment for emergencies to be kept in readiness at specified locations;
 - (m) notification requirements for informing the authorities;
 - (n) notification requirements for requesting additional resources;
 - (o) The actions to be taken by persons and bodies involved in the implementation of the plan;
 - (p) provisions for informing the public;
 - (q) provisions for the training of personnel, including specification of the frequency and scope of drills;
 - (r) provisions for the termination of and recovery from the emergency.
- (3) The emergency plan shall be implemented by means of emergency procedures in the form of documents and instructions detailing the implementation actions and the arrangements required to mitigate the

consequences of the emergency. The emergency plan and procedures shall be reviewed at specified periods and shall be amended as necessary to ensure that lessons learned are incorporated.

(4) The operating personnel shall take appropriate action in accordance with established emergency procedures in response to an emergency. Other on-site support service groups and off-site agencies shall be involved as specified in the emergency plan, depending on the nature and the extent of the emergency.

(5) The emergency response team shall include persons with up to date knowledge of the operations of the research reactor, and it should normally be led by the reactor manager or delegate. All personnel involved in responding to the emergency shall be instructed, trained and retrained periodically as necessary in the performance of their duties in an emergency. All persons on the site shall receive instruction on the steps to take in an emergency. Instructions shall be prominently displayed.

(6) Exercises shall be conducted at suitable intervals and shall involve, to the extent practicable, all those persons with duties in responding to the emergency. The results of the exercise shall be reviewed and, where necessary, the lessons learned shall be incorporated into revisions of the emergency plan.

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

20. PHYSICAL PROTECTION

(1) The licensee shall take measures for physical security and physical protection as appropriate to prevent or deter unauthorized access to, intrusion into, theft of, surface attack on and internal or external sabotage of safety related systems and nuclear materials.

(2) All reasonable precautions shall be taken to prevent individuals from deliberately carrying out unauthorized actions that could jeopardize safety.

(3) The licensee shall have plans and procedures in place to provide for physical protection of the site in the event of civil disturbance.

21. RECORDS AND REPORTS

(1) For the safe operation of the research reactor the licensee shall retain all essential information concerning the design, construction, commissioning,

current configuration and operation the reactor. This information shall be maintained up to date throughout the operational stage of the reactor and shall be kept available during decommissioning. Such information includes site data and environmental data, design specifications, details of the equipment and material supplied, as-built drawings, information on the cumulative effects of modifications, logbooks, operating and maintenance manuals and quality assurance documents.

(2) Administrative procedures consistent with the quality assurance programme shall be developed for the generation, collection, retention and archiving of records and reports. Information entries in logbooks, checklists and other appropriate records shall be properly dated and signed.

(3) Records of non-compliance and the measures taken to return the research reactor to compliance shall be prepared and retained and shall be made available to the Authority. The licensee shall specify the records to be retained and their retention periods.

(4) The arrangements made for storing and maintaining records and reports shall be in accordance with the quality assurance programme. The document management system shall be designed to ensure that obsolete documents are archived and that personnel use only the latest version of each document. The off-site storage (e.g. in the emergency control centre) of documents for access in an emergency shall be considered.

(5) Periodic summary reports on matters relating to safety shall be submitted to the Authority as required, including reports and records relevant to reviews carried out following abnormal events and accidents.

22. UTILIZATION AND MODIFICATION OF THE RESEARCH REACTOR

(1) The licensee shall be responsible for all safety aspects of the preparation and performance of a modification or experiment. It may assign or subcontract the execution of certain tasks to other organizations but it shall not delegate its responsibilities. In particular, the licensee shall be responsible for the management of the proposed utilization or modification project, in which the reactor manager shall participate according to established procedures. For major projects this shall include the setting of the objectives and the structure of the project, the appointment of a project manager, the specification of responsibilities and the allocation of adequate resources. In addition, before the project commences, it shall establish and follow approved procedures for controlling utilization and modification projects.

- (2) The licensee shall be responsible for ensuring that:
 - (a) Safety analyses of the proposed utilization or modification are conducted.
 - (b) The relevant safety documentation is followed.
 - (c) The associated requirements for review and approval are met. These may include the requirement to obtain the approval of the Authority before proceeding or the establishment of a formal licensing process.
 - (d) Proper safety precautions and controls are applied with regard to all persons involved in the performance of the modification or experiments, and with regard to the public and the environment.
 - (e) Quality assurance is applied at all stages in the preparation and performance of the experiment or modification to ascertain whether all applicable safety requirements and criteria have been satisfied.
 - (f) 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, if necessary, trained in advance in the effect of this modification or utilization on reactor operation and the safety characteristics of the reactor.
 - (g) All documents that relate to the safety characteristics of the research reactor, such as the SARs, the OLCs and the relevant procedures for operation, maintenance and emergencies, are promptly updated as necessary.
- (3) Proposals for the utilization and modification of the research reactor shall be categorized and relevant criteria for this categorization shall be established. Proposals for utilization and modification shall be categorized either according to the safety significance of the proposal or on the basis of a statement of whether or not the proposed change will put the operation of the research reactor outside the OLCs.
- (4) Utilization and modification projects having a major safety significance shall be subject to safety analyses and to procedures for design, construction and commissioning.

(5) In implementing utilization and modification projects for research reactors, the radiation exposure of the workers involved shall be kept as low as reasonably achievable.

(6) The reactor manager shall establish a procedure for the review and approval of proposals for experiments and modifications and for the control of their performance. This procedure shall include all relevant information such as:

- (a) A description of the purpose of the experiment or modification;
- (b) A justification for the necessity of the experiment or modification;
- (c) The requirements and criteria for design, including their safety assessment;
- (d) A description of the manufacturing processes involved;
- (e) A description of the installation procedures involved;
- (f) A description of the commissioning process;
- (g) A review of the operational procedures and emergency procedures;
- (h) A description of the possible radiation hazards to experimenters;
- (i) A description of the radiation safety measures necessary to prevent accidental exposure (including the restriction of access to the irradiation facility and to radioactive sources and/or neutron beams);
- (j) A description of the radiation shielding required around the facility to prevent an increase in radiation (direct or scattered) generated in normal and abnormal conditions;
- (k) A description of the need for the disposal of radioactive waste generated in the experiment or modification;
- (l) A list of the relevant documentation that needs to be updated;
- (m) Any special requirements for the training and, if necessary, relicensing of reactor operators;
- (n) The quality assurance requirements.

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

(8) 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.

23. RADIATION PROTECTION

23.1 General

(1) Radiation exposures at the research reactor facility shall be subject to dose constraints that are set or approved by the Authority for the purpose of ensuring that the relevant dose limits are not exceeded. In all operational states, the main aims of radiation protection shall be to avoid unnecessary exposure to radiation and to keep doses below the dose constraints and as low as reasonably achievable, social and economic factors being taken into account.

(2) For accident conditions, the radiological consequences shall be kept low by means of appropriate engineered safety features and the measures provided for in the emergency plan.

(3) All documentation and activities for radiation protection shall conform to the quality assurance requirements for operation.

23.2 Radiation Protection Programme

(1) A radiation protection programme shall be established by the licensee in accordance with PNRA regulations PAK/904 "Regulations on Radiation Protection". This programme shall include a policy statement from the licensee that includes the radiation protection objective and a statement of the licensee's commitment to the principle of optimization of protection.

(2) The radiation protection programme shall include measures for:

- (a) Ensuring that there is cooperation between the radiation protection staff and the operating staff in establishing operating procedures and maintenance procedures when radiation hazards are anticipated, and ensuring that direct assistance is provided when required;
- (b) Providing for the decontamination of personnel, equipment and structures;

- (c) Controlling compliance with applicable regulations for the transport of radioactive material;
- (d) Detecting and recording any releases of radioactive material;
- (e) Recording the inventory of radiation sources;
- (f) Providing adequate training in practices for radiation protection;
- (g) Providing for the review and update of the programme in the light of experience.

23.3 *Radiation Protection Personnel*

(1) The radiation protection programme shall include the appointment of qualified persons with responsibility for radiation protection who are knowledgeable about the radiological aspects of the design and operation of the research reactor. These individuals shall work in cooperation with the group that operates the reactor, but they shall have reporting lines to the licensee that are independent of the reactor management.

(2) A qualified expert shall be identified according to criteria given in Appendix-II who shall advise the reactor manager on the observance of the radiation protection programme.

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

23.4 *Reference Levels*

(1) To assist the reactor management in ensuring that radiation doses are kept as low as reasonably achievable and that the dose constraints are not exceeded, the licensee shall set reference levels for doses and/or dose rates and reference levels for radioactive releases that are below the authorized limits on releases. These reference levels shall be included in the OLCs and shall be set to comply with the radiation protection objective given in section 2 of PAK-911 "Regulation on Safety of Nuclear Power Plant Design". If the reference levels are exceeded, the licensee shall investigate the matter for the purpose of taking corrective action.

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

23.5 Control of Occupational Exposure

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 these records shall be made available to the Authority.

23.6 Radioactive Waste Management

(1) 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. Arrangements shall be put in place for the management of solid, liquid and gaseous radioactive waste in the research reactor and its ultimate removal from the facility. All activities concerning radioactive effluents and waste shall be conducted in accordance with the quality assurance programme.

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

(3) Written procedures shall be followed for the handling, collection, processing, storage and disposal of radioactive waste. These activities shall be carried out in accordance with the requirements of the Authority.

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

24. SAFETY ASSESSMENT AND AGEING RELATED ASPECTS

(1) The licensee shall conduct safety assessments throughout the operational lifetime of the research reactor. The scope of the assessments shall cover all safety related aspects of operation, including radiation protection, site re-evaluation, physical protection and emergency planning. In conducting the safety assessments, the licensee shall give due consideration to information drawn from operating experience and other relevant sources. A programme of comprehensive periodic review will fulfill this requirement for safety assessments. On the basis of the results of the safety assessments, the licensee

shall implement any necessary corrective actions and shall consider making justified modifications to enhance safety.

(2) The programme of periodic review shall cover aspects of the programme for the management of ageing to demonstrate the status of the facility with regard to ageing and to provide a basis for taking actions in relation to ageing. Thus, periodic reviews are operational tools to prevent and mitigate the effects of ageing and of modifications made around the site. Reviews of research reactor SSCs carried out by using non-destructive techniques are called in-service inspections. In-service inspections shall be conducted by the licensee under its programme for the management of ageing.

24.1 Peer Reviews

Some reviews of research reactors shall be performed as peer reviews by other operating reactors. Such peer reviews will provide access to the practices and programmes at other research reactors.

25. EXTENDED SHUTDOWN

(1) The licensee shall take appropriate measures during an extended shutdown to ensure that materials and components do not seriously degrade. The following measures shall be considered:

- (a) Unloading the fuel elements from the reactor core to the storage racks;
- (b) Changing the OLCs in accordance with the requirements for the shutdown reactor;
- (c) Removing components for protective storage;
- (d) Taking measures to prevent accelerated corrosion and ageing;
- (e) Retaining adequate staff in the facility for the purposes of performing the necessary inspection, periodic testing and maintenance.

Explanation: A research reactor facility may have a period of extended shutdown pending decisions on its future, owing to budgetary considerations, a lack of utilization or equipment failure, for example. While an extended shutdown may be planned, more often it will be unanticipated.

(2) The licensee shall take the necessary decisions as soon as possible to reduce the period of extended shutdown to a minimum. During a period of extended shutdown, the licensee shall consider the consequences of the

shutdown for the fulfillment of the licence conditions (e.g. for the physical protection of the fuel) and for the qualification of the operating staff.

26. REPEAL

Regulations 39(c), 40, 42, 62 and 63 of Pakistan Nuclear Safety and Radiation Protection Regulations, 1990 (SRO 957(I)/90) are hereby repealed.

Appendix-I

CRITERIA FOR LICENSING OF RESEARCH REACTOR OPERATING PERSONNEL

1. General provisions

- (1) Licence will be one of the prerequisites for the research reactor operations, in a specific category as per clause 3 below.
- (2) All Licenses will be issued by the Regional Directorates of the Authority.
- (3) Following two categories of nuclear research reactor operation licenses hereinafter called "Licence" will be issued to the operation personnel who will function in accordance with approved operation documents:
 - (a) Shift Supervisor Licence
 - (b) Reactor Operator Licence
- (4) The issuance of Licence shall be carried out in three different steps as per regulations 2, 3 and 4 of this Appendix.

2. Pre-Requisites

- (1) Each applicant for licence is required to undergo in-class and field training, to be arranged by the relevant research reactor management. After successful completion of in-class training and acquiring the prescribed minimum experience for each category as per section 4 of this Appendix, the candidate will become eligible to appear in the written licensing examination.
- (2) Licensing Examination:
 - (a) Each candidate has to qualify written, oral and operating examinations.

- (b) All the written licensing examinations shall be conducted by the relevant research reactor management.
- (c) Oral and operating examination of the persons, qualifying the written examinations as per section 7 of this Appendix and recommended by the Reactor Management will be conducted by Regional Directorate of the Authority.

3. Eligibility criteria

(1) Shift Supervisor Licence:

- (a) The minimum educational qualification for Shift Supervisor licence shall be as follows:
 - (i) Bachelors degree in Electrical, Mechanical, Electronics and Chemical Engineering or in an engineering discipline related to Nuclear Technology from a recognized University.
 - or
 - (ii) Master degree in Physics, Chemistry, Mathematics, Computer Science or Nuclear/Power Engineering or in a discipline related to Nuclear Technology from a recognized University.
- (b) The candidate shall possess a valid reactor operator Licence.
- (c) The candidate shall possess a minimum experience of one year in operation and maintenance of the relevant research reactor in case of engineers/scientists or five (05) years as licensed reactor operators working on the same reactor. These periods include in-class and field training arranged by the relevant research reactor management.

Explanation: For the first batch, previous operation experience of other Nuclear Power Plant/Research Reactor may be acceptable provided that they have participated in commissioning of the relevant research reactor.

- (d) The candidate shall qualify the written, operating and oral examinations as per sections 2(2) and 4 of this Appendix.

(2) Reactor Operator Licence:

- (a) The minimum educational qualification for Reactor Operator Licence shall be as follows:

- (i) three (03) year diploma from a recognized Polytechnic Institute in Electrical, Mechanical, Power or Chemical technology or in a discipline related to Nuclear Technology.
 - or
 - (ii) Bachelors of Science degree from a recognized University
- (b) The candidate shall possess a minimum experience of two years in operation and maintenance of the relevant research reactor. These periods include classroom and field training arranged by the relevant research reactor management.

Explanation: For the first batch previous operation experience of other Nuclear Power Plant/Research Reactor may be acceptable provided that they have participated in commissioning of the relevant research reactor.

- (c) The candidate shall qualify the written, operating and oral examinations as per regulations 2(2) and 4 of this Appendix.

4. Issuance of licence

(1) The technical knowledge, skills and abilities of a candidate, to perform the duties as per approved operation documents, in a safe manner under all operational and accident states will be determined through written, oral and operating examination. The written examination for licensing shall cover the following subjects:

- (a) Nuclear reactor theory
- (b) Heat Transfer and Fluid Flow
- (c) Nuclear Engineering
- (d) Reactor Process Systems, I&C
- (e) Radiation Protection
- (f) Nuclear Safety
- (g) Emergency Preparedness and Planning
- (h) Operating Policies & Principles or Technical Specifications
- (i) Radioactive Waste Management
- (j) Operating Procedures

(k) **Applicable Regulatory Requirements**

Explanation: The level of courses and questions for "Reactor Operators" will be of lower standard than that for "Shift Supervisors".

(3) Required Courses/syllabus for the training/retraining and the written examination for each category of licence shall be prepared by the relevant research reactor management and duly approved by the Regional Directorate (R-I) of the Authority.

(4) The candidate will qualify for operating test and oral examination only if all written test papers are passed separately. The pass marks for the written test will be 75% in each paper.

(5) The candidate will normally be allowed only two attempts to clear the operating and oral licensing examinations. In very exceptional cases and on specific recommendations/suggestions of the relevant research reactor management, a third chance may be allowed by Executive Member.

(6) The relevant research reactor management shall provide certification of medical (including psychological) fitness of the candidate. Such certificate will also record whether the candidate is or has been on prolonged medical treatment during the last twelve (12) months.

(7) Upon successfully clearing/passing the written, operating and oral examinations the licence will be issued by Regional Directorate of the Authority subject to medical fitness as per clause 6 above.

5. Retraining of operation personnel

(1) All licensed personnel will have to undergo a formal retraining to be arranged by the relevant research reactor management for a period of fifteen (15) working days during a calendar year.

(2) The licensed persons after retraining will be examined once per year by the relevant research reactor management and the assessment made by the management along with medical fitness certification will be sent to Regional Directorate of the Authority.

6. Validity and revalidation of licence

6.1 Validity

(a) All categories of licenses shall remain valid for a period of one (1) year. The licenses will be extended for a further period of one year by Regional Directorate of the Authority on

recommendation of the relevant research reactor management and certifying compliance with retraining according to section 5 of this Appendix.

- (b) A Licence is deemed to be automatically cancelled on one of the following reasons:
 - (i) inability of a licensed person to carry out duties for medical reasons as recommended by a duly constituted Medical Board;
 - (ii) permanent physical disability that renders the licensed person unable to carry out the duties;
 - (iii) lack of familiarity as a result of being away from operations of the relevant research reactor for which licence was issued, for a period of more than one year;
 - (iv) inability of licensed person to complete retraining successfully, as mentioned in section 5 of this Appendix;
 - (v) failure of a licensed person to perform a minimum of ten (10) shift duties during a year and participation in one startup. In case of Shift Supervisor the ten (10) shift duties should have been performed acting as independent In charge of the shift.

6.2 Revalidation

Licensed persons who are at the relevant research reactor but fail to perform ten (10) shift duties in reactor operations as Shift Supervisor or Reactor Operator or have remained away from the reactor operation (shift duties) for a period of more than a year but less than two years, can re-acquire operation license after the following:

- (a) Successful completion of retraining as provided in section 5 of this Appendix.
- (b) Performance of one month shift duty along with a licensed counterpart.
- (c) Oral and operating examination by Regional Directorate of the Authority to ascertain familiarity of the candidate with the current status of the research reactor and the reactor operating procedures.

- (d) Licensed person who remained away from the reactor operation (shift duties) for a period of more than two years will have to undergo complete re-examination.

7. Retention of record

Record of education, licence and renewal of licence, written examination/tests, medical fitness and all retraining exercises shall be retained by the relevant research reactor management for ten (10) years or two (2) years after formal withdrawal of the licence, whichever is later.

8. Waiver and exemption

On application from the relevant research reactor management, that issuance of a licence is in the national interest and recommendation of regional director, the Executive Member may waive any or all requirements for a licence if it is satisfied that the candidate has had extensive actual operating experience of the relevant research reactor, and that safety of the public and the environment will not be jeopardized or compromised by the issuance of the licence.

Appendix -II

CRITERIA FOR HEALTH PHYSICIST

The Health Physicist shall fulfill the following criteria:

- (a) hold a masters in science/health physics with an experience in radiation protection.
- (b) be familiar with the implementation of legislative and regulatory framework of the Authority on nuclear safety and radiation protection for general public and research reactor.
- (c) be familiar with the Emergency plans for accident situation and capable of implementing/exercising this plan by all organizations concerned. This capability to implement emergency plans shall be in place before the commencement of operation.
- (d) be familiar with procedure/principle for radioactive releases. Shall be capable of handling the emergency situations in which any failure or combination of failures leading to significant radiological consequences, the exposure to radiation of site

personnel and releases of radioactive materials to the environment is kept as low as reasonably achievable.

- (e) be familiar with the reporting of incidents significant to safety to the Authority in accordance with the relevant PNRA and international regulations.
- (f) be vigilant about the activities of operation, inspection, testing, maintenance & supporting functions, the personnel involved are adequately trained and authorized in accordance with nuclear safety and radiation protection procedures.
- (g) be familiar with procedures for radioactive waste treatment and interim storage and safe disposal thereafter.

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ABDUL MANNAN
Secretary.