

Extraordinary



Federal Republic of Nigeria

Official Gazette

No. 66

Abuja -14th November, 2008

Vol. 95

Government Notice No. 52

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

<i>S. I. No.</i>	<i>Short Title</i>	<i>Page</i>
22	Nigerian Radiation Safety in Industrial Irradiator Regulations, 2008	B 147-201

Printed and Published by The Federal Government Printer, Abuja, Nigeria
FGP 153/112008/650 (OL 51)

Annual Subscription from 1st January, 2008 is Local : ₦15,000.00 Overseas : ₦21,500.00 [Surface Mail] ₦24,500.00 [Second Class Air Mail]. Present issue ₦500 per copy. Subscribers who wish to obtain *Gazette* after 1st January should apply to the Federal Government Printer, Abuja for amended Subscriptions.

NIGERIAN RADIATION SAFETY IN INDUSTRIAL IRRADIATOR REGULATIONS, 2008



ARRANGEMENT OF SECTIONS

Regulation :

PART I—GENERAL

1. Objective.
2. Scope.
3. Application.

PART II—GENERAL REQUIREMENTS

4. Radiation Safety Requirements.
5. Authorization of the Practice.
6. Requirements for Authorization.
7. Duration of Authorization.
8. Responsibilities of the Licensee.
9. Management and Organizational Requirements.
10. Appointment of Radiation Safety Adviser.
11. Appointment of Radiation Safety Officers.
12. Qualification and Experience of Radiation Safety Officers.
13. Appointment of Qualified Operators.
14. Staff Training.

PART III—INDIVIDUAL MONITORING OF WORKERS

15. Statutory Dosimeters and Dose Records.
16. Protection of Personnel Dosimeters during Use.
17. Storage of Personnel Dosimeters.
18. Loss of Personnel Dosimeters.
19. Investigation of Doses.
20. Reading of Dosimeter.
21. Personal Alarm Monitor.

PART IV—WORKPLACE MONITORING

22. Maintenance of Workplace Monitoring.
23. Survey Meters.

24. Maintenance and Calibration.
25. Radiation Safety Philosophy.
26. Design of Irradiators.
27. Defense-in-Depth.
28. Redundancy.
29. Diversity.
30. Independence.
31. Programmable Electronic Systems.
32. Safety Analysis.

PART V—RESPONSIBILITIES OF DESIGNERS AND MANUFACTURERS,
IMPORTERS AND SUPPLIERS, CONSTRUCTORS AND INSTALLERS

33. Designers and Manufacturers.
34. Importers and Suppliers.
35. Constructors and Installers.
36. Arrangements for Visitors.
37. Testing and Maintenance of Equipment.
38. Weekly Tests.
39. Monthly Tests.
40. Bi-Annual Test.
41. Leak Test Criteria.
42. Leak Test Report.
43. Records.
44. Maintenance and Modification.
45. Operational Instructions.
46. Procedural Matters.
47. Control of Access Keys.
48. Portable Radiation Survey Monitor.
49. Entry Procedure.

PART VI—REGULATORY CONTROL

50. Stages of the Approval Process and its Review.
51. Requirements for the Applicant.

PART VII—SITE REQUIREMENTS

52. Geological Site Considerations.
53. Aircraft Crashes.
54. Chemical Explosions.
55. Other Important Human Induced Events.
56. Other Important Consideration.

PART VIII—DESIGN AND CONSTRUCTION REQUIREMENTS

57. Source Design.
58. Requirements of Industrial Irradiator Source Design.
59. Specific Requirements for Wet Storage Conditions.
60. Certification and Documentation.
61. Design and Construction of the Industrial Irradiator Building.
62. Source Holder and Rack.
63. Source Guard.
64. Product Positioning System.
65. Shielding.
66. Access to the Radiation Source and Interlocked Systems.
67. Personnel Access Door Interlocks.
68. Product Entry and Exit Port Interlocks.
69. Removable Radiation Room Shield Plugs.
70. Fixed Radiation Monitor with Alarms.
71. Source Status and Exposure System Interlocks.
72. Product Exit Monitor.
73. Water Treatment System Monitor.
74. Fully Shielded Facilities.
75. Control Console.
76. Access Key.
77. Emergency Stop Device.
78. Source Exposure Disconnection Mechanism For Servicing.
79. Safety Delay Timer with Alarms.
80. Emergency Exit or Shielding.
81. Emergency Stop Device.
82. Pool Accessories.
83. Pool Integrity.
84. Pool Component Material.
85. Water Level Control — Normal.
86. Water Level Control — Abnormal (low).
87. Water Conditioning.
88. Water Cooling.
89. In-pool Piping.
90. Pool Guard and Cover.
91. Fire Protection.
92. Power Failure —Electrical.
93. Non-electrical.
94. Ventilation.
95. Irradiation Device Warning Sign.
96. Irradiation Status Indicators.
97. Audible Signals.

- 98. Status Indicator Colours.
- 99. Labeling.
- 100. Importation of Sources.

PART IX—COMMISSIONING AND DECOMMISSIONING
OF INDUSTRIAL IRRADIATOR

- 101. Commissioning of the Industrial Irradiator .
- 102. Decommissioning of the Industrial Irradiator.
- 103. Removal of a Damaged or Leaking Source.

PART X—TRANSPORTATION OF RADIOACTIVE SOURCE

- 104. General Requirements.
- 105. Receipt of Radioactive Materials.
- 106. Dispatch of Radioactive Materials.
- 107. Empty Packages.
- 108. Unused Sources.
- 109. Dispatch of Consignment.
- 110. Transportation Routes.
- 111. Details of Consignment.
- 112. Security for the Consignment.

Part XI—Emergency Planning and Preparedness

- 113. Programme for Emergency Planning and Preparedness.
- 114. Consultation for Emergency Plan.
- 115. Implementation of Emergency Plan.
- 116. Initial Safety Assessment.
- 117. Sealed Sources.
- 118. Development of Emergency Plans.
- 119. Features of Emergency Plan.
- 120. Emergency Equipment.
- 121. Inspection and Maintenance of Emergency Equipment.
- 122. Training.
- 123. Emergency Exercises.
- 124. Periodic Reviews of Emergency Plans.
- 125. Accident Report.
- 126. Details of the Accident Report.

PART XII—OFFENCES, PENALTIES, APPEAL, INTERPRETATION
AND CITATION

- 127. Offences and Penalties.
- 128. Appeal
- 129. Interpretation.
- 130. Citation.

SCHEDULES

S. I. 22 of 2008

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

**NIGERIAN RADIATION SAFETY IN INDUSTRIAL
IRRADIATOR REGULATIONS**

[12th November, 2008]

Commence-
ment.

In exercise of the powers conferred on it by Section 47 of the Nuclear Safety and Radiation Protection Act 1995 and of all other powers enabling it in that behalf, THE NIGERIAN NUCLEAR REGULATORY AUTHORITY, with the approval of the President, hereby makes the following Regulations :

PART I—OBJECTIVE, SCOPE AND APPLICATION

1. These Regulations shall set up the basic technical and organizational requirements to be complied with by all operators of industrial irradiation facilities in Nigeria, in order to ensure the protection of human health and the environment from the hazards associated with ionizing radiation within and beyond the national borders of Nigeria to—

Objective.

(a) establish safety policies, principles, associated criteria, regulations and guidance upon which to base regulatory control ; and

(b) lay down a step-by-step procedure for the licensing of all stages of site, design and construction, commissioning, operation, modification and decommissioning of Industrial Irradiator and transport of its radioactive source.

2.—(1) These Regulations shall specify the minimum requirements for radiation protection and safety for all operators of all types of Industrial Irradiator, whether operated on a commercial basis or for research and development purposes.

Scope.

(2) It does not deal with radiotherapy or radiography units.

(3) It is solely concerned with radiation safety and does not deal with the uses of irradiation facilities and their requirements, nor does it cover the topics of the irradiation of products and their quality assurance.

3.—(1) The application of these Regulations shall be in addition to the Nigeria Basic Ionizing Radiation Regulations 2003 and any other existing ionizing radiation and nuclear regulations such as the Nigerian Safety and Security of Radioactive Sources Regulations, 2006 and the Nigerian Transportation of Radioactive Sources Regulations, 2006 in force.

Application.

(2) These Regulations shall apply to—

- (a) all types of industrial irradiators with possible exemption prior to authorization by the Authority ;
- (b) industrial irradiators installed, used or stored ;
- (c) the operation of industrial irradiators ;
- (d) the duties and responsibilities of the users, their internal safety organization and working procedures related to radiation protection ;
- (e) the monitoring of persons occupationally exposed and their work places ;
- (f) medical examination of persons occupationally exposed ;
- (g) radioactive sources or materials in storage or in transit ;
- (h) handling of wastes from sub regulation (2) paragraphs (a), (b), (c), (d), (e), (f) and (g) of this regulation ;
- (i) handling of radiological emergencies or accidents;
- (j) import or export requirements ;
- (k) quality control of equipment and calibration of instruments, et cetera ;
- (l) program for education, training and development ; and
- (m) handling of radiation injuries and medical preparedness.

PART II—GENERAL REQUIREMENTS

Radiation
Safety
Requirements.

4. The principal radiation safety requirements related to justification of the practice, dose limitation, optimization of protection and dose constraints, as specified in Nigeria Basic Ionizing Radiation Regulations 2003 shall apply to industrial irradiator.

Authorization
of the
Practice.

5.—(1) An applicant intending to carry out industrial irradiation practice or any of the following associated activities shall notify the Authority of his intention and obtain an authorization for the—

- (a) purchase, sale, manufacture, repair of or modification to, sealed sources used for industrial irradiation including ancillary equipment which incorporates radioactive materials such as depleted uranium source containers, etcetera ;
- (b) importation, transportation, handling and storage of sealed sources for industrial irradiation facility including ancillary equipment, which incorporates radioactive materials ;
- (c) site, design, construction, commissioning, operation and decommissioning of facilities for industrial irradiation ;
- (d) disposal of any sealed sources including ancillary equipment, which incorporates radioactive materials ; and

(e) transfer of ownership of any radiation generator or sealed source including ancillary equipment which incorporates radioactive materials or any facility used for industrial radiography.

(2) When applying for a Licence, the applicant shall provide documentary evidence to the Authority which demonstrates an adequate level of radiation safety provided and maintained.

6.—(1) An applicant shall provide all relevant information in his request for authorization to the Authority which shall include the following—

Requirement
for
authorizations.

(a) site, design and construction of facilities, equipment and radiation sources;

(b) systems for managing radiation safety, radiation safety programme, results of safety assessments and quality assurance procedures; and

(c) procedures for the safe operation of radiation sources including local rules and record-keeping.

7.—(1) Authorization granted by the Authority shall be renewed periodically as may be determined by the Authority.

Duration of
Authorization.

(2) The Authority may suspend or revoke the authorization where the Licensee is in breach of the licence conditions, the Act, the Nigeria Basic Ionizing Radiation Regulations or these Regulations.

(3) In order to be able to resume operation, the Licensee shall—

(a) reapply for authorization in case of revocation ; and

(b) reconsideration in case of suspension.

8.—(1) The Licensee shall be responsible for setting up and implementing the technical and organizational measures that are needed for ensuring the protection and safety of sources for which he is authorized.

Responsibilities
of the
Licensee.

(2) The Licensee shall—

(a) notify the Authority of all the activities stated in these Regulations ;

(b) notify the Authority of any intentions to introduce modifications to any practice or source for which he is authorized ;

(c) prepare and implement an operational radiation protection and safety programme including, the establishment of policies, procedures and standards for the safe keeping and use of radiation sources, the protection of workers and other persons ;

(d) appoint at least two or more Radiation Safety Officers to oversee the implementation of the radiation safety programme, provide such Radiation Safety Officers with appropriate authority and adequate resources ;

- (e) consult and appoint a Radiation Safety Adviser where necessary ;
- (f) perform the required Safety Assessments as contained in these Regulations :
- (g) ensure that workers are adequately trained in—
 - (i) radiation protection and safety ;
 - (ii) the operating procedures, local rules and emergency plans appropriate to the practice ;
 - (iii) specific types of equipment used within the organization ; and
 - (iv) provide workers with personal dosimeter and appropriate health surveillance ;
- (h) ensure that every equipment used for the practice is suitable for its intended and actual use and is properly maintained ;
- (i) provide workers with appropriate survey meters that are maintained, in good working conditions and tested regularly ;
- (j) ensure that adequate radiation monitoring is carried out and that records are kept ;
- (k) provide contingency plans for all reasonably foreseeable radiation accidents and incidents ;
- (l) make provisions for the safe disposal or return to the supplier of all existing radioactive sources that are no longer required ;
- (m) when applying for a new authorization for the importation, use or storage of any radioactive source including ancillary equipment that incorporates depleted uranium shielding, provision shall be made for a program for the safe disposal or return of radioactive sources to the supplier when they are no longer required ; and
- (n) ensure that any provider of radiation protection and safety related services for example, dosimeter laboratories are authorized or approved by the Authority.

Management
and
Organizational
Requirements.

9.—(1) The Management of the operating organization shall provide the human and material resources necessary to ensure safe working conditions and compliance with the Licence conditions.

(2) Every operating organization shall develop and promote a safety culture to encourage a questioning and learning attitude to protection, safety and discourage complacency.

(3) The safety culture shall include establishing and maintaining a radiation safety programme, the objectives which shall include the following elements—

(a) taking all practicable steps to ensure that the exposure of all persons is kept as low as reasonably achievable and below the dose limits set in these Regulations as in Schedule 1 ;

(b) taking all necessary steps to ensure the physical safety and security of radiation sources to minimize risk to persons not connected with the practice ; and

(c) compliance with these Regulations and Licence requirements, ensuring that all necessary tests, inspections and records are maintained to enable the operating organization to demonstrate compliance with these requirements.

10.—(1) The Operating Organization shall appoint one or more suitably qualified persons accredited by the Authority as Radiation Safety Advisers to advise on all matters concerning radiation safety in the use and operation of the industrial irradiator.

Appointment
of Radiation
Safety
Advisers
(RSA).

(2) The appointment may be on a part-time basis and the Radiation Safety Adviser need not be an employee of the organization but shall be available to give advice and help when required.

(3) The Radiation Safety Adviser shall also advise on regulatory matters in so far as they relate to radiation safety.

(4) The Radiation Safety Adviser shall have qualification not less than a Master Degree in Radiation Protection or its equivalent, registered with an appropriate professional body, experienced in radiation protection matters and have—

(a) such theoretical training as would ensure the necessary knowledge of the properties of the ionizing radiations used in the work undertaken by the Operating Organization ;

(b) a thorough knowledge of the hazards of the ionizing radiations present and the ways in which the hazards shall be controlled and minimized;

(c) an understanding and detailed knowledge of the working practices used in the establishment and a general knowledge of the working practices in other establishments of the same type ;

(d) a detailed working knowledge of all regulatory provisions, relevant codes of practice and protection standards, guidance material and other information needed for giving advice in connection with the work with ionizing radiation undertaken by the Operating Organization ;

(e) the ability to give advice to enable the Operating Organization comply with the requirements by these Regulations and follow good radiation protection practice ;

(f) the personal qualities to be able to communicate with the employees working or involved in the work with ionizing radiation and their representatives ;

(g) the ability to be up-to-date with developments in the use of ionizing radiation in the field in which he gives advice and with developments in radiation protection ;

(h) an awareness of legislation, in addition to that in paragraph (d) of this sub regulation and practices which may affect the work with ionizing radiation on which he gives advice.

(5) When an Operating Organization has appointed a Radiation Safety Adviser, the organization shall consult that adviser on matters that require expert advice, including—

(a) restriction of exposure and maintenance of engineering controls and other equipment provided for such restriction ;

(b) identification of controlled and supervised areas ;

(c) control of access to controlled areas ;

(d) dosimetry and monitoring ;

(e) drawing up written administrative procedures that define the means of complying with regulatory or other requirements ;

(f) selection of radiation protection officers ;

(g) investigation of abnormally high exposures and over exposures ;

(h) training ;

(i) deciding whether any special restrictions are required with respect to the exposure of female employees ;

(j) hazard assessment and contingency arrangements ;

(k) prior examination of any plans for new plant, premises or modifications to existing plant or premises from a radiation safety aspect ; and

(l) other aspects of radiation protection and safety that apply to the work with ionizing radiation carried out by the Operating Organization.

(6) The Operating Organization shall—

(a) not restrict the Radiation Safety Adviser from performing his function ;

(b) provide adequate information and facilities to enable him work effectively and the information shall include a clear statement of the scope of the advice the adviser shall be required to give ; and

(c) provide facilities including the necessary equipment and support services except in the case of an outside consultant who provides his own facilities.

(7) In establishments and organizations where there is a potential for serious exposures or substantial contamination which present special problems and demands for the services of the Radiation Safety Adviser, special support facilities shall be provided and such facilities shall be separate from production and operational units and management.

11.—(1) The Operating Organization shall also appoint at least two Radiation Safety Officers one of whom shall be the accounting officer.

Appointment
of Radiation
Safety
Officers
(RSOs).

(2) A Radiation Safety Officer's duties shall include ensuring that the written administrative procedures are implemented and the operating organization shall—

- (a) not restrict him from performing his function ; and
- (b) provide adequate information and facilities to enable him to work effectively.

(3) A Radiation Safety Officer shall—

(a) play a supervisory role in assisting the Organization to comply with the requirements of the approval or regulations ; and

(b) be directly involved with the work of ionizing radiation, preferably in a line management position that would allow him to exercise close supervision to ensure that the work is done in accordance with the written administrative procedures and at least one Radiation Safety Officer shall be available at all times.

(4) The Radiation Safety Officer may not be the immediate line manager or supervisor overseeing the work of ionizing radiation but his responsibility shall include—

(a) supervising the day-to-day radiation work to the extent necessary to ensure that procedures including local rules and licence conditions are complied with ;

(b) ensuring that operation manuals for all equipment are provided and are understood by the authorized users with translations into official language if required ;

(c) arranging for and supervising the use of personnel dosimetry and ensuring that the appropriate dose records are maintained ;

(d) ensuring that there is adequate monitoring of workplaces in order to prevent unnecessary exposure and to demonstrate compliance with national regulations and licence conditions ;

(e) determining the additional requirement for protection of any female staff engaged in the work with ionizing radiation that is or may be pregnant ;

- (f) maintaining radioactive material inventories or source records ;
- (g) identifying situation where a qualified expert shall be consulted ; and
- (h) any other relevant responsibility that would ensure a good level of safety.

(5) The Operating Organization owes a duty of general responsibility of compliance with these Regulations and the terms of the approval issued by the Authority which cannot be delegated to the Radiation Safety Adviser.

Qualifications
and
Experience
of Radiation
Safety
Officer.

12.—(1) No person shall be appointed as a Radiation Safety Officer unless he—

- (a) has a requisite qualification equivalent to a postgraduate diploma in Radiation Protection from a recognized institution ;
- (b) knows and understands the requirements of the approval and the written administrative procedures drawn up by the Radiation Safety Adviser as they affect the work supervised ;
- (c) commands sufficient respect from the people doing the work to be able to exercise the necessary supervision of radiation protection ; and
- (d) understands the necessary precautions to be taken and the extent to which these precautions restrict radiation exposures.

(2) The Operating Organization shall not delegate the responsibility for compliance with these Regulations to the Radiation Safety Officer.

Appointment
of Qualified
Operators.

13.—(1) Qualified operators are those who through training, experience, attitude and competence work most closely with particular industrial irradiator and shall be responsible for the day-to-day operation in order to establish the degree of safety associated with operation of the industrial irradiator.

(2) Each operator shall—

- (a) hold an appropriate certificate of competence and approved training, which is recognized by the Authority ;
- (b) be familiar with—
 - (i) the basic design, operation and preventive maintenance of the industrial irradiator ;
 - (ii) the principles and practices of radiation protection ;
 - (iii) the biological effects of radiation ;
 - (iv) the written procedures for routine and emergency industrial irradiator operation ; and
 - (v) the requirements of the Authority ;
- (c) know the exposure rate at all defined areas around the industrial irradiator and shall be familiar with area security safeguards such as locks,

posting of signs, warning lights, audible and visible signals and interlock systems ;

(d) be familiar with the radiation detection instrumentation which is used and the requirements for personal dose monitoring as specified by the Authority ;

(e) demonstrate competence in the use of radiation source and its related components, and to maintain the required operation logs and records; and

(f) be familiar with the overall organizational structure pertaining to management of the industrial irradiator, including specific delegations of authority and responsibility for operation of the industrial irradiator.

(3) Each worker who operates or maintains the industrial irradiator shall have the responsibility to ensure that the established safety procedures are observed.

14.—(1) The Operating Organization shall ensure that its employees who are engaged in work with ionizing radiation receive such information, instruction and training that would enable them to conduct the work in accordance with the requirements of the written rules of the organization.

Staff
Training.

(2) Training shall be both internal and external and the topics in which these employees shall be trained include—

- (a) the nature of ionizing radiation ;
- (b) the health hazard from such radiation ;
- (c) the basic principles and methods of protection for example shielding ;
- (d) measurement of radiation fields and the units of measurement ;
- (e) the plant safety systems, the warning signs and signals and any actions to be taken ;
- (f) safe operation of the plant ;
- (g) actions to be taken in emergencies ;
- (h) current technical information and other motivating factors ; and
- (i) regulatory processes.

(3) Training of workers shall be regular and updated, when necessary an annual review of staff training shall be undertaken, arrangement shall be made to ensure that all new staff receive the required training and that the training needs of staff affected by any internal reorganization are reviewed.

(4) The Radiation Safety Adviser shall provide advice on staff training needs, how those needs shall best be satisfied and in most cases, the Radiation Safety Adviser shall be able to provide much of the training that is required.

(5) The training specified in this regulation shall be in addition to that required to operate the industrial irradiator safely.

PART III—INDIVIDUAL MONITORING OF WORKERS

Statutory
Dosimeters
and Dose
Records.

15.—(1) An Employer shall assess the occupational exposure of all workers and any other person who may—

- (a) regularly work in controlled areas ; or
- (b) receive significant occupational exposure,

shall be provided with appropriate individual dosimeters to assess their cumulative occupational radiation exposure.

(2) The dosimeters coverage shall be subject to the following—

(a) the dosimeter shall be a film badge or a thermo-luminescent dosimeter ;

(b) the supplying laboratory shall be subject to the approval of the Authority ;

(c) the period for the use of a dosimeter shall be for a maximum period of three months ;

(d) every worker shall be required to wear additional dosimeters such as extremity thermo-luminescent dosimeter during source changes or additional dosimeters if neutron radiography is undertaken ;

(e) the statutory personal dosimeter shall be used only by the person to whom it is assigned ;

(f) the Licensee shall maintain a dose record for each worker in the manner specified in these Regulations ;

(g) the Licensee shall draw up a procedure to describe the way each worker's dosimeters are administered including any worker who—

(i) orders and receives the dosimeters from the dosimeter laboratory ;

(ii) distributes them to the operators and Radiation Safety Officer ;

(iii) collects them and dispatches them to the dosimeter processing laboratory ; and

(iv) reviews and maintains the dose records ;

(h) the Licensee shall obtain a copy of the worker's dose record from previous occupational exposure before he starts work ; and

(i) the Licensee shall also supply to a operator on termination of his employment relevant information on his record of service.

Protection
of Personnel
Dosimeters
during Use.

16. In order to ensure the protection of the personnel dosimeters, every monitored worker shall—

- (a) take good care of their dosimeters; protect them from loss, theft or damage ;

- (b) return them at the end of every specified period of usage ; and
- (c) inform the Radiation Safety Officer without delay, if any of their dosimeter is missing, damaged or has been accidentally exposed to radiation when not in use.

17. In order to ensure accurate reading of the dosimeters when not in use, the storage of each worker's dosimeters shall include the following elements—

Storage of
Personnel
Dosimeters.

(a) dosimeters shall be stored in a suitable environmental condition which shall not damage or affect the properties of the dosimeter ;

(b) each worker's dosimeters shall not be stored in source stores, near radioactive luminous items or in any other area where there are raised dose rates ; and

(c) dosimeters shall not go through x-ray mail inspection systems.

18.—(1) The Licensee shall take all reasonable steps to recover the loss of any dosimeter.

Loss of
Personnel
Dosimeters.

(2) If the dosimeter cannot be located, the Licensee shall carry out an investigation and prepare a report including an estimate of the dose received by the worker for the relevant period.

19.—(1) Result of personal dosimeters shall be reported to the Radiation Safety Officer who shall inspect them to determine whether unexpected high doses have been received and to determine whether every worker is keeping their doses within the dose limits.

Investigation
of Doses.

(2) In addition, the Radiation Safety Officer shall set investigation levels of doses above which a formal investigation and written report shall be prepared.

20.—(1) Direct reading dosimeters such as quartz fibre electrosopes shall be used to supplement the Thermo-luminescent Dosimeter or film badge, whenever it is important to have an immediate indication of exposure, for example, during emergency recovery of a source.

Reading of
Dosimeter.

(2) Such usage shall be subject to the following conditions—

(a) direct reading dosimeters shall be read or reset at the start of each work shift and then read at regular intervals with accurate records kept ;

(b) if the direct reading dosimeter exceeds a level set by the Radiation Safety Officer, the operator shall stop work and discuss the situation with the Radiation Safety Officer to establish how procedures might be improved ; and

(c) the Licensee shall ensure that direct reading dosimeters and personal alarm monitors are kept in good working condition and subject to regular operational checks.

Personal
Alarm
Monitor.

21. Every operator shall wear a personal alarm monitor that emits an audible and sometimes visible alarm when exposed to dose rates above a preset level as determined by the Radiation Safety Officer.

PART IV—WORKPLACE MONITORING

Maintenance
of
Workplace
Monitoring.

22. The Licensee shall develop and maintain a programme for workplace monitoring in order to—

- (a) evaluate radiological conditions ;
- (b) assess exposures in controlled and supervised areas ; and
- (c) review the classification of controlled and supervised areas.

Survey
Meters.

23.—(1) The Licensee shall ensure that a sufficient number of suitable radiation survey meters are available for the operator and Radiation Safety Officer.

(2) Radiation survey meters shall satisfy the following conditions for it to be suitable for the work environment—

- (a) survey meters shall be robust, waterproof if likely to be used in the rain and have an illuminated display if likely to be used in the dark ;
- (b) batteries shall be readily available ;
- (c) survey meters shall be scaled in units of dose rate and shall be able to indicate radiation levels from about $1 \mu\text{Sv h}^{-1}$ up to about 10 mSv h^{-1} ; and
- (d) the Licensee shall ensure that equipment obtained for this purpose is of a type approved by the Authority and that it comes with an operating manual and with an initial certificate of testing by the manufacturer or supplier.

Maintenance
and
Calibration.

24.—(1) The operator shall inspect the operation of the radiation survey meter at the start of each working shift.

(2) This inspection shall include—

- (a) battery condition ;
- (b) any other instrument checks such as high voltage setting ; and
- (c) background radiation level is as expected.

(3) Every radiation survey meter used during irradiation shall be checked regularly in compliance with—

- (a) normal tests as in sub regulation (2) of this regulation ;

(b) any specific inspection of instrument specified by the manufacturer ;

(c) inspection of indicated gamma dose rate versus actual dose rate at a range of dose rates to establish linearity of response ;

(d) inspection of indicated dose rate versus actual dose rate at a range of dose rates to establish linearity of response ; and

(e) over-load check to confirm that the survey meter indicator remains at maximum, under condition of a very high dose rate.

25. The objectives of radiation safety for industrial irradiator shall be to ensure that—

Radiation
Safety
Philosophy.

(a) during normal operation, maintenance, decommissioning and in emergency situations the radiation exposure of both workers and the public is kept as low as reasonably achievable principle ;

(b) during normal operation, maintenance, decommissioning, in emergency situations the radiation exposure of both workers and the public is kept below the relevant dose limits prescribed in the Nigeria Basic Ionizing Radiation Regulations ; and

(c) the probability of events giving rise to significant exposures and the magnitude of such exposures are kept as low as reasonably achievable, taking into account economic and social factors.

26. The design of any industrial irradiator shall comply with the principles of defence-in-depth, redundancy, diversity, independence and programmable electronic systems.

Design of
Irradiators.

27.—(1) The concept of defence-in-depth shall be applied to all safety activities, whether organizational, behavioural or design related, to ensure that the activities in industrial irradiator are covered by a series of provisions and in case a failure occurs, it may be compensated for or corrected.

Defence-in-
Depth.

(2) The design process shall incorporate defence-in-depth such that multiple levels of protection are provided and the necessity for human intervention is minimized which shall include—

(a) the provision of multiple means for ensuring each of the basic safety functions, that is, access control, shielding and the confinement of radioactivity ;

(b) the use of high integrity protective devices in addition to the inherent safety features ;

(c) the supplementing of the control of the industrial irradiator by automatic activation of safety systems and by operator actions ; and

(d) the provision of equipment and procedures to control the course and limit the consequences of accidents.

(3) The concept of defence-in-depth shall incorporate a series of levels of defence in terms of equipment and procedures provided in order to prevent accidents or to mitigate their consequences in the event that preventive measures fail—

(a) the aim of the first level of defence is to prevent deviation from normal operation which requires that the industrial irradiator be soundly and cautiously designed, constructed and operated, an appropriate quality assurance programme be established and maintained at all stages and in order to meet this objective, careful attention shall be paid to the—

(i) selection of appropriate design codes, materials and the control of fabrication of components and of irradiator facility construction, and

(ii) procedures involved in industrial irradiator inspection, maintenance and testing, ease of access to appropriate parts of the industrial irradiator to undertake these activities, the way the industrial irradiator is operated and the manner in which operating experience shall be utilized ;

(b) (i) the aim of the second level of defence is to detect and respond to deviations from normal operating conditions which shall help in preventing anticipated operational occurrences from escalating into accident conditions ; and

(c) (ii) it is however, recognized that radiation incidents do occur during the service life of an irradiation facility, despite the care taken to prevent them, the second level requires the provision of specific systems and the definition of operating procedures to prevent or minimize the consequences of such incidents ; and

(d) the aim of the third level of defence is to mitigate the consequences of an accident which is achieved particularly through the establishment of stable and acceptable conditions and also requires the provision of additional equipment and procedures.

(4) The industrial irradiator shall only be operated if all levels of defence are in place and functioning.

Redundancy.

28.—(1) In accordance with the principle of redundancy and in order to tolerate without loss of safety functions due to any failure or unavailability of one item, the following shall be provided—

(a) four or more interlocks shall be provided for a particular function when any two would be capable of carrying it out ;

(b) several types of radiation monitors ; and

(c) alternative powers sources.

(2) Identical or diverse components may be used for the purpose of redundancy.

29.—(1) The reliability of some systems can be enhanced by applying the principle of diversity to redundant systems or components that perform the same safety function by incorporating different attributes into the systems or components, such attributes can be different principles of operation, different physical variables, different operating conditions, production by different manufacturers, et cetera.

Diversity.

(2) The causes of potential failures shall be examined to determine where the principle of diversity may be applied effectively.

(3) Care shall be exercised to ensure that diversity actually achieves the desired increase in reliability in the implemented design; for example, to reduce the potential for failures, the designer shall examine the materials, components, manufacturing processes, operating principles and common support features for any similarities in the diverse components or systems.

(4) If diverse components or systems are used, there shall be reasonable assurance that they are of overall benefit, taking into account the disadvantages, such as added complication in operation and maintenance.

30. Independence shall be achieved in the design of systems through functional isolation and physical separation, however the reliability of systems may be improved upon by applying the following principles for independence in design—

Independence.

- (a) maintaining independence among redundant system components ;
- (b) maintaining independence between system components and the equipment designed to mitigate the effects of incidents ; for example, an incident shall not cause the failure or loss of a safety system or safety function that is required to mitigate the effects of the event ;
- (c) maintaining appropriate independence of systems or components of different importance to safety ; and
- (d) maintaining independence between items important to safety and those not important to safety.

31.—(1) Programmable Electronic Systems shall be used more often in safety control applications in order to avert problems that may arise relating to the integrity of the hardware and validation of the software, which may lead to faults in the system and designers of the Programmable Electronic Systems shall pay attention to problem areas.

Programmable
Electronic
Systems
(PES).

(2) Only fully trained and competent staff shall be allowed to alter software, however, procedures for doing so shall be formalized.

(3) No alterations to the software shall be made unless authorized by the Authority.

Safety
Analysis.

32.—(1) A formal method of assessment shall be used, including a hazard analysis technique such as probabilistic safety analysis, each component within the system shall be considered in turn, the likely types of failure and their consequences for the system as a whole shall be taken into account including consideration of the reliability of operating procedures where safety depends on them, encompassing both inadvertent and deliberate failure to follow procedures.

(2) The Operating Organization shall demonstrate to the Authority how the design of irradiation facility and related operational procedures will contribute to the prevention of accidents and mitigation of their effects.

(3) The information in sub regulation (2) of this regulation shall be provided in the form of documented safety analysis describing and evaluating the predicted response of the plant to incidents such as postulated malfunctions or failures of equipment, common cause failures, human errors, external events, *et cetera*, which could lead to accident condition.

(4) These analysis shall be extended to relevant combinations of such malfunctions, failures, errors and events, the analysis shall also show the extent to which the irradiation facility can control or accommodate situations related to the various operational stages and accident conditions.

(5) The results of the analysis shall be expressed in terms of the likelihood of the events, the extent of the damage to the barriers between the sources of radiation, the personnel, the public and as far as possible, in terms of the likely radiation doses to the personnel and the public.

(6) As failures and disturbances could range from relatively frequent events with minor radiological consequences on highly improbable events having serious consequences, the safety analysis shall facilitate the comparison of the events relating to both their probabilities and consequences to enable decisions to be made on the category of people to be taken into account in the design of the irradiation facility otherwise known as '*design basis events*'.

(7) For each initiating event and accident sequence, the extent to which process systems or a functioning part and safety systems are required to function under accident conditions shall be indicated.

(8) A representation in diagram such as an event tree of the sequences of the accidents associated with each initiating event be provided and the effects of the degradation of safety system components during normal operation and under accident conditions shall be evaluated.

(9) The accident conditions to be examined in the safety analysis report shall include—

- (a) loss of access control ;
- (b) malfunctions and failures of structures, systems and components ;
- (c) loss of control over the source movement system ;
- (d) loss of system or component integrity, including shielding, source encapsulation and pool integrity ;
- (e) electrical distribution faults, from very localized faults to complete loss of external energy sources ;
- (f) failure resulting from external causes such as storms, floods, earthquakes or explosions ;
- (g) failure of personnel to observe proper, safe procedures for whatever reasons ;
- (h) breakdown of procedures for preventing access to the irradiation facility by unauthorized persons ; and
- (i) breakdown of administrative procedures, leading to unsafe practices.

PART V—RESPONSIBILITIES OF DESIGNERS AND MANUFACTURERS,
IMPORTERS AND SUPPLIERS, CONSTRUCTORS AND INSTALLERS

33.—(1) The designers and manufacturers of irradiation facilities shall ensure that the facilities are designed to meet the radiation safety objectives as stipulated by the Authority which shall be achieved by—

Designers
and Manu-
facturers.

(a) carrying out research, testing and examination to ensure safe design for these facilities ; and

(b) ensuring that the Operating Organization of the industrial irradiator is provided with adequate information so that it can operate the irradiator safely and the information shall consist of—

(i) a detailed description of the design and operation of the safety systems, including control circuit diagrams,

(ii) detailed operating and maintenance procedures, including the type and frequency of checks for safety control systems, contamination monitoring and radiation surveys,

(iii) hazard assessments using formal analysis methods as appropriate to the level of risk associated with the industrial irradiator,

(iv) the Operating Organization also responsible to carry out a hazard assessment based on information from the supplier and the organization's own administrative rules ; and

(v) instructions and procedures to be followed in emergency situations as outlined in Section 26 of the Act.

(2) All documents provided by the manufacturer, supplier or installer such as operating manuals, operating rules, procedures and emergency procedures shall be carefully translated into the official language in co-operation with the Operating Organization, to avoid the risk of misunderstanding.

(3) Every Manufacturer or supplier shall ensure that any new information about the irradiation facility that relates to safety, for example defects in materials, equipment and weaknesses in operating procedures is provided to the Operating Organization as soon as possible, such information shall include any necessary advice on actions to be taken.

Importers
and
Suppliers.

34. Importers and suppliers shall ensure that the industrial irradiator is of safe design and that information on safe operating procedures, including those specified in regulation 33 of these Regulations passed on to the Operating Organization who shall make their own safety checks if they assembled the equipment.

Constructors
and
Installers.

35.—(1) Every constructor and installer shall ensure that their work does not compromise the safety aspects of the industrial irradiator, but shall comply with the requirements of the designer and the manufacturer.

(2) On completion of the installation or at appropriate stages in the construction and installation, the constructor or installer, in conjunction with a Radiation Safety Adviser, shall thoroughly and critically review the industrial irradiator or any component before it is commissioned to ensure that—

- (a) the safety features and warning devices have been properly installed and operate correctly ;
- (b) there is sufficient radiation protection for all persons and the environment.

(3) The constructor and installer shall also ensure that the Operating Organization is provided with adequate information for proper commissioning, operation, maintenance and decommissioning of the industrial irradiator.

(4) Every Designer, manufacturer, constructor, installer and the Operating Organization shall co-operate to ensure that employees of the Operating Organization are given the necessary theoretical and practical training to enable them to do their work in a safe manner.

Arrangements
for Visitors.

36.—(1) When visitors are permitted to enter the radiation room they shall be escorted by a qualified operator and the Radiation Safety Officer who shall survey the area immediately prior to the visit.

(2) Visitors shall wear dosimeter, which shall be read promptly and recorded after each visit.

37. In order to ensure the continued safe operation of the industrial irradiator, the Operating Organization shall ensure that all safety functions are tested regularly by setting up a formal programme of maintenance and testing where the following shall be carried out—

Testing and
Maintenance
of
Equipment.

(a) regular testing of safety interlock components for correct operation, according to the instructions of the equipment manufacturers, these tests shall be carried out by appropriately qualified persons in the presence of a Radiation Safety Officer ;

(b) calibration of portable radiation meters before they are first used, after repair and at intervals as specified by the Authority ;

(c) the pre-use test shall include a test of the instrument's overload performance, to ensure that it operates correctly up to the maximum credible dose rate it may encounter ;

(d) periodic examination of the hoist cable and guide cables and their replacement as required by existing national regulations or at intervals recommended by the manufacturers ; and

(e) periodic leak tests of the radiation sources in a manner and at a frequency determined as agreed with the source supplier, plant manufacturer and in accordance with national requirements.

38.—(1) The following tests shall be carried out weekly—

Weekly
Tests.

(a) a check to ensure that the continuous radiation monitoring device on the pool water circulation system is functioning correctly in the case of irradiation facility ;

(b) analysis of samples of pool water taken from the water circulation system or a less frequent analysis may be appropriate if experience shows this to be acceptable by a laboratory approved by the Authority ;

(c) a check of the water filter for correct operation and contamination ; and

(d) a check for correct function of the emergency stop button on the control console, the emergency stop device inside the radiation room, the door interlock and in the case of wet industrial irradiators, the water level control, the low pool water interlock and the water treatment system.

(2) Attempts shall be made to operate the industrial irradiator where the approved start-up procedure is deliberately violated, to ensure that the interlocks and sequential controls are functioning correctly.

39.—(1) These additional tests shall be carried out separately on a monthly basis—

Monthly
Tests.

(a) a test to ensure that the radiation room monitor is functioning properly which shall be done by exposing the monitor probe to a check source until the alarm sounds ;

(b) a check of the safety control systems which prevent access to the radiation room when there is any radiation present, this shall be done in accordance with the manufacturer's instructions ;

(c) a test to ensure that the product exit monitor is functioning properly with the industrial irradiator operating and exposing the monitor probe to a check source until the alarm sounds, when the product exit conveyor stops the source shall automatically become fully shielded ;

(d) a test of the source exposure mechanism, the ventilation system and similar hardware which contribute to the safe operation of the industrial irradiator and its related product positioning mechanism ;

(e) a check to ensure that other main items of equipment associated with source movement and control function properly without showing signs of potential failure ; and

(f) a check to ensure that all product containers are not damaged and in good condition.

(2) If any of the checks indicate a fault or the interlocks do not function properly, the industrial irradiator shall not be used until repairs have been carried out.

Bi-Annual
Test.

40. An inspection of the source movement and suspension system including the entire length of the cable shall be carried out bi-annually and where necessary the entire length of the cable shall be replaced.

Leak Test
Criteria.

41.—(1) Where the test results are considered negative that is, if the levels of contamination are less than those specified in the Nigeria Basic Ionizing Radiation Regulations, no action other than record keeping shall be required.

(2) Tests which reveal the presence of contamination on the test sample, shall be considered as an evidence that the sealed source is leaking and in such circumstance, the industrial irradiator shall be immediately withdrawn from service while appropriate action is taken to prevent exposure of personnel and further dispersal of radioactive material.

Leak Test
Report.

42.—(1) The Operating Organization shall immediately report to the Authority, the manufacturer of the equipment and the supplier of the source of the incident which has occurred and has caused or threatens to cause a radiation hazard.

(2) The report shall be as contained in the Second Schedule to these Regulations.

(3) Under no circumstances shall an unauthorized or untrained person attempt to examine or decontaminate the industrial irradiator.

43.—(1) A logbook or file shall be kept in which all tests, maintenance tasks, modifications or changes to the industrial irradiator including all usages shall be recorded. Records.

(2) The results of all tests described in sub regulation (1) of this regulation shall be recorded in a formal checklist signed by the Radiation Safety Officer who witnessed the tests.

(3) The compliance inspectors from the Authority shall pay attention to the records which shall be kept for such periods of time as are specified in the Nigeria Basic Ionizing Radiation Regulations.

44.—(1) Regular maintenance for all industrial irradiator components shall be done in accordance with the manufacturer's instructions. Maintenance and Modification.

(2) Every Manufacturer shall issue warning notices to advise Operating Organizations and the Authority of any previously unforeseen conditions which may cause accidents that have resulted in hazardous situations or that might have the potential to become hazardous and these notifications shall explain the corrective actions to be taken.

(3) The Operating Organization shall ensure that the corrective actions are implemented, unless there are reasons for not taking action in which case the consent of the Authority shall be obtained and the reasons recorded.

(4) Where there is need for modification it shall be undertaken by appropriately qualified persons with the approval of the Authority.

(5) The modification shall be thoroughly checked to ensure that they have been properly carried out to ensure that the safety aspects of the industrial irradiator have not been compromised.

(6) The Operating Organization shall notify the Authority and the supplier of the industrial irradiator of any modification.

(7) Approval shall be obtained from the Authority prior to any modifications which may cause a radiation hazard which include—

- (a) modifying operating procedures ;
- (b) modifying the safety control system ;
- (c) major modifications to the Industrial Irradiator ;
- (d) source loading, replenishment, removal or redistribution, in any way at variance with the agreed approval ; and
- (e) changes in supervisory personnel or advisers.

(8) The Operating Organization shall not be required to notify the Authority when performing routine maintenance procedures, including the changing of components, which do not cause a radiation hazard or compromise

the safety of the industrial irradiator, provided that approval conditions are not violated.

**Operational
Instructions.**

45.—(1) As the safe operation of the industrial irradiator depends on the operator following clearly defined procedures laid down by the manufacturer or supplier approved by the Authority, suitably trained and qualified persons shall be employed by the Operating Organization.

(2) Such employees shall be allowed to operate the industrial irradiator if specifically approved for that purpose by the Authority and shall be referred to as 'authorized personnel'.

(3) The requirements in sub-regulation (4) of this regulation shall apply equally to all workers who operate the industrial irradiator, whether or not they have been specifically authorized by the Authority.

(4) The operational instructions shall be fully understood by the authorized personnel including as a minimum, the following—

(a) a reminder of the nature of the hazard posed by the industrial irradiator and the safety features used to minimize the risks ;

(b) a reference to the existence and location of the written emergency procedures ;

(c) a description of the safety organization, including the functions, duties and responsibilities of the radiation safety adviser and officers ;

(d) the method of implementing the operating instructions and ensuring that the industrial irradiator is being operated safely which shall include—

(i) a description and schedule of the inspections and test procedures for ensuring that all safety interlocks, devices and components associated with the industrial irradiator are functioning properly ;

(ii) each safety item, the appropriate test, check and inspection for it shall be specified ; and

(iii) requirement that the operating procedures be made available at the control station and that the emergency procedures be conspicuously posted in the area ;

(e) the method of ensuring that all persons entering the controlled radiation area wear proper radiation monitoring devices and that the results are recorded ; and

(f) the method of ensuring that only authorized persons that is, qualified operators can use the industrial irradiator or have access to the area which include controlling keys to the door to the room containing the industrial irradiator control console, controlling operating console keys or other positive methods of excluding access.

(5) Written instructions shall be provided covering action to be taken in the event of machine malfunction which include a general outline of the action to be taken by the qualified persons who have been notified of a machine malfunction the correction of which may involve the source.

(6) The written instructions shall clearly state that remedial action in situations involving work around the industrial irradiator shall be attempted only by persons specially trained in radiological safety who are authorized to perform such work or under the direct supervision of such persons.

(7) In a situation where repair is done under the direct supervision of a person specially trained in radiological safety, entry to the radiation room shall never be made by one person alone.

46. The Operating Organization shall maintain the industrial irradiator as prescribed by the manufacturer, paying particular attention to ensure that all product positioning system components, product boxes and carriers continue to meet design specifications, for example, it is important to ensure that the correct product boxes or carriers are used and that they are maintained in a condition that would not cause a malfunction of the industrial irradiator.

Procedural
Matters.

47.—(1) Where access is achieved by a key interlocked system, the keys shall be controlled to ensure that the qualified operator who is entering the radiation room has the only key for each operation and that no other copies of key are available in the operating area that could allow another person to initiate startup or to gain access.

Control of
Access
Keys.

(2) Spare keys shall be kept in a safe outside the control room under the control of the Senior Manager.

48.—(1) Arrangement shall be made to ensure that a portable radiation survey monitor is carried out by the operator whenever he is entering the radiation room.

Portable
Radiation
Survey
Monitor.

(2) A check source shall be used to verify that the survey monitor is operating before each entry to the room and a similar spare survey monitor shall be available for use when calibration or repair of one monitor is required.

49.—(1) Arrangement shall be made to ensure that the operator checks that all visual indicators of the plant conditions show it is safe to enter the radiation room.

Entry
Procedure.

(2) In addition, administrative procedures shall be established for continuous monitoring of the radiation levels with the portable radiation survey monitor throughout the entry procedure.

PART VI—REGULATORY CONTROL

Stages of the
Approval
Process and
its Review.

50.—(1) The major stages of the approval process shall encompass the regulation of site, design, construction, transportation of the source, commissioning, operation, maintenance and decommissioning.

(2) The approval process shall be considered as ongoing, starting at the site planning and feasibility study stage and continuing through to decommissioning.

(3) Detailed assessment of all stages of Authorization shall be submitted to Authority.

(4) The fact that an approval has been granted shall not preclude a modification in the approval during the period of its validity.

(5) The modification of an approval may be desirable or necessary as a result of experience gained either during operation of the Industrial Irradiator or elsewhere, as a result of technological innovation or as a consequence of research and development with respect to radiation safety.

(6) The applicant may apply for such modifications or the Authority may impose it on the Licensee.

Requirements
for the
Applicant.

51.—(1) An applicant shall be responsible for ensuring safety in the site, design, transportation, construction, commissioning, operation, maintenance and decommissioning of the industrial irradiator and undertake to carry out the following activities—

(a) demonstrate to the Authority that workers, the public and the environment have been and will continue to be protected ;

(b) acquire a complete understanding of the industrial irradiator design and its safety aspects which would necessitate close co-operation with the manufacturer or supplier of the industrial irradiator ;

(c) make appropriate arrangements with the supplier to ensure that all information required for the application for approval is available ;

(d) make arrangements for the eventual removal of spent radioactive sources ;

(e) keep the Authority informed of any relevant information that might become available and of any alterations to the previously submitted information that might be relevant to the licensing process ;

(f) co-operate with the constructor and installer of the industrial irradiator to ensure that the construction or installation is undertaken according to the specifications ;

(g) ensure that workers are given appropriate and sound training and retraining to operate the industrial irradiator safely which shall involve

the co-operation with the supplier or manufacturer of the industrial irradiator ; and

(h) submit and make available to the Authority such information as might be required.

(2) The format and content of documents to be submitted by the applicant in support of an application for approval shall be obtained from the Authority prior to the application being made.

(3) The applicant shall note that the process of review and assessment of the information by the Authority is a continuous one.

(4) All relevant documents shall be submitted to the Authority at an early stage in order to facilitate a systematic review and assessment procedure and prevent unnecessary delay in the approval process.

(5) Other requirements might be imposed upon the applicant by the Authority which include—

- (a) appointment of radiation protection personnel ;
- (b) assessment of hazards and preparation of contingency plans ;
- (c) periodic tests and surveys of radiation protection and safety aspects of the industrial irradiator ;

(d) regular reports to the Authority on such matters in relation to the industrial irradiator such as—

- (i) senior staff changes,
- (ii) radiological data such as radiation surveys, contamination monitoring, personal dosimetry and medical surveillance,
- (iii) changes in operating practice that might have significant consequences for safety, contingency plan containing procedures to be followed in abnormal circumstances and this document shall be kept in a secure place,
- (iv) unusual occurrences such as significant malfunction of the safety control system, and
- (v) procedures governing the authorization of changes in site, design, construction, transportation of the source, commissioning, operation, maintenance and decommissioning in accordance with approval conditions and other regulatory requirements.

PART VII—SITE REQUIREMENTS

52.—(1) The Licensee shall take into account the physical properties of materials underlying the industrial irradiator site or its environs when evaluating the geological features that could adversely affect the integrity of the radiation shields.

Geological
Site
Considerations.

(2) Areas of potential or actual surface or subsurface subsidence, uplift or collapse shall be taken into consideration when assessing the suitability of a site.

(3) Other factors that are not necessarily due to natural features such as underground mining but may result in instability shall also be considered.

External Human Induced Events

Aircraft
Crashes.

53.—(1) The Licensee shall conduct hazard assessment and in doing so shall take into account potential for craft crashes on the site.

(2) If the assessment shows that there is a potential for an aircraft crash on site that could affect the safety of the installation or indicates that the hazards are unacceptable and where no practicable solutions are available, the site shall be deemed unsuitable if the assessment indicates that the hazards are unacceptable and where no practicable solutions are available.

(3) The hazards associated with an aircraft crash to be considered shall include fire and explosions.

Chemical
Explosions.

54.—(1) The Licensee shall identify activities in the locality of the industrial irradiator that involves the handling, processing, transport and storage of chemicals having a potential for explosions or production of gas clouds capable of deflagration or detonation.

(2) Hazards associated with chemical explosions shall be expressed in terms of overpressure and toxicity, if possible, with account taken of the effect of distance.

(3) A site shall be considered unsuitable if such activities take place in its locality and there are no practicable solutions available.

Other
Important
Human
Induced
Events.

55.—(1) The locality of the industrial irradiator shall be investigated for installations including installations within the site boundary in which flammable explosive, asphyxiate, toxic, corrosive or radioactive materials are stored, possessed, transported and otherwise dealt with so that, if released under normal or accident condition may jeopardize the safety of the installation.

(2) The potential effects of electromagnetic interference, eddy currents in the ground and clogging of air or water inlets by debris shall also be evaluated by the Operating Organisation.

(3) The site shall be deemed unsuitable if the effects of such phenomena and occurrences could produce an unacceptable hazard and where no practicable solution is available.

56.—(1) The Licensee shall collect and assess historical data concerning phenomena that have potential to give rise to adverse effects and the safety of the industrial irradiator such as earth tremor, flood, thunderstorm, land slide, *et cetera*.

Other
Important
Consideration.

(2) If the potentials are confirmed, the hazards shall be assessed and design basis for these events shall be derived.

(3) The site shall be deemed unsuitable where the hazards for the industrial irradiator are unacceptable and no practical solution is available.

PART VIII—DESIGN AND CONSTRUCTION REQUIREMENTS

57. Source design shall be based on the as low as reasonably achievable principle taking into account constraints specified in the Nigeria Basic Ionizing Radiation Regulations and the Authority may require an Operating Organization to submit evidence that the design of the source meets the objectives before granting Licence.

Source
Design.

58.—(1) The industrial irradiator source design shall conform with the general requirements for sealed sources given in ISO/TC 85/SC 2/WG UN 31C (Ref. [2]) the standards of which are contained in the Third Schedule to these Regulations.

Requirements
of Industrial
Irradiator
Source
Design.

(2) Where the activity of the source exceeds that given in the International Standards Organisation's standard, a specific evaluation of the use of the sealed source and its design shall be made by the manufacturer and the Operating Organisation.

(3) The manufacturer and user shall also take account of the possible effects of fire, explosion, corrosion, any aspect related to the continuous use of the sealed source in addition to those covered by sub-regulation (2) of this regulation and factors that shall be considered are—

- (a) the quantity of radioactive material contained in the sealed source ;
- (b) the radiotoxicity, leachability and solubility of the radioactive material ;
- (c) the chemical and physical form of the radioactive material ; and
- (d) the environment in which the source is stored, moved and used.

59.—(1) The outer capsule material shall be such that it does not significantly corrode under the conditions of storage of the sealed source in the pool taking into account the need to limit thermal fatigue in the selection of the capsule material.

Specific
Requirements
for Wet
Storage
Conditions.

(2) The source itself shall be substantially insoluble in water so that the consequences of a breach in the containment are kept to a minimum and in

this context, the use of ^{137}Cs in form of cesium chloride or other soluble radioactive compound shall not be authorized.

Certification
and
Documenta-
tion.

60.—(1) The source manufacturer or supplier and user shall maintain records relating to the sealed source and this information shall be provided as required by the Authority for the purpose of licensing of the industrial irradiator and transportation of the source.

(2) The records shall include the following—

(a) model number, identification number of the source, the contained radionuclide, the source activity and the date to which the source activity relates ;

(b) International Standards Organisation classification certificate ;

(c) Bend test certificate ;

(d) leak test certificate ;

(e) contamination test certificate ;

(f) special form test certificate for transportation purpose ; and

(g) any other documentation that may be required by the Authority.

Design and
Construction
of the
Industrial
Irradiator
Building.

61.—(1) The industrial irradiator building shall be designed in such a way that the quality control of components used receive the highest priority so that none of the industrial irradiator accessories is exposed to dust, heat, wind or rain from outside.

(2) The building shall be designed in such a way that the influence of ambient weather condition do not affect normal operation of the industrial irradiator.

(3) The Operation Organization shall submit to the Authority documents relating to quality control test and evidence of proper supervision of the various stages of construction of the building by qualified experts.

Design of Industrial Irradiator Accessories

Source
Holder and
Rack.

62.—(1) The sealed source shall be firmly fixed within its holder and rack so that it cannot be readily dislodged from them.

(2) There shall be provided means to position and retain the sealed source in the design position, devices used for positioning and removing sources shall be capable of being operated from outside the radiation shields and in the event of failure of the sealed source holder or rack, it shall not be possible for all the source to move into a position that may cause a radiation hazard.

Source
Guard.

63. The radiation source shall be provided with adequate mechanical protection to prevent interference and damage by items such as product boxes or carriers, for example, the mechanical protection may take the form of a protective shroud, guide bars or floor guides on the product positioning system.

(2) The product positioning systems shall not come into contact either directly or indirectly with the radiation source.

64. In order to avoid damage to the radiation source or its incorrect positioning which may result in radiation hazard, the product positioning system shall be provided with controls that detect any malfunction of the system, cause the source to automatically become fully shielded and the industrial irradiator to shut down.

Product
Positioning
System.

65.—(1) Direct radiation exposure from the operation of industrial irradiator shall be limited by appropriate shielding, the amount of shielding shall be determined by reference to any dose rate requirements specified by the Authority which may demand that the shielding calculation be done and submitted to it.

Shielding.

(2) The shielding design shall ensure that there is no direct radiation leakage path from ventilation, other ducts and that the use of maze entrances and shield plugs are sufficient to reduce the radiation fields at the point of exit to acceptable levels, where it is not feasible, access to areas of high dose rate shall be restricted and care taken to ensure that all significant radiation paths are fully evaluated.

(3) Notwithstanding the general guidance on shielding given in this regulation and other relevant publications of the Authority, all shielding calculations carried out for the purpose of design shall be undertaken by specialists.

66.—(1) Attention shall be paid to the accessibility of the radiation room in industrial irradiators in categories II and IV of Schedule III to these Regulations, the design of these facilities shall be such that no person shall have access to the radiation room while the source is in an exposed position.

Access to
the
Radiation
Source and
Interlocked
Systems.

(2) The control of such access shall rely heavily on the use of interlocked systems, thus interlocked controls shall be provided for personnel access, locking of the radiation room and irradiation operations, the interlocked controls shall be designed in such a way that any attempt to override them or apply them out of sequence would automatically abort the intended operation and require the sequence to be restarted.

67.—(1) There shall be provided means to ensure that the personnel access door to the radiation room is closed and secured before the irradiation process can begin, the door inter-locks shall be integrated with the master control system such that violation of the interlock system or use of the door would cause the irradiation to be automatically terminated and any failure of the control system shall generate visible and audible alarm signals.

Personnel
Access Door
Interlocks.

(2) The opening of the access door shall also interrupt the source hoist control circuit and cut off the motive power to the source hoist operating mechanism.

(3) The interrupted source hoist control circuit and the cut-off of the motive power to the source hoist operating mechanism shall be accomplished by independent actions.

Product
Entry and
Exit Port
Interlocks.

68.—(1) Suitable means shall be provided at the product entry and exit ports to prevent inadvertent entry of personnel into high radiation areas.

(2) The ports shall be interlocked in such a way that a visible or audible alarm shall indicate when the entry or exit port control mechanism has malfunctioned, been overridden or tampered with and the irradiation shall terminate when this occurs and shall not be restarted unless the cause has been remedied.

Removable
Radiation
Room
Shield
Plugs.

69. Removable radiation room shield plugs shall be interlocked with the master control system to prevent or terminate irradiation operations if a plug is removed and the interlock control shall be accessible outside the radiation shields.

Fixed
Radiation
Monitor
with Alarms.

70.—(1) A monitoring system with a built-in redundancy shall be provided to detect the radiation level in the radiation room when the irradiation is indicating it is terminated.

(2) The monitor shall be integrated with the personnel access door interlocks to prevent access to the room when the monitor detects a radiation level in excess of that specified, malfunctions or is turned off.

(3) The monitor shall generate visible and audible alarm signals if the radiation level exceeds that specified when the irradiation is indicating it to be terminated.

(4) As the situation in sub regulation (3) of this regulation is a potentially hazardous situation in which it may be necessary to override interlocks or other safety systems, written administrative procedures shall provide detailed guidance for correcting such actions, which shall only be undertaken under the direct control of a Radiation Safety Officer.

Source
Status and
Exposure
System
Interlocks.

71.—(1) There shall be provided means to ensure that, if a malfunction occurs in the source exposure mechanism, the radiation source shall automatically become fully shielded.

(2) There shall be provided means to prevent access and provide a visible and audible signal if the source cannot be returned to its shielded position.

(3) An alarm which is audible both inside the radiation room and at all access ports shall be provided to indicate when the radiation source is neither fully shielded nor in the 'source in use' status.

72.—(1) A fixed radiation monitoring system with a built-in redundancy and audible alarms shall be located in such a way that the monitors can detect any part of a radioactive source being brought out on a product carrier.

Product Exit
Monitor.

(2) These monitors shall be interlocked with the irradiation controls, so that if radiation at the exit port exceeds a predetermined level, the conveyor which carries products from the radiation room to the exit port would stop and the source automatically become fully shielded.

73.—(1) A fixed radiation monitor with an audible alarm shall be located on the deionizer column to detect contamination arising from source leakage.

Water
Treatment
System
Monitor.

(2) This monitor shall be interlocked with the irradiation controls so that the source returns to its shielded position when the radiation reaches the preset alarm level, the water circulation shall stop.

(3) The level shall be set above the natural background level to avoid an excessive number of false alarms.

74.—(1) The industrial irradiator shall not be operated until all shielding is in place and all other safety devices are actuated.

Fully
Shielded
Facilities.

(2) Movable shielding shall be interlocked so that it cannot be displaced in a manner that results in radiation levels in excess of those specified in the design.

(3) An interlocked radiation monitor shall be provided as a backup check that the shielding is in place.

75.—(1) The industrial irradiator shall have a master control that shall be used to prevent unauthorized operation and in power operated industrial irradiator facilities, this control may be a key operated switch while in manually operated industrial irradiators, a keyed mechanical lock or simple padlock may be used.

Control
Console.

(2) There shall be provided means to terminate an irradiation and return the industrial irradiator to its 'source not in use' status at any time.

76.—(1) The industrial irradiator controls shall be designed in such a way that a single multipurpose key is used to operate the industrial irradiator during normal use.

Access Key.

(2) The key shall be used to operate the control console, to gain access to the radiation room and to actuate the safety delay timer.

(3) In industrial irradiator systems employing two or more keys, one key must remain captive when the other keys are being used.

Emergency
Stop Device.

77. In addition to any other means normally available at the control console to shut down the industrial irradiator, a clearly labeled emergency stop device shall be provided at the control console to prevent, quickly interrupt or abort industrial irradiator operations and terminate the irradiation at any time.

Source
Exposure
Disconnect-
ion
Mechanism
for
Servicing.

78.—(1) The motive power such as electrical, pneumatic, hydraulic used to expose the source shall be provided with a disconnecting mechanism to enable servicing to be carried out without the danger of the source being inadvertently exposed.

(2) There shall also be provided means to positively isolate the source control system or to mechanically lock the moving parts.

Radiation Room

Safety Delay
Timer with
Alarms.

79.—(1) The radiation room shall be equipped with a safety delay timer which shall automatically generate visible and audible signals to alert persons in the area that the source exposure sequence has begun.

(2) The timer shall allow sufficient time for the operator to make a complete search of the area to ensure that no one else is present and then to leave the area.

(3) The timer shall be integrated with the master control system so that irradiation cannot begin unless the startup sequence has been properly completed within a preset time.

(4) Closed circuit television and communication systems shall be provided to view and communicate the radiation room in case of an unexpected occurrence.

Emergency
Exit or
Shielding.

80. For the protection of anyone inadvertently shut inside the radiation room, one or more of the following systems shall be provided—

(a) a means of exit from the radiation room which may require a system for opening the personnel access door from inside the radiation room, thus activating the normal safety interlocks ; or

(b) a clearly marked location where radiation dose rates are sufficiently low, where the trapped person can move to, to avoid excess irradiation.

Emergency
Stop Device.

81.—(1) There shall be provided means within the radiation room to prevent, quickly interrupt or abort industrial irradiator operations and terminate the irradiation at any time.

(2) The devised means shall be clearly labeled and readily accessible to workers in the radiation room and shall cause a visible or audible signal to be given outside the room.

Wet Storage Industrial Irradiators

82.—(1) Water shall be used as the radiation shielding medium in wet storage industrial irradiators and an automatic water level control shall be provided to maintain the water above a preset level.

Pool
Accessories.

(2) Every component of the automatic water level control that are placed below water level shall be made of a material with a specific gravity of 1.000 or more, except for float switches.

(3) If hollow tubing is used, it shall be fully vented to allow the water to flood the tubing in order to eliminate the risk of a high radiation beam up the tube.

83.—(1) The containment of the pool shall be watertight and designed to retain water under all foreseeable circumstances.

Pool
Integrity.

(2) A non-corrodible stainless steel liner shall be used and the containment shall be designed to support radiation source transport containers used during source transfer operations without compromising the integrity of the pool.

(3) There shall be no penetration such as pipes or plugged holes through the bottom of the pool and be no penetration through the walls of the pool more than 300 mm below normal water level.

84. All permanent pool components shall be made of corrosive resistant materials which may affect the integrity of the sealed source and where practicable, stainless steel components such as brackets or pulleys shall be used which shall be passivated particularly after fabrication.

Pool
Component
Material.

85.—(1) There shall be provided means to automatically replenish water losses due to evaporation.

Water Level
Control—
Normal.

(2) The means shall be capable of maintaining the pool water at a level sufficient to provide the necessary radiation shielding.

(3) A device meter shall be installed in the make-up water supply line to indicate major changes in water replenishment requirements that may be associated with pool leakage.

Water Level
Control—
Abnormal
(low).

86. There shall be provided means to activate audible and visible signals in the control area if the pool water falls to a level more than 300 mm below the normal make-up water level.

Water
Conditioning

87.—(1) The pool shall be equipped with a water conditioning system capable of maintaining the water in a clean condition and at a level of conductance not exceeding 1000 $\mu\text{S}/\text{m}$ which shall reduce the possibility of corrosion of the sealed source.

(2) Care shall be taken to avoid the introduction of contaminants into the water system such as deionizer regenerants, cleaning materials, corrosive fire extinguishing materials and spilled product.

Water
Cooling.

88.—(1) As a result of heat produced by industrial irradiator emitting sources, high humidity levels may damage the electrical equipment, the product boxes and the product positioning system and where such damage is likely to occur—

(a) an appropriate pool water cooling system shall be provided ; or

(b) reduction in evaporation losses from the pool shall also be reduced to facilitate maintenance of the conductance of the water below 1000 $\mu\text{S}/\text{m}$ for a longer time before regeneration or replacement of deionizer resins is required.

In-pool
Piping.

89.—(1) Suitable siphon breakers shall be provided to prevent the siphoning of pool water to lower than 300 mm below the normal make-up water level since pipes are used in source storage pools for the water level and water quality systems.

(2) Every pool water circulation suction pipes shall have intakes not lower than 300 mm below the normal make-up water level.

Pool Guard
and Cover.

90.—(1) A physical barrier, such as a railing and a metal cover shall be installed to prevent personnel from accidentally falling into the source storage pool.

(2) This physical barrier may be removed during maintenance or service operations.

Fire
Protection.

91.—(1) Heat and smoke sensing devices with visible and audible alarms shall be provided to detect combustion in the radiation room.

(2) The triggering of the devices shall cause the source to automatically become fully shielded, the product positioning and ventilation systems to shut down.

(3) The design of the industrial irradiator shall be such in such a way that fire damage to any component part cannot inhibit the source from returning to the fully shielded position.

(4) A fire extinguishing system shall be provided in the radiation room and where a water sprinkling system has been installed, provision shall be made to control any overflow of water that may arise from its use.

(5) Chemicals and corrosive substances that may adversely affect the integrity of the sealed source shall not be used in fire extinguishing systems.

Power Failure

92.—(1) There shall be provided means to ensure that, if an electrical power failure occurs, the source shall automatically be returned to the fully shielded position and the industrial irradiator shut down. Electrical.

(2) The safety control system shall not be compromised in the event of a power failure and such means shall be designed to appropriate standards as may be specified by the Standards Organization of Nigeria.

93. There shall be provided means to ensure that failure of non-electrical power such as pneumatic or hydraulic power which is used to control or operate any Industrial Irradiator safety feature or device shall cause the source to automatically become fully shielded and the Industrial Irradiator to shut down. Non-electrical.

94.—(1) Measures shall be taken to protect personnel against exposure to concentrations of ozone and other noxious gases produced by radiolysis above the threshold limit values prescribed by the ministry responsible for environmental matters. Ventilation.

(2) The industrial irradiator shall be designed to prevent the migration of the ozone produced in an industrial irradiator into areas that may be occupied and where the concentration may potentially build up to exceed the currently accepted limit to be achieved by using a ventilation system that creates a negative pressure in the radiation room.

(3) Where forced air systems are utilized, the flow of air shall be continuously monitored in such a way that failure of the system shall automatically terminate irradiation.

(4) A large capacity continuous operated ventilation system shall be used so as to reduce the delay time for entering the irradiation room after termination of irradiation.

(5) A time delay interlock mechanism which prevents personnel access doors from being opened before ozone concentration is at acceptable level in the irradiation room shall be installed.

Warning Signs and Symbols

Irradiation
Device
Warning
Sign.

95.—(1) There shall be a clearly visible sign at the personnel access door to the radiation room bearing the radiation symbol and Warnings according to the Nigeria Basic Ionizing Radiation Regulations.

(2) Any warning signs positioned inside the radiation room shall be made from materials that can withstand high doses of radiation and the general environmental conditions that may exist.

Irradiation
Status
Indicators.

96.—(1) Clearly visible irradiation status indicators shall be provided at the control console to indicate—

- (a) when the irradiation is terminated that is, source down ;
- (b) when the irradiation is in progress that is, source up ; and
- (c) when the irradiation is in preparation that is, source in transit position.

(2) An irradiation status indicator shall be visible at each personnel, product entry or exit port.

Audible
Signals.

97. Each audible signal designed into the industrial irradiator control system shall be distinct and loud enough to attract the immediate attention of persons in the area and shall not be capable of being confused with any other signals in use in the area.

Status
Indicator
Colours.

98. The following colours are recommended for use when illuminated or colour coded controls are used are as contained in Appendix B to Third Schedule of these Regulations.

Labeling.

99.—(1) Category I industrial irradiators shall have clearly visible labels identifying the contained radionuclides, their activities, the dates to which the source activities relate and the industrial irradiator shall bear the radiation symbol and warnings as may be specified by the Authority.

(2) The industrial irradiator shall also bear a label or labels with the following information—

- (a) name and address of manufacturer ;
- (b) model and serial number of industrial irradiator ;
- (c) approval number if appropriate ; and
- (d) maximum source activity of industrial irradiator.

(3) Where a separate control panel or console is utilized, it shall be easily identified as being part of the industrial irradiator.

(4) When labels are being secured on fully shielded industrial irradiators, care shall be taken not to drill through the metal container shell into the lead shield.

100.—(1) The Operating Organization shall plan all importation properly by obtaining information on the Authority's requirements and use such information in ordering their sources. Importation of Sources.

(2) This information together with the project concept shall be made available to the manufacturer or supplier to enable them select suitable source configuration for the planned project.

(3) Request for import licence shall be accompanied by transport schedules to enable the Authority ascertain that the importation of such source does not violate the provisions of the Nigerian Basic Ionizing Radiation Regulations and the international regulations.

(4) The Operating Organization shall ensure that all documents concerning the source design are made available to the Authority.

(5) The Operating Organization shall also submit the schedule for installation, commissioning and use of the source prior to actual importation of the source.

(6) The document to be presented shall include evidence on what to do with the source when it is no longer in use or is depleted which may be in form of an agreement with the manufacturer or supplier to return source back to them or an agreement with a waste management organization in Nigeria on disposal of the source after use.

PART IX—COMMISSIONING AND DECOMMISSIONING OF INDUSTRIAL IRRADIATOR

101.—(1) Commissioning programme may be divided into two phases, cold commissioning and hot commissioning— Commissioning of the Industrial Irradiator.

(a) the cold commissioning - involves installation of the industrial irradiator accessories, testing them and certifying their functionality including staff training and certification on operation of the industrial irradiator system ; and

(b) the hot commissioning - involves the measurement of background radiation level, loading of the radioactive sources, measuring radiation level after installation, testing the functionality of the system after loading and certification of the operators and Radiation Safety Officers.

(2) In order to avoid dose rates in excess of doses experienced in normal operations of the industrial irradiator during loading and unloading, an

evaluation of procedures shall be made in advance to ensure that the exposure of persons is kept as low as reasonably achievable.

(3) An assessment shall also be carried out on any safety hazards associated with the loading and unloading work, where necessary any contingency plan shall be incorporated into the written instructions for operation of the industrial irradiator.

(4) The integrity of the safety control systems shall not be compromised by the source loading and unloading procedures.

(5) The loading and unloading of the radioactive source on arrival at the industrial irradiator or on dispatch from it shall be carried out under the close supervision of the Radiation Safety Officer.

(6) The Operating Organization shall obtain from the supplier all information needed for the safe transportation of the source.

(7) Results of tests carried out and duly signed by a qualified personnel representing the Operating Organization shall be made available to the Authority for the purpose of authorizing the operation of the industrial irradiator after showing that the operators are well trained and certified.

(8) Further certification shall be made by the Authority and where possible, approval of the certification of operators and Radiation Safety Officers.

Decommissioning of the Industrial Irradiator.

102.—(1) The procedure for decommissioning shall be submitted and approved by the Authority before decommissioning work starts.

(2) The Operating organization shall show evidence that the decommissioning of the facility is foreseeable at the on-set and under emergency situations when applying for commissioning Licence.

Removal of a Damaged or Leaking Source.

103.—(1) Where an actual or suspected source leakage has occurred, the use of the Industrial Irradiator shall be terminated, a decision taken as to the desirability of closing down the water circulation and air ventilation systems to prevent the spread of contamination and exposure of workers.

(2) The affected area shall be isolated and contact shall be established with the following, as appropriate, for the purpose of obtaining assistance—

- (a) the Authority ;
- (b) the Radiation Safety Adviser ;
- (c) the manufacturer of the source ; and
- (d) the supplier and the installer of the source, if different from the manufacturer of the source.

(3) Removal of the defective source shall be prompt, once the decision to remove it has been made and shall be performed by, or under the supervision and in the presence of a person or persons authorized by the Authority.

PART X—TRANSPORTATION OF RADIOACTIVE SOURCES

104.—(1) The transportation of sealed sources shall comply with the requirements of the International Atomic Energy Agency for Safe Transport of Radioactive Materials, TS-R-1, and Nigerian Transport of Radioactive Sources Regulations.

General
Requirements.

(2) The following steps shall be taken in proper packaging and transportation of Radioactive sources—

(a) the package shall be suitable for its intended use and the modes of transport involved ;

(b) industrial irradiator sources shall be transported only in Type B packages that has a valid certificate.

(c) the Licensee shall have a valid copy of the certification ;

(d) industrial irradiator sources shall locked in their shielded position and any key removed ;

(e) all shipping plugs or caps shall be fitted correctly and, where possible, locked in place ;

(f) the package shall be in good condition, fit for transport and labeled correctly ;

(g) radiation levels shall be measured at the surface of the package at one meter from it to ensure that the levels are within allowed limits and to ensure that appropriate shipping labels are displayed ;

(h) applicable shipping labels shall be applied to the outer surface of the package based on the radiation levels obtained ;

(i) a radioactive source for transportation shall have a valid leak test certificate and if not, a leak or wipe test shall be performed on the outer surface of the source container and the shipping package before shipment ;

(j) the package shall be properly secured and braced in the transport vehicle ;

(k) the vehicle carrying the package shall have placards on both sides of the vehicle and on the rear of the vehicle with radioactive placards as defined in the Nigerian Transportation of Radioactive Sources Regulations and in the International Atomic Energy Agency (TS-R-1) ; and

(l) appropriate transportation papers shall accompany the shipment for example consignor's statement and information for the carrier, such as emergency contact details.

Receipt of
Radioactive
Materials.

105.—(1) Prior to each shipment of radioactive, the Licensee shall make necessary arrangements with the source supplier, to receive all relevant information which shall include the following for each package or container—

- (a) the nuclide, number and activity of sources ;
- (b) a description of the source, construction and performance tests, including leakage tests ;
- (c) special form approval certificate ;
- (d) a description of the package ;
- (e) approval certificate for Type B packages or Statement of compliance with the requirements of the International Atomic Energy Agency (TS-R-1) for other packages ;
- (f) details of any special arrangements required, including multilateral approvals, where necessary; and
- (g) a copy of the transportation documents to be sent to the Licensee by fax or e-mail before dispatch, if possible.

(2) The Licensee shall not agree to the dispatch of the consignment by the supplier, unless all the items listed in sub-regulation (1) of this regulation are complied with.

(3) The supplier and Licensee shall agree on the transportation route and responsibility for each stage of the journey.

(4) Arrangements shall also be made for the followings where necessary—

- (a) checking of radiation dose rates from the package or container ;
- (b) ensuring that the correct transport labels are attached to the package or container, and replacing any that is damaged or illegible ;
- (c) ensuring that the package or container is securely attached to the vehicle and that the vehicle is correctly labeled ;
- (d) dealing with border controls ; and
- (e) security of the consignment during transport, particularly during delays or overnight stops.

Dispatch of
Radioactive
Materials.

106.—(1) The Licensee shall return packages or containers to the source supplier after receipt of a consignment of radioactive material.

(2) All requirements in the Nigerian Transportation of Radioactive Sources Regulations and International Atomic Energy Agency (TS-R-1) concerning packaging, labeling, placarding, where necessary, consignor responsibilities and all authorizations and approvals shall be met before dispatching radioactive materials.

107. With regard to returning empty packages the Licensee shall—

Empty
Packages.

(a) carry out dose rate and contamination monitoring of both the inside and outside of the package or container to ensure that there is no residual radioactive material present so that it can be treated as an empty package or container ;

(b) remove or cover all transport labels relating to the sources contained in the package or container when received ;

(c) examine the package or container to ensure that it is in good condition with reference to any procedure provided by the source supplier before closing it securely ;

(d) attach a label to the outside of the package or container stating "UN 2908 RADIOACTIVE MATERIAL EXCEPTED PACKAGE — EMPTY PACKAGING" ;

(e) complete a transportation document ;

(f) contact the source supplier and agree on the transport route and responsibility for each stage of the journey; and

(g) inform the source supplier of the proposed date of dispatch.

108. With regard to returning unused sources, the Licensee shall provide the following information to the consignee for each package or container—

Unused
Sources.

(a) the nuclide, number and activity of sources ;

(b) a description of the source construction including leakage tests ;

(c) special form approval certificate ;

(d) a description of the packaging in which the source is to be transported ;

(e) approval certificate for Type B package, or statement of compliance with the requirement of the International Atomic Energy Agency (TS-R-1) for other packages ;

(f) details of any special arrangements required, including multilateral approvals, where necessary ; and

(g) a copy of the transportation documents to be sent to the consignee by fax or e-mail before dispatch, if possible.

109. The Licensee shall not dispatch the consignment, unless he has received confirmation from the consignee that he is prepared to accept it.

Dispatch of
Consignment.

110.—(1) The Licensee and consignee shall agree on the transportation route and the responsibility for each stage of the journey.

Transportation
Routes.

(2) The Licensee shall be responsible from dispatch until the consignment reaches the consignee's premises and other arrangements are satisfactory, provided both parties agreed in advance and that agreement is also acceptable to the regulatory authorities.

Details of
Consignment.

111. In order to prepare the consignment for dispatch, the Licensee shall—

(a) load the sources into the package, verifying the details to be provided to the consignee such as serial numbers and comparable information to be entered on the transport document ;

(b) close it securely and before examining the package or container to ensure that it is in good condition, with reference to any procedure provided by the source supplier ;

(c) carry out contamination monitoring of the outside of the package or container to ensure that there is no residual radioactive material present and therefore suitable for transport ;

(d) carry out dose rate monitoring of the package or container and attach appropriate transport labels ;

(e) refrain from using the transport labels relating to the sources contained in the package or container when received ; and

(f) complete a transportation document.

Security for
the
Consignment.

112. Arrangements shall also be made for—

(a) ensuring that the package is securely attached to the vehicle and that the vehicle is correctly labeled ;

(b) dealing with border controls ; and

(c) providing security for the consignment during transportation, particularly during delays or overnight stops.

PART XI—EMERGENCY PLANNING AND PREPAREDNESS

Programme
for
Emergency
Planning
and
Preparedness.

113. Where a safety assessment identifies that an accident is likely to affect workers or members of the public, the Licensee shall prepare emergency plans which are designed to secure the protection and safety of anyone who may be affected by such accident.

Consultation
for
Emergency
Plan.

114.—(1) A Radiation Safety Adviser shall be consulted when drawing up emergency plans.

(2) Emergency planning and preparedness shall comprise the following stage—

(a) identification of potential accidents and other unplanned events during industrial irradiation and an evaluation of the risks associated with them ;

(b) development of emergency plans to deal with the identified hazards ;

- (c) specification and acquisition of emergency equipment ;
- (d) training to implement the emergency plan, including necessary training in the use of the emergency equipment ;
- (e) exercises at appropriate intervals to test the implementation of the emergency plan ; and
- (f) periodic reviews and necessary updates of the emergency plans.

115.—(1) The Licensee of industrial irradiator organisation shall be responsible for adequately implementing each of the six stages contained under regulation 114 sub regulation (2) of these Regulations.

Implementa-
tion of
Emergency
Plan.

(2) The resulting emergency plans and associated arrangements shall form a part of the license application to the Authority.

(3) Implementation of the emergency plan may involve participation by external organizations, specialized consultants and the plan shall clearly address such external participation, ensuring that the participators are fully aware of and accept their various responsibilities.

116. At the initial safety assessment stage, reasonable foreseeable accident and incident situations shall be identified, likely consequences evaluated and potential doses estimated for all persons who may be involved including members of the public if applicable, taking into account local circumstances.

Initial Safety
Assessment.

117. Failure to fully retract a source involving sealed sources shall be recognized as constituting a potential event necessitating implementation of an emergency plan.

Sealed
Sources.

118. Emergency plans shall address each of the reasonably foreseeable accident situations identified during safety assessment and shall aim to restrict, as far as is reasonably possible, any exposures that may result from them.

Development
of
Emergency
Plans.

119. The emergency plans should develop the following components—

Features of
Emergency
Plan.

- (a) identification of persons authorized to implement the various stages of the plans ;
- (b) identification of persons or organizations that may need be notified at the various stages of the plans, including all necessary telephone, fax, e-mail numbers and addresses ;
- (c) advice on when to implement the emergency plans ;
- (d) procedures specific to each identified emergency situation, to be followed at various stages, as applicable—
 - (i) initial stage, to contain the situation ;
 - (ii) planning stage, to plan and practice the recovery stage ;

- (iii) recovery stage ;
- (iv) post accident stage, to return working situation to normal ; and
- (v) preparation of accident report ;

- (e) special procedures to follow in life threatening situations ;
- (f) availability of emergency response equipment; and
- (g) notification to the Authority.

Emergency
Equipment.

120. The Licensee shall ensure that all necessary equipment is available to deal with emergency situations. Emergency equipment shall include—

- (a) appropriate and functioning survey meters, personal alarming dosimeters and direct reading dosimeters (QFE or electronic) ;
- (b) additional personal dosimeters, thermo luminescent dosimeters or film badges ;
- (c) barrier materials and warning notices ;
- (d) bags of lead shot, spare lead sheet and lead tunnel ;
- (e) suitable tool kit and source recovery equipment, long handling tongs, pliers, screwdrivers, bolt cutters, adjustable spanner, hacksaw and torch light ;
- (f) emergency shielded storage container, spare source container and communication equipment such as mobile phones, walkie-talkies ;
- (g) spare batteries for survey meters, personal alarms and torch ;
- (h) stationery supplies and incident logbook ; and
- (i) equipment manuals.

Inspection
and
Maintenance
of
Emergency
Equipment.

121. The Licensee shall carry out regular audits to ensure that all available emergency equipments are functioning correctly.

Training.

122.—(1) All persons nominated to participate in the emergency plans shall be adequately trained to ensure efficient and effective implementation of their roles including familiarization and understanding of the plans together with training in the use of the emergency equipment.

(2) Training provisions shall be audited at intervals, not exceeding 12 months.

Emergency
Exercises.

123. Emergency exercises shall be held to test critical components of the emergency plans at intervals and lessons learned shall form part of future reviews of emergency plans.

124. Formal reviews of emergency plans shall be undertaken annually to ensure—

Periodic
Reviews of
Emergency
Plans.

(a) names of persons, contact details, telephone and fax numbers shall be up to date ; and

(b) emergency equipments are available and are maintained.

125. In order to learn from the accident situations that have occurred within the organization or elsewhere and report back the lessons learned so as to improve equipment, operating procedures and emergency plans, reports of any accidents shall be prepared by Radiation Safety Officer with the assistance of a Radiation Safety Adviser after which the reports shall be submitted to the Authority.

Accident
Report.

126. The Accident Report shall include—

Details of
the Accident
Report.

(a) a description of the accident, giving as much details as possible concerning the specific equipment involved, including model and serial numbers ;

(b) names and designations of all persons affected by the accident ;

(c) environmental conditions at the time of the accident ;

(d) the specific cause of the accident, where known ;

(e) details of actions taken to stabilize the accident situation and restore conditions back to normal ;

(f) evaluation of doses received by all persons affected by the accident ; and

(g) recommendations made with the aim of preventing a similar accident occurring in the future.

PART XII—OFFENCES AND PENALTIES

127.—(1) Any person who contravenes any of the provisions of these Regulations commits an offence.

Offences
and
Penalties.

(2) Any person who commits an offence under these Regulations shall be liable to the penalties as established in the enforcement policy issued by the Authority.

(3) The Authority shall impose penalties such as suspension, revocation of authorization, charging of administrative fine, closure of facility or any combination of these.

(4) Any person or body corporate who, being a holder of authorization under these Regulations, commits an offence shall be liable to prosecution in the court of law and upon conviction be liable to pay a fine not exceeding ₦1,000,000.00 (One million naira) for an individual and not exceeding

₦10,000,000.00 (Ten million naira) for a corporate body or sentence to a term not exceeding ten years or both.

Appeal.

128. Any person may appeal to the Board of the Authority if he is not satisfied with the decision made against him pursuant to these Regulations.

Interpretation.

129. In these Regulations—

“*act*” means Nuclear Safety and Radiation Protection Act ;

“*absorbed dose*” means the quotient $\frac{dE}{dm}$ (in Gy) where dE is the mean energy imparted by ionizing radiation to matter in a volume element and dm is the mass of matter in the volume element ;

“*activity*” means the quotient $\frac{dN}{dt}$ (in Bq or Ci) where dN is the expectation value of the number of spontaneous nuclear transformations from the given energy state in the time interval dt ;

“*applicant*” means a person and any legal person who applies to the Nigerian Nuclear Regulatory Authority for authorization to undertake any of the actions covered by the scope of the regulations ;

“*approved*” means approval by the Authority ;

“*authority*” means the Nigerian Nuclear Regulatory Authority, established under Section 1 of Act 19 of 1995 ;

“*authorization*” means permission granted in a document by the Authority to a legal person who has submitted an application to carry out a practice within the scope of the regulations which can take the form of a registration or a Licence ;

“*cold commissioning*” means testing of machine components without radioactive sources ;

“*collective dose*” means an expression for the total radiation dose incurred by a population, defined as the product of the number of individuals exposed to a source and their average radiation dose (man.Sv) ;

“*chronic exposure*” means exposure persisting in time ;

“*disused source*” means a radioactive source, no longer intended to be used for its original purpose ;

“*decontamination*” means the removal or reduction of contamination by a physical or chemical process ;

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

“*dosimeter*” means an instrument used for measuring the absorbed dose of radiation ;

“*employer*” means a legal person with recognized responsibility, commitment and duties towards a worker in his or her employment by

virtue of a mutually agreed relationship. This includes a self-employed person who is regarded as both an employer and a worker ;

"effective dose" means the quantity E , defined as a summation of the tissue equivalent doses, each multiplied by the appropriate tissue weighting factor—

$$E = \sum_T w_T \cdot H_T$$

where H_T is the equivalent dose in tissue T and w_T is the tissue weighting factor for tissue T . From the definition of equivalent dose, it follows that—

$$E = \sum_T w_T \cdot \sum_R w_R D_{T,R}$$

where w_R is the radiation weighting factor for radiation R and $D_{T,R}$ the average absorbed dose in the organ or tissue T . The unit of effective dose is $J.kg^{-1}$, termed the sievert (Sv).

"health professional" means an individual who has been accredited through appropriate national procedures to practice a profession related to health for example medicine, dentistry, chiropractic, pediatrics, nursing, medical physics, radiation and nuclear medical technology, radio-pharmacy, occupational health;

"hot commissioning" means testing of machine components with radioactive sources ;

"industrial irradiator" means facility or device in which matter can be deliberately and safely treated with energy ;

"ionizing radiation" means radiation capable of producing ion pairs in biological materials ;

"licence" means an authorization granted by the Authority on the basis of a safety assessment and accompanied by specific requirements and conditions to be complied with by the Licensee ;

"licensee" means the holder of a current Licence granted for a practice or source who has recognized rights and duties for the practice or source, particularly in relation to protection and safety ;

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

"management" means all activities, administrative or operational, that are involved in the manufacture, supply, receipt, storage, use, transfer, import, export, transport, maintenance or disposal of radioactive sources ;

"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 ;

"Nigeria Basic Ionizing Radiation Regulations" means the Nigeria Basic Ionizing Radiation Regulations, 2003 ;

"Nigerian Transportation of Radioactive Sources Regulations" means the Nigerian Transportation of Radioactive Sources Regulations, 2006 ;

"notification" means a document submitted to the Authority by a legal person to notify an intention to carry out a practice or any other action within the scope of the Regulations ;

"occupational exposure" means all exposures of workers incurred in the course of their work, with the exception of exposures from practices or sources exempted by the scope of the Regulations ;

"operating organization" means an operator of Industrial Irradiation equipment and facilities in Nigeria ;

"public exposure" means exposure incurred by members of the public from radiation sources, excluding any occupational or medical exposure and the normal local natural background radiation but including exposure from authorized sources, practices and intervention situations ;

"practice" means any human activity that introduces additional sources of exposure or exposure pathways or extends exposure to additional people or modifies the network of exposure pathways from existing sources, so as to increase the exposure or the likelihood of exposure of people or the number of people exposed ;

"qualified expert" means an individual who, by virtue of certification by appropriate boards, societies, professional licensees, academic qualifications and experience, duly recognized as having expertise in any specialized field such as medical physics, radiation protection, occupational health, fire safety, quality assurance or any relevant engineering or safety specialty ;

"radiation safety officer" means an individual technically competent in radiation protection and safety matters relevant for a given type of practice who is designated by the Registrant or Licensee to oversee the application of the requirements of the Regulations ;

"radiation source" means anything that may cause radiation exposure, such as by emitting ionizing radiation or releasing radioactive substances or materials and a complex or multiple installations situated at one location or site may, as appropriate, be considered a single source for the purposes of application of the regulations ;

"radioactive waste" means a material, whatever its physical form, remaining from practices or interventions and for which no further use is foreseen—

(i) that contains or is contaminated with radioactive substances and has an activity or activity concentration higher than the level from regulatory requirements, and

(ii) exposure to which is not excluded from the regulations ;

“regulatory control” means any form of control applied to facilities or activities by the Authority for reasons related to radiation protection, safety and security of radioactive sources ;

“risk” means a multi-attribute quantity expressing hazard, danger or chance of harmful or injurious consequences associated with actual or potential exposures which relates to quantities such as the probability that specific deleterious consequences may arise and the magnitude and character of such consequences ;

“safety” means any measures intended to minimize the likelihood of accidents with radiation sources and, shall such an accident occur, to mitigate its consequences ;

“sealed source” means a radioactive material that is—

(a) permanently sealed in a capsule ; or

(b) closely bounded in a solid form and the capsule or material of a sealed source shall be strong enough to maintain leak tightness under the condition of use and wear for which the source was designed and also for foreseeable mishaps ;

“self-employed person” means who is in his own business ;

“supervised area” means any area not designated as a controlled area but for which occupational exposure conditions are kept under review even though specific protective measures and safety provisions are not normally needed ;

“supplier” means any legal person to whom a registrant or licensee delegates duties, totally or partially, in relation to the design, manufacture, production or construction of a source and including an importer of a source ;

“unsealed source” means a source that does not meet the definition of a sealed source ;

“worker” means any person who works, whether full time, part time or temporarily, for an employer and who has recognized rights and duties in relation to occupational radiation protection and does not include a self-employed person who is regarded as having the duties of both an employer and a worker.

130. These Regulations may be cited as the “Nigerian Radiation Safety in Industrial Irradiator Regulations” and came into effect on 12th November, 2008. Citation.

FIRST SCHEDULE

DOSE LIMITS

1. The occupational exposure of any worker shall be so controlled that the following limits are not exceeded—

- (a) an effective dose of 20 mSv per year averaged over five consecutive years ;
- (b) an effective dose of 50 mSv in any single year ;
- (c) an equivalent dose to the lens of the eye of 150 mSv in a year ; and
- (d) an equivalent dose to the extremities (hands and feet) or the skin of 500 mSv in a year.

2. For apprentices of 16 to 18 years of age who are training for employment involving exposure to radiation and for students of age 16 to 18 who are required to use sources in the course of their studies, the occupational exposure shall be so controlled that the following limits be not exceeded—

- (a) an effective dose of 6 mSv in a year ;
- (b) an equivalent dose to the lens of the eye of 50 mSv in a year ; and
- (c) an equivalent dose to the extremities or the skin of 150 mSv in a year.

3. For members of the public, the practice shall be so controlled that the exposure limit of 1 mSv per year is not exceeded.

SECOND SCHEDULE

LEAK TEST REPORT

A contamination test report shall contain the following information—

- (a) identification of the Industrial Irradiator by manufacturer, model, serial number and type of radioactive material ;
- (b) location of the Industrial Irradiator ;
- (c) date of test ;
- (d) test sample collection method ;
- (e) identification of the measuring instrument by manufacturer, model and serial number ;
- (f) date of the most recent measuring instrument calibration ;
- (g) the correction factors, if any, used to compensate for measuring instrument variables and environmental conditions ;
- (h) the conversion factor used to convert to the activity for the type of radioactive material under test ;
- (i) measuring instrument reading of test sample ;

- (j) measuring instrument background reading ;
- (k) calculation of activity detected ;
- (l) evaluation of test results ;
- (m) action taken ; and
- (n) identity of the worker responsible for the test.

THIRD SCHEDULE

APPENDIX A

INDUSTRIAL IRRADIATOR SOURCE DESIGN STANDARDS

1. Category I: 43323.
2. Category II: 53424.
3. Category III: 53424.
4. Category IV: 53424.

APPENDIX B

STATUS INDICATOR COLOURS

<i>Condition</i>	<i>Colour</i>
1. <i>Emergency that is, stop buttons or lights</i>	Red
2. <i>Warning that is, hazard</i>	International trefoil or Red
3. <i>Critical Information that is, irradiation in malfunction</i>	Red
4. <i>Caution that is, not an emergency, but some function taking place to be aware of</i>	Yellow or Orange
5. <i>Normal that is, irradiation not in use, or function safe</i>	Green
6. <i>Information</i>	Blue

MADE at Abuja this 11th day of November, 2008.

PROFESSOR SHAMSIDEEN BABATUNDE ELEGBA
Director General/Chief Executive Officer
Nigerian Nuclear Regulatory Authority

EXPLANATORY NOTE

(This note does not form part of the regulations but it is intended to explain its purport)

These Regulations provide, among other things, for the protection of persons from the harmful effects of exposure to ionizing radiation.





