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

DRAFT NIGERIAN RADIATION SAFETY IN INDUSTRIAL IRRADIATOR REGULATIONS, 200?

ARRANGEMENT OF REGULATIONS

REGULATION

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

PART VI- REGULATORY CONTROL

PART VII - SITE REQUIREMENTS

PART VII - DESIGN AND CONSTRUCTION REQUIREMENTS

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

PART IX - COMMISSIONING AND DECOMMISSIONING OF GIF

PART X – TRANSPORTATION OF RADIOACTIVE SOURCE

PART XI - EMERGENCY PLANNING AND PREPAREDNESS

PART XII - OFFENCES AND PENALTIES

PART XII - CITATION

NUCLEAR SAFETY AND RADIATION PROTECTION ACT

(1995 No. 19)

Nigerian Radiation Safety in Industrial Irradiator Regulations

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 –

Commencement: 200?

PART I- GENERAL

Interpretation

1. For the puRSOse of these Regulations, unless the context otherwise requires;

"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 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. The authorization can take the form of a registration or a licence;

"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 puRSOse;

"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. A self-employed person is regarded as being 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:

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

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 (e.g. medicine, dentistry, chiropractic, pediatrics, nursing, medical physics, radiation and nuclear medical technology, radio-pharmacy, occupational health);

"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;

"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 Gamma Irradiation Facilityequipment 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 and practices and from 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 e.g. 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. A complex or multiple installations situated at one location or site may, as appropriate, be considered a single source for the puRSOses 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. It 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 and in a solid form. 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 under foreseeable mishaps;

"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. An importer of a source is considered a supplier of the 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. A self-employed person is regarded as having the duties of both an employer and a worker.

Objective

2. The regulations shall set up the basic technical and organizational requirements to be complied with by all operators of gamma 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. It is also to establish safety policies, principles, associated criteria, regulations and guidance upon which to base regulatory control. The objective is, therefore, to lay down a step-by-step procedure for the licensing of all stages of **siting**, **design and construction, commissioning**, **operation**, **modification** and **decommissioning** of GIF and **transport of its radioactive source**

Scope

3. The regulations shall specify the minimum requirements for radiation protection and safety for all operators of al types of GIF, whether operated on a commercial basis or for research and development puRSOses. It does not, however, deal with radiotherapy or radiography units. 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.

Application

4 (1) The application of these Regulations shall be in addition to the Nigeria Basic Ionizing Radiation Regulations 2003 (NiBIRR) and any other existing ionizing radiation and nuclear regulations e.g. safety and security of radioactive sources regulations, transport of radioactive sources regulations in force.

(2) These Regulations shall apply to:

a) all types of GIFs and industrial irradiators puRSOses, with possible exemption prior to authorization by the authority;

b) facilities GIFs and industrial irradiators are installed, used or stored;

c) the operation of GIFs and 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 of work places;

f) medical examinations of persons occupationally exposed;

g) radioactive sources or materials in storage or in transit;

h) handling of wastes from the above uses;

i) handling of radiological emergencies or accidents;

j) import or export requirements;

k) quality control of equipment and calibration of instruments, etc;

l) program for education, training and development;

m) handling of radiation injuries and medical preparedness.

PART II - GENERAL REQUIREMENTS

Radiation Safety Requirements

5. The principal radiation safety requirements related to justification of the practice, dose limitation, optimization of protection, and dose constraints, as specified in NiBIRR 2003 shall be applied to GIF.

Authorization of the Practice

6. (1) A legal person 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:

(a) purchase, sale, manufacture, repair of or modification to, sealed sources used for industrial irradiation including ancillary equipment, which incoRSOrates radioactive materials such as depleted uranium source containers etc;

(b) importation, transportation, handling and storage of sealed sources for industrial irradiation facility including ancillary equipment, which incoRSOrates 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 incoRSOrate radioactive materials;

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

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

Requirement for authorizations

7.(1) Legal persons shall provide all relevant information in their request for authorization to the Authority which shall include the following:

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

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

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

Duration of Authorization

8 (1) **A**uthorization granted by the Authority shall be for a period as may be determined by the Authority and shall be renewable.

(2) The Authority may suspend or revoke the authorization where the licensee is in breach of the licence conditions, the Act, NiBIRR or these regulations.

(3) In order to be able to resume operation, the licensee shall reapply for authorization in case of revocation and reconsideration in case of suspension.

Responsibilities of the Licensee

9(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 they are authorized.

(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 they are authorized;

(c) prepare and implement an operational radiation protection and safety programme, which includes, the establishment of policies, procedures and standards for the safe keeping and use of radiation sources and 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 and provide such Radiation Safety Officers with appropriate authority and adequate resources;

(e) consult and appoint 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 specific types of equipment used within the organization;

iii. provide workers with personal dosimeter and appropriate health surveillance;

(h) ensure that all equipment used for the practice is suitable for its intended and actual uses and is properly maintained;

(i) provide workers with appropriate survey meters that are maintained in good working order and tested regularly;

(j) ensure that adequate radiation monitoring is carried out and that records are kept;

(k) provide emergency plans (contingency plans) for all reasonably foreseeable radiation accidents and incidents;

(l) make provisions for the safe disposal or return to the supplier of 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 incoRSOrates depleted uranium shielding, provide for a program for the safe disposal or return of radioactive sources to the supplier when they are no longer required;

(n) ensure that any provider of radiation protection and safety related services (e.g. dosimeter laboratories) are authorized or approved by the Authority;

Management and Organizational Requirements

10(1**)** The Management of the operating organization shall provide the human and material resources necessary to ensure safe working conditions and compliance with License conditions.

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

(3) This includes establishing and maintaining a radiation safety programme which objectives 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 the 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;

compliance with the Regulations and License requirements, ensuring that all necessary tests, inspections and records are maintained to enable the operating organization to demonstrate compliance with these requirements

Appointment of Radiation Safety Officers (RSOs)

11.(1) The Operating Organization shall also appoint at least two RSOs whose duties shall include ensuring that the written administrative procedures are implemented. One of these must be the accounting officer.

(2) The Operating Organization shall not restrict the RSO from performing his or her function and shall provide adequate information and facilities to enable him or her to work effectively.

(3) The RSOs play a supervisory role in assisting the Organization to comply with the requirements of the approval or regulations. They shall be directly involved with the work with ionizing radiation, preferably in a line management position that would allow them to exercise close supervision to ensure that the work is done in accordance with the written administrative procedures. At least one RSO must be available at all times. The RSO may not be the immediate line manager or supervisor overseeing the work with ionizing radiation. The RSO's responsibility shall include:

i. Supervising the day-to-day radiation work to the extent necessary to ensure that procedures (including local rules) and license conditions are complied with;

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

iii. Arranging for and supervising the use of personnel dosimetry and ensuring that the appropriate dose records are maintained;

iv. Ensuring that there is adequate monitoring of workplaces in order to prevent unnecessary exposure and to demonstrate compliance with national regulations and license conditions;

v. Determining the additional requirement for protection of any female staff engaged in the work with ionizing radiation that are or may be pregnant;

vi. Maintaining radioactive material inventories (source records);

vii. Identifying situation where a qualified expert shall be consulted;

viii. Any other relevant responsibility that would ensure a good level of safety.

(4) The Operating Organization carries the general responsibility of compliance with the regulations and the terms of the approval issued by the NNRA. It cannot delegate that responsibility to the RSO any more than it can to the RSA.

Appointment of Radiation Safety Advisers (RSA)

12. (1) The Operating Organization shall appoint one or more suitably qualified persons to advise on all matters concerning radiation safety in the use and operation of the GIF. The RSA (also sometimes referred to as the qualified expert) will also advise on regulatory matters in so far as they relate to radiation safety, but the Operating Organization shall not delegate the responsibility for compliance with the regulations to the RSA. The appointment can be on a part-time basis, and the RSA need not necessarily be an employee of the organization but shall be available for giving advice and help when required.

(2). The RSA shall be experienced in radiation protection matters and shall 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. The RSA must have qualification not less than a Master in Radiation Protection and must be registered with an appropriate professional body

(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, as well as 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 so that the Operating Organization can do what is required by regulations and follow good radiation protection practice;

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

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

(h) An awareness of legislation, in addition to that in (d) above, and practices which could affect the work with ionizing radiation on which he or she gives advice;

(i) An appreciation of his or her own limitations, whether of knowledge, experience, faculties or resources.

(3) The Operating Organization shall not restrict the RSA from performing his or her function and shall provide adequate information and facilities to enable him or her to work effectively. The information shall include a clear statement of the scope of the advice the adviser will be required to give. The facilities will need to include the necessary equipment and support services except in the case of an outside consultant who provides his or her own facilities.

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

(5) When an Operating Organization has appointed a RSA, the organization shall consult that adviser about 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 overexposures;

(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 or premises or for modifications to existing plant or premises from a radiation safety aspect;

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

Qualifications and Experience

(7) No person shall be appointed as a RSO unless he or she:

(a) knows and understands the requirements of the approval and the written administrative procedures (drawn up by the RSA) as they affect the work supervised;

(b) Commands sufficient respect from the people doing the work to be able to exercise the necessary supervision of radiation protection;

(c) Understands the necessary precautions to be taken and the extent to which these precautions restrict radiation exposures;

(d) Has a qualification equivalent to a postgraduate diploma in Radiation Protection from a recognized institution.

Responsibilities of Qualified Operators

(8). Qualified operators are usually those who work most closely with particular GIFs, and day-to-day responsibility for safe operation is generally theirs. The operator's training, experience, attitude and competence will establish the degree of safety associated with operation of the GIF.

i. Each individual who operates or maintains the GIF shall have a responsibility to ensure that the established safety procedures are observed.

ii. Each operator shall hold an appropriate certificate of competence and approved training, which is recognized by the NNRA.

iii. Each operator shall be familiar with: the basic design, operation and preventive maintenance of the GIF; the principles and practices of radiation protection; the biological effects of radiation; the written procedures for routine and emergency GIF operation; and the requirements of the NNRA.

iv. Each operator shall know the exposure rate at all defined areas around the GIF. Operators shall be familiar with area security safeguards such as locks, posting of signs, warning

lights, audible and visible signals, and interlock systems.

v. Each operator shall be familiar with the radiation detection instrumentation which is used and the requirements for personal dose monitoring as specified by the NNRA.

vi. Each operator shall demonstrate competence in the use of radiation source and its related components, and to maintain the required operation logs and records. Operators shall be familiar with the overall organizational structure pertaining to management of the GIF, including specific delegations of authority and responsibility for operation of the GIF.

Staff Training

13. The Operating Organization shall ensure that those of 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.

(1). Training shall be both internal and external and the topics in which these employees shall be trained shall include:

(a) The nature of ionizing radiation;

(b) The health hazard from such radiation;

(c) The basic principles and methods of protection (e.g. 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 any other motivating factors;

(i) Regulatory processes.

(2). Training must be reinforced regularly and updated when necessary. An annual review of staff training shall be undertaken. Arrangements shall be made to ensure that all new staff receives the required training and that the training needs of staff affected by any internal reorganization are reviewed.

(3). It is the role of the RSA to provide advice on staff training needs and on how those needs shall best be satisfied. In many cases, the RSA shall be able to provide much of the training that is required.

(4). The training discussed above shall be in addition to that required to operate the GIF safely.

Part III- Individual Monitoring of Workers

Statutory (Legal) Dosimeters and Dose Records

14(1**)** Employers shall assess the occupational exposure of all workers, Radiographers, assistant radiographers and any other persons who may regularly work in controlled areas or may receive significant occupational exposure which shall be provided with appropriate individual dosimeters to assess their cumulative occupational radiation exposure.

(2) The dosimeters coverage is 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 3 month;

d. workers 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 only be used by the person to whom it is assigned;

f. the Licensee shall maintain a dose record for each individual in the manner specified in the regulations;

g. before a radiographer starts work, the licensee shall obtain a copy of the workers' dose record from previous occupational exposure;

h. the licensee shall also supply relevant information of their record of service to radiographers on termination of their employment;

i. licensee shall draw up a procedure to describe the way individual dosimeters are administered and this shall include persons who;

1. order and receive the dosimeters from the dosimeter laboratory;

2. distributes them to the radiographers and Radiation Safety Officer;

3. collects them and dispatches them to the dosimeter processing laboratory;

4. reviews and maintains the dose records.

Protection of Personnel Dosimeters during Use

15. In order to ensure the protection of the personnel dosimeters, the Radiographers shall:

(1) take good care of their dosimeter; protect them from loss, theft or damage;

(2) return them at the end of every specified period of usage;

(3) inform the Radiation Safety Officer without delay, if their dosimeter is missing, damaged or if it has been accidentally exposed to radiation when not in use.

Storage of Personnel Dosimeters

16. To ensure accurate reading of the dosimeters when not in use, the storage of individual dosimeters shall include the following elements:

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

(b) individual dosimeters shall not be stored in source stores, inside radiography enclosures, near exposure containers, near radioactive luminous items or in any other area where there are raised dose rates;

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

Loss of Personnel Dosimeters

17 (1) For the loss of any dosimeter, the operating organization shall take all reasonable steps to recover it.

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

Investigation of Doses

18(1**)** Results of personal dosimeters shall be reported to the Radiation Safety Officer who shall inspect them to determine whether any unexpectedly high doses have been received and to determine whether individuals are keeping their doses within the dose limits.

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

Reading of Dosimeter

19 (1**)** Direct reading dosimeters (e.g. quartz fibre electroscopes) shall be used to supplement the TLD or film badge, whenever it is important to have an immediate indication of exposure, for example during site radiography in a confined space or during emergency recovery of a source.

(2) Such uses 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 radiographer shall stop work and discuss the situation with the Radiation Safety Officer to establish how procedures might be improved;

c) licensees 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

20. All radiographers 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

21. Licensees shall develop and maintain a programme for workplace monitoring in order to:

(1) evaluate radiological conditions;

(2) assess exposures in controlled and supervised areas and;

(3) review the classification of controlled and supervised areas.

Survey Meters

22(1**)** The licensee shall ensure that a sufficient number of suitable radiation survey meters are available for the radiographers and Radiation Safety Officer.

(2) A survey meter shall be used before and after every exposure of a radioactive source to confirm that the source is in its fully shielded position. For it to be suitable for the work environment, radiation survey meters shall satisfy the following conditions:

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) they shall be scaled in units of dose rate and shall be able to indicate radiation levels from about 1 μSvh^{-1} up to about $10mSvh^{-1}$;

d) licensees 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

23. (1) The radiographer 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 (e.g. high voltage setting);

(c) background radiation level is as expected;

(d) response against a gamma exposure container or other suitable check source.

(3) Every radiation survey meter used during radiography shall be checked regularly:

(a) normal tests as in proceeding paragraph;

(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;

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

Use of Radiation Survey Meters

24(1) Radiation survey meters shall be used to evaluate the radiological conditions in all workplaces, in particular at the following locations:

(a) around controlled and supervised areas to review classification and assess exposures;

(b) around a transport container when a new gamma source is received;

(c) around a gamma source container when collecting it from a store;

(d) around a gamma source container when returning it to a store to confirm the source is present and is fully shielded;

(e) around a gamma source container when loading and offloading it into a vehicle used for transport; and

(2) In the following situations:

(a) after every exposure of a gamma source to confirm that it has fully returned to the shielded position in its exposure container;

(b) to check the dose rates at the controlled area barriers during site radiography;

(c) when transferring gamma sources between containers;

(d) when dealing with emergencies involving gamma sources.

(3) The results of radiation surveys shall be recorded in the following instances:

(a) when commissioning a new fixed radiography compound or one that has been significantly modified;

(b) when commissioning a new radiation source store;

(c) when checking the dose rate around a gamma radiography exposure container prior to transporting it so that the transportation index can be recorded on the consignment document;

(d) routine surveys around fixed radiographic facilities at least once every year;

(e) during site radiography with mobile sources to confirm that barrier distances are set correctly;

(f) during emergencies and investigations so that dose estimates can be performed;

(4) Records of radiation surveys should include the following details:

(a) location;

(b) date;

(c) name of person performing survey;

(d) survey meter type and serial number;

(e) radiation source details, e.g. type of source, activity, beam direction, x-ray tube settings, etc;

(f) locations of measuring points;

(g) dose rate in $\mu Sv h^{-1}$.

(5) The licensee shall ensure that records of radiation surveys are kept in a manner specified in any License conditions or the Regulations.

Radiation Safety Philosophy

25 The objectives of radiation safety for GIF shall be**:**

(a) to ensure that during normal operation, maintenance and decommissioning and in emergency situations, the radiation exposure of both workers and the public is kept as low as reasonably achievable, economic and social factors being taken into account (ALARA).

(b) to ensure that during normal operation, maintenance decommissioning and in emergency

situations the radiation exposure of both workers and the public is kept below the relevant dose limits given in the NIBIRR

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

Design of Irradiators

26 The design of any GIF is determined by factors such as the puRSOse of its operation and the category of the GIF. Several design principles are applied, if necessary in combination, to achieve and maintain the required reliability. For this puRSOse defence-in-depth principle, redundancy, diversity, independence and programmable electronic systems shall apply.

Defence-in-Depth

27. 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 GIF are covered by a series of provisions and shall a failure occur, it would be compensated for or corrected.

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

(a) The provision of multiple means for ensuring each of the basic safety functions, i.e. 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 GIF by automatic activation of safety systems and by operator actions;

(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 incoRSOrate a series of levels of defence in terms of equipment and procedures is 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.* This requires that the GIF be soundly and cautiously designed, constructed and operated and that an appropriate quality assurance programme be established and maintained at all stages. To meet this objective, careful attention shall be paid to the selection of appropriate design codes and materials, and to the control of fabrication of components and of GIF construction. Attention shall also be given to the procedures involved in GIF inspection, maintenance and testing, to the ease of access to appropriate parts of the GIF to undertake these activities, to the way the GIF is operated and to the manner in which operating experience shall be utilized.

(b) *The aim of the second level of defence is to detect and respond to deviations from normal operating conditions.* This shall help in preventing anticipated operational occurrences from escalating into accident conditions. It is however, recognized that radiation incidents do occur during the service life of an irradiation GIF, despite the care taken to prevent

them. This level requires the provision of specific systems and the definition of operating procedures to prevent or minimize the consequences of such incidents.

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

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

Redundancy

28. In consonance with the principle of redundancy and in order that the failure or unavailability of one item could be tolerated without loss of safety functions, the following shall be provided:

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

ii Several types of radiation monitors;

iii Alternative powers sources

Identical or diverse components may be used for the puRSOses of redundancy.

Diversity

29. The reliability of some systems can be enhanced by applying the principle of diversity. Diversity shall be applied to redundant systems or components that perform the same safety function by incoRSOrating 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, etc. The causes of potential failures shall be examined to determine where the principle of diversity could be applied effectively.

(2). 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. 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.

Independence

30. Independence shall be achieved in the design of systems through functional isolation and physical separation. The reliability of systems can be improved by applying the following principles for independence in design:

(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.

(d) Maintaining independence between items important to safety and those not important to safety.

Programmable Electronic Systems

31. Programmable Electronic Systems (PES) shall be used increasingly in safety control applications. In order to avert problems that can arise relating to the integrity of the hardware and validation of the software, which may lead to faults in the system, designers of the PES shall pay particular attention to problem areas. It is extremely important that only fully trained and competent staff be allowed to alter software, however, procedures for doing so shall be formalized. No alterations to the software shall be made unless authorized by the NNRA.

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. This includes consideration of the reliability of operating procedures, where safety depends on them, and encompasses both inadvertent and deliberate failure to follow procedures.

(2). The Operating Organization shall demonstrate to the NNRA how the design of GIF and related operational procedures will contribute to the prevention of accidents on the one hand, and to mitigation of their effects on the other. This information shall be provided in the form of documented safety analyses describing and evaluating the predicted response of the plant to incidents (postulated malfunctions or failures of equipment, common cause failures, human errors, external events, etc.), which could lead to accident conditions. These analyses shall be extended to relevant combinations of such malfunctions, failures, errors and events.

(3). The analyses shall show the extent to which the irradiation GIF can control or accommodate situations related to the various operational stages and accident conditions. The results shall be ultimately expressed in terms of the likelihood of the events and the extent of the damage to the barriers between the sources of radiation and the personnel and the public and, as far as possible, in terms of the likely radiation doses to the personnel and the public.

(4). Failures and disturbances could range from relatively frequent events with minor radiological consequences to highly improbable events having serious consequences. The safety analysis facilitates the comparison of these events, with respect to both their probabilities and their consequences, so that decisions can be made on those that shall be taken into account in the design of the irradiation GIF **('design basis events').**

(5). For each initiating event and accident sequence, the extent to which process systems (or a functioning part thereof) and safety systems are required to function under accident conditions shall be indicated. A diagrammatic representation (such as an event tree) of the sequences of the accidents associated with each initiating event may be helpful. The effects of the degradation of safety system components during normal operation and under accident conditions shall be evaluated.

(6). The 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 GIF by unauthorized persons;

(i) Breakdown of administrative procedures, leading to unsafe practices.

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

Designers and Manufacturers

33. The designers and manufacturers of irradiation facilities shall ensure that the facilities are designed to meet the radiation safety objectives as stipulated by the NNRA This shall be achieved by:

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

(b) Ensuring that the Operating Organization of the GIF is provided with adequate information so that it can operate the GIF safely. This 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 GIF. (It shall be noted that it is also the responsibility of the Operating Organization to carry out a hazard assessment based on information from the supplier and the organization's own administrative rules.)

  (iv) Instructions and procedures to be followed in emergency situations as outlined in Section 10

(2). All documents provided by the manufacturer, supplier or installer (operating manuals, operating rules and 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) Manufacturers or suppliers shall ensure that any new information about the GIF that relates to safety (for example regarding defects in materials and equipment and weaknesses in operating

procedures) is provided to the Operating Organization as rapidly 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 GIF is of safe design and that information on safe operating procedures, including that specified in para. 201(b) above, is passed on to the Operating Organization. If they assemble equipment they shall make their own safety checks.

Constructors and Installers

35. Constructors and installers shall ensure that their work does not compromise the safety aspects of the GIF. It is essential that they shall comply with the requirements of the designer and the manufacturer. On completion of the installation, or at appropriate stages in the construction and installation, the constructor or installer, in conjunction with a RSA, shall thoroughly and critically review the GIF or any component before it is commissioned to ensure that:

(a) The safety features and warning devices have been properly installed and shall operate correctly;

(b) There is sufficient radiation protection for all persons and the environment.

(2). 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 GIF.

(3). Designers, manufacturers, constructors, installers and the Operating Organization must 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. When visitors are permitted to enter the radiation room they shall be escorted by a qualified operator and the RSO who must have surveyed the area immediately prior to the visit. Visitors shall wear dosimeter, which can be read promptly and recorded after each visit.

Testing and Maintenance of Equipment

37. To ensure the continued safe operation of the GIF, the Operating Organization shall ensure that all safety functions are regularly tested by setting up a formal programme of maintenance and testing. The following shall be carried out:

(a) Particular attention must be given to 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 and shall be undertaken in the presence of a RSO.

(b) Portable radiation meters shall be calibrated before they are first used, after repair and at intervals specified by the NNRA. The pre-use test shall include a test of the instrument's overload performance, i.e. it shall operate correctly up to the maximum credible dose rate it may encounter.

(c) Periodic examination of the hoist cable and guide cables shall be made and the cables shall be replaced as required by existing national regulations or at intervals recommended by the manufacturers.

(d) Periodic leak tests of the radiation sources shall be carried out in a manner and at a frequency determined in discussion with the source supplier and plant manufacturer and in accordance with national requirements.

Weekly tests

38. The following tests shall be carried out weekly:

(a) A check that the continuous radiation monitoring device on the pool water circulation system is functioning correctly (in the case of Category IV gamma irradiation facilities).

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

(c) A check of the water filter for correct operation and for contamination.

(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 GIFs, the water level control, the low pool water interlock and the water treatment system.

(2). Attempts shall also be made to operate the GIF after deliberately violating the approved startup procedure, to ensure that the interlocks and sequential controls are functioning correctly.

Monthly Tests

39. The following additional tests shall be carried out separately on a monthly basis:

(a) A test that the radiation room monitor is functioning properly; this is done by exposing the monitor probe to a check source until the alarm sounds.

(b) A check, in accordance with the manufacturer's instructions, of the safety control systems that prevent access to the radiation room when there is any radiation present.

(c) A test that the product exit monitor is functioning properly; the test is carried out, with the GIF operating, by exposing the monitor probe to a check source until the alarm sounds. The product exit conveyor shall stop and 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 GIF and its related product positioning mechanism.

(e) A check that other main items of equipment associated with source movement and control function properly and show no signs of potential failure.

(f) A check that all product containers are undamaged and in good condition.

(2). If any of the checks indicate a fault or if interlocks do not function properly, the GIF must not be used until repairs have been made.

Semi-Annual Test

40. An inspection of the source movement and suspension system shall be carried out semiannually. This shall include the entire length of the cable. Any necessary replacement of the cable shall be carried out.

Leak Test Criteria

41. If the test results are considered negative i.e. if the levels of contamination are less than those specified in NiBIRR, no action other than record keeping is 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. In this event, the GIF shall be immediately withdrawn from service and appropriate action taken to prevent exposure of personnel and further dispersal of radioactive material. The Operating Organization shall immediately notify the NNRA, the manufacturer of the equipment and the supplier of the source that an incident has occurred which might have caused or threatens to cause a radiation hazard. Under no circumstances shall unauthorized or untrained persons attempt to examine or decontaminate the GIF.

Leak Test Report

42. A contamination test report shall contain the following information:

(a) Identification of the GIF by manufacturer, model, serial number and type of radioactive material;

(b) Location of the GIF;

(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;

(1) Evaluation of test results;

(m) Action taken;

(n) Identity of the individual responsible for the test.

Records

43. A logbook or file shall be kept in which all tests, maintenance tasks, modifications or

changes to the GIF shall be recorded. All use of the GIF shall also be recorded in a logbook or file.

(2). The results of all tests described above shall be recorded on a formal checklist signed by the RSO who has witnessed the tests.

(3). Since failure of the safety systems could cause radiation exposure to personnel, the compliance inspectors from the NNRA will pay particular attention to these records. The records shall be kept for such periods of time as are specified in NiBIRR.

GIF Maintenance and Modification

44. Regular maintenance for all GIF components shall be done according to the manufacturer's instructions.

(2) Manufacturers shall issue warning notices to advise Operating Organizations and NNRA of any previously unforeseen conditions that could cause accidents, that have resulted in hazardous situations or that might have the potential to become hazardous. These notifications shall explain the corrective actions to be taken.

(3) It is extremely important that Operating Organizations ensure that the corrective actions are implemented, unless there are reasons for not taking the action. In the latter case the agreement of the NNRA must be obtained and the reasons recorded.

(4) All modifications shall be undertaken by appropriately qualified persons and with the approval of the NNRA. The modifications shall be thoroughly checked to ensure that they have been carried out properly and that the safety aspects of the GIF have not been compromised.

(5). The Operating Organization shall notify the NNRA and supplier and obtain approval from the NNRA prior to any modifications which may cause a radiation hazard. These could include:

(a) Modifying operating procedures;

(b) Modifying the safety control system;

(c) Major modifications to the GIF;

(d) Source loading, replenishment, removal or redistribution, in any way at variance with the agreed approval;

(e) Changes in supervisory personnel or advisers.

(6). The Operating Organization is not required to notify the NNRA when performing routine maintenance procedures, including the changing of components, which will not cause a radiation hazard or compromise the safety of the GIF, provided that approval conditions are not violated.

Operational Instructions

45. The safe operation of the GIF shall depend on the operator following clearly defined procedures laid down by the manufacturer or supplier and approved by the NNRA. Suitably trained and qualified persons shall be employed by the Operating Organization and such persons shall be allowed to operate the GIF if specifically approved for that puRSOse by the NNRA. Such persons are referred to as 'authorized personnel'. Although the following requirements

relate to authorized personnel, they apply equally to all persons who operate the GIF, whether or not they have been specifically authorized by the NNRA.

(2). The operational instructions shall be fully understood by the authorized personnel and shall include, as a minimum, the following:

(a) A reminder of the nature of the hazard posed by the GIF 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 protection adviser and officers.

(d) The method of implementing the operating instructions and ensuring that the GIF is being operated safely. This 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 GIF are functioning properly. Each safety item and the appropriate test, check and inspection for it shall be specified,

(ii) The requirement that the operating procedures be 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.

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

(3). Written instructions shall also be provided covering action to be taken in the event of machine malfunction. These shall include a general outline of the action to be taken by people who are notified of a machine malfunction the correction of which may involve the source. It shall be made clear that remedial action in situations involving work around the GIF shall be attempted only by persons specially trained in radiological safety who are authorized to perform such work, or under the direct or indirect supervision of such persons. In such situations entry to the radiation room shall never be made by one person alone.

Procedural Matters

46. The Operating Organization shall maintain the GIF as prescribed by the manufacturer, paying particular attention to ensuring 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 GIF malfunction.

Control of Access Keys

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

Portable Radiation Survey Monitor

48. Arrangements shall be made to ensure that a portable radiation survey monitor is carried by the operator whenever entering the radiation room. A check source shall be used to verify that the survey monitor is operating before each entry to the room. A similar spare survey monitor shall be available for use when calibration or repair of one monitor is required.

Entry Procedure

49. Arrangements 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. In addition, administrative procedures shall be established for continuously monitoring the radiation levels with the portable radiation survey monitor throughout the entry procedure.

PAET VI - REGULATORY CONTROL

Regulatory Programme

50. An essential part of radiation safety and protection for any use of ionizing radiation is a regulatory programme to be enforced by the NNRA.

(2). Control of irradiation facilities is achieved by means of systems of notification, registration or licensing. A common system of regulatory control is licensing or approval. This system is described in detail in this guide. It must be recognized that the primary responsibility for safety rests with the person undertaking a particular task, be it design, transportation, installation, operation, maintenance or decommissioning.

(3). This section deals first with the approval process and then with regulatory inspection and enforcement.

Approval Process

51. Operating Organizations shall know that control over radiation safety in the siting, design, transportation, construction, commissioning, operation, maintenance and decommissioning of the GIF are subject to NNRA's authorization.

(2). It is a primary task of the NNRA to review and assess the material and documents provided by the applicant and any other material that is relevant to determine whether approval shall be granted.

Functions of Approvals

52. It shall be noted that an approval is an official document which:

(a) Authorizes a specified activity or set of activities dealing with the siting, design, construction, commissioning, operation, maintenance and decommissioning of GIF and transportation of the radioactive source to and from the GIF;

(b) Establishes requirements and conditions governing the performance of these activities;

(c) Where appropriate, places time limits on the validity of the approval.

Stages of the Approval Process and its Review

53. The major stages of the approval process shall encompass the regulation of siting, 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. Detailed assessment of all stages of Authorization shall be submitted to NNRA.

(3). The fact that an approval has been granted shall not preclude a change in the approval during the period of its validity. The modification of an approval may be desirable or necessary as a result of experience gained either during operation of the GIF or elsewhere, as a result of technological innovation or as a consequence of research and development with respect to radiation safety. The applicant may initiate such modifications, or the change may be imposed by the NNRA.

Requirements for the Applicant

54. An applicant shall know that the primary responsibility for ensuring safety in the siting, design, transportation, construction, commissioning, operation, maintenance and decommissioning of the GIF rest on him. The applicant shall undertake the following activities:

— Demonstrating to the NNRA that workers, the public and the environment have been and will continue to be adequately protected. The applicant must acquire a complete understanding of the GIF design and its safety aspects. This would necessitate close co-operation with the manufacturer or supplier of the GIF.

— Submitting and making available to the NNRA such information as might be required.

— Making appropriate arrangements with the supplier to ensure that all information required for the application for approval is available.

— Making arrangements for the eventual removal of spent radioactive sources.

— Keeping the NNRA informed of any relevant new information that might become available and of any alterations to the previously submitted information that might be relevant to the licensing process.

— Co-operating with the constructor and/or installer of the GIF to ensure that the construction or installation is undertaken according to the specifications.

— Ensuring that workers are given appropriate and sound training and retraining to operate the GIF safely. This shall involve the co-operation with the supplier or manufacturer of the GIF.

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

(3). The applicant shall be aware that the process of review and assessment of the information by the NNRA is a continuous one. Therefore, all relevant documents shall be submitted to the NNRA at an early stage. This approach would facilitate a systematic review and assessment procedure and prevent unnecessary delays in the approval process.

(4). Other requirements might be imposed upon the applicant by the NNRA. These requirements could 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 GIF.

(d) Regular reports to the NNRA on such matters in relation to the GIF 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 and the contingency plan shall contain procedures to be followed in abnormal circumstances. This document must be kept in a secure place.

(iv) Unusual occurrences such as significant malfunction of the safety control system.

(v) Procedures governing the authorization of changes in siting, design, construction, transportation of the source, commissioning, operation, maintenance and decommissioning in accordance with approval conditions and other regulatory requirements.

PART VII - SITE REQUIREMENTS

Geological Site Considerations

55. Geological features that could adversely affect the integrity of the radiation shields shall be evaluated, taking into account the physical properties of materials underlying the GIF site or its environs. Areas of potential or actual surface or subsurface subsidence, uplift or collapse shall be taken into consideration when assessing the suitability of a site. Other factors that are not necessarily due to natural features (e.g. underground mining) but that could result in instability shall also be considered.

External Human Induced Events

Aircraft Crashes

56. (a) The potential for craft crashes on the site shall be assessed with account taken, to the extent practicable, of characteristic of air traffic and aircraft.

(a) If the assessment shows that there is a potential for an aircratf on site that could affect the safety of the installation, then an assessment of the hazards shall be made.

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

(d) If the assessment indicates that the hazards are unacceptable, and if no practicable solutions are available, then the site shall be deemed unsuitable

Chemical Explosions

57. (a) Activities in the locality of the GIF that involves the handling, processing, transport and storage of chemicals having a potential for explosions or for the production of gas clouds capable of deflagration or detonation shall be identified.

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

(c) 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

58 The locality of the GIF 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 that, if released under normal or accident condition could jeopardize the safety of the installation. The potential effects of electromagnetic interference, eddy currents in the ground and clogging of air or water inlets by debris shall also be evaluated. If the effects of such phenomena and occurrences could produce an unacceptable hazard and if no practicable solution is available, the site would be deemed unsuitable.

Other Important Consideration

59 Historical data concerning phenomena that have potential to give rise to adverse effects and the safety of the GIF such as earth tremor, flood, thunderstorm, land slide, etc shall be collected and assessed. If the potentials are confirmed, the hazards shall be assessed and design basis for these events shall be derived. If the hazards for the GIF are unacceptable and no practical solution is available, the site would be deemed unsuitable.

PART VII - DESIGN AND CONSTRUCTION REQUIREMENTS

Source Design

60. Source design shall be based on the ALARA principle taking into account constraints specified in NiBIRR. The NNRA may require Operating Organization to submit evidence that the design of the source meets these objectives before granting license.

Requirements of GIF Source Design

61. The GIF source design shall conform with the general requirements for sealed sources given in ISO/TC 85/SC 2/WG UN 31C (Ref. [2]). These standards are:

Category I: 43323

Category II: 53424

Category III: 53424

Category IV: 53424

(2). If the activity of the source exceeds that given in the ISO standard, a specific evaluation of the use of the sealed source and its design shall be made.

(3). The manufacturer and user shall also take account of the possible effects of fire, explosion, corrosion and any aspects related to the continuous use of the sealed source in addition to those covered by Ref. [2]. Factors that shall be considered are:

(i) The quantity of radioactive material contained in the sealed source;

(ii) The radiotoxicity, leachability and solubility of the radioactive material;

(iii) The chemical and physical form of the radioactive material;

(iv) The environment in which the source is stored, moved and used.

Specific Requirements for Wet Storage Conditions

62. 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. Account shall also be taken of the need to limit thermal fatigue in the selection of the capsule material.

(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. In this context, the use of ^{137}Cs in form of ceasium chloride or other soluble radioactive compound cannot be authorized.

Certification and Documentation

63. The source manufacturer or supplier and users shall maintain records relating to the sealed source. This information shall be provided as required by the NNRA for such puRSOses as licensing of the GIF and transportation of the source. The records shall include the following:

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

(b) ISO classification certificate;

(c) Bend test certificate;

(d) Leak test certificate;

(e) Contamination test certificate;

(f) Special form test certificate for transportation puRSOses (see Ref. [4]);

(g) Any other documentation that might be required by the NNRA.

Design and Construction of the Gif Building

64. The GIF building must be designed such that quality control of components used receive highest priority and such that none of the GIF accessories is exposed to dust, heat, wind or rain from outside.

(2). The building must be designed such that the influence of ambient weather condition do not affect normal operation of the GIF.

(3). The Operation Organization must submit to NNRA documentation related to quality control test and evidence of proper supervision of the various stages of construction of the building by qualified experts.

Design of Gif Accessories

Source Holder and Rack

65. The sealed source shall be firmly fixed within its holder and rack such that it cannot be readily dislodged from them. Means shall be provided to position and retain the sealed source in the design position. Devices used for the puRSOse of positioning and removing sources shall be capable of being operated from outside the radiation shields. In the event of failure of the sealed source holder or rack it shall all not be possible for the source to move into a position that may cause a radiation hazard.

Source Guard

66. 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, this may take the form of a protective shroud, guide bars or floor guides on the product positioning system. Product positioning systems shall not be able to come into contact either directly or indirectly with the radiation source.

Product Positioning System

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

Shielding

68. Direct radiation exposure from the operation of GIF shall be limited by appropriate shielding. The amount of shielding shall be determined by reference to any dose rate requirements specified by the NNRA. The NNRA might demand that the shielding calculation be done and submitted.

(2). The shielding design shall ensure that there is no direct radiation leakage path from ventilation and 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 this is not feasible, access to areas of high dose rate shall be restricted. Care shall be taken to ensure that all significant radiation paths are fully evaluated.

(3). Although general guidance on shielding is given in this Guide and other relevant publications of the NNRA, all shielding calculations carried out for the puRSOse of design shall be undertaken by specialists.

Access to the Radiation Source and Interlocked Systems

69. Particular attention must be paid to the accessibility of the radiation room in GIFs in categories II and IV. The design of these facilities shall be such that persons cannot have access to the radiation room while the source is in the exposed position. Such control of access shall rely heavily on the use of interlocked systems.

(2). Sequentially interlocked controls shall be provided for personnel access, locking of the radiation room and irradiation operations. The controls shall be designed such 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.

Personnel Access Door Interlocks

70. Means shall be provided such 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. Any failure of the control system shall generate visible and audible alarm signals. Opening the access door shall also disable the source hoist control circuit and cut off the motive power to the source hoist operating mechanism. The disabling of the source hoist control circuit and the cut-off of the motive power to the source hoist operating mechanism must be accomplished by independent actions.

Product Entry and Exit Port Interlocks

71. Suitable means shall be provided at the product entry and exit ports to prevent inadvertent entry of personnel into high radiation areas. The ports shall be interlocked such that a visible or audible alarm indicates when the entry/exit port control mechanism has malfunctioned or been overridden or tampered with. The irradiation shall be terminated when this occurs and shall not be restarted unless the cause has been remedied.

Removable Radiation Room Shield Plugs

72. Removable radiation room shield plugs shall be interlocked with the master control system to prevent or abort GIF operations if a plug is removed. The interlock control shall be accessible outside the radiation shields.

Fixed Radiation Monitor with Alarms

73. A monitoring system with built-in redundancy shall be provided to detect the radiation level in the radiation room when the irradiation is indicated to be terminated. The monitor shall be integrated with the personnel access door interlocks to prevent room access when the monitor detects a radiation level in excess of that specified, malfunctions or is turned off. The monitor shall generate visible and audible alarm signals if the radiation level exceeds that specified when the irradiation is indicated to be terminated. This is a potentially hazardous situation in which it may be necessary to override interlocks or other safety systems. Written administrative procedures shall therefore provide detailed guidance for such actions, which shall only be undertaken under the direct control of a RSO.

Source Status and Exposure System Interlocks

74. Means shall be provided to ensure that, if a malfunction occurs in the source exposure mechanism, the radiation source would automatically become fully shielded. If the source cannot be returned to its shielded position, then means shall be provided to prevent access and provide a visible and audible signal.

(2). 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.

Product Exit Monitor

75 A fixed radiation monitoring system with built-in redundancy and audible alarms shall be located such that the monitors can detect any part of a radioactive source being brought out on a product carrier. These monitors shall be interlocked with the GIF controls such 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.

Water Treatment System Monitor

76. A fixed radiation monitor with an audible alarm shall be located on the deionizer column to detect contamination arising from source leakage. This monitor shall be interlocked with the irradiation controls such that the source returns to its shielded position and the water circulation stops shall the radiation reach the preset alarm level. The level must be set sufficiently above the natural background level to avoid an excessive number of false alarms.

Fully Shielded Facilities

77. The GIF shall not be operable until all shielding is in place and all other safety devices are actuated. 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. An interlocked radiation monitor shall be provided as a backup check that the shielding is in place.

Control Console

78. The GIF shall have a master control that could be used to prevent unauthorized operation. In power operated GIFs, this control may be a key operated switch. In manually operated GIFs, a keyed mechanical lock or simple padlock may be used

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

Access Key

79. The GIF controls might be designed such that a single multipurpose key is used to operate the GIF during normal use. This key might be used to operate the control console, to gain access to the radiation room and to actuate the safety delay timer. In systems employing two or more keys, one key must remain captive when the other keys are being used.

Emergency Stop Device

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

Source Exposure Mechanism Disconnect For Servicing

81. The motive power (e.g. 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. Means shall also be provided for positively isolating the source control system or for mechanically locking the moving parts.

Radiation Room

Safety Delay Timer with Alarms

82. The radiation room shall be equipped with a safety delay timer that will automatically generate visible and audible signals to alert persons in the area that the source exposure sequence has begun. 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. The timer shall be integrated with the master control system such that irradiation cannot begin unless the startup sequence has been properly completed within a preset time. 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

83. 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. This may require a system for opening the personnel access door from inside the radiation room, thus activating the normal safety interlocks.

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

Emergency Stop Device

84. Means shall be provided within the radiation room to prevent, quickly interrupt or abort GIF operations and terminate the irradiation at any time. The device 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 GIFs

Pool Accessories

85. Water is used as the radiation shielding medium in wet storage GIFs. An automatic water level control shall be provided to maintain the water above a preset level. Except for float

switches, all components 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. 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.

Pool Integrity

86. The containment of the pool shall be watertight and designed to retain the water under all foreseeable circumstances. A non-corrodible stainless steel liner shall be used. The containment must be designed to support radiation source transport containers used during source transfer operations without compromising the integrity of the pool. There shall be no penetration (e.g. pipes or plugged holes) through the bottom of the pool. There shall be no penetration through the walls of the pool more than 300 mm below normal water level.

Pool Component Material

87. All permanent pool components shall be made of corrosion resistant materials that might affect the integrity of the sealed source. Where practicable, stainless steel components (e.g. brackets or pulleys) are used. They shall be passivated particularly after fabrication.

Water Level Control — Normal

88. Means shall be provided to automatically replenish water losses due to evaporation. The system shall be capable of maintaining the pool water at a level sufficient to provide the radiation shielding necessary. A metering device shall be installed in the make-up water supply line to indicate major changes in water replenishment requirements that might be associated with pool leakage.

Water Level Control — Abnormal (low)

89. Means shall be provided 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

90. 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 □ S/m. This will reduce the possibility of corrosion of the sealed source. Extreme care shall be exercised to avoid the introduction of contaminants into the water system (e.g. deionizer regenerants, cleaning materials, corrosive fire extinguishing materials, spilled product).

Water Cooling

91. Because heat is produced by gamma emitting sources, the resulting high humidity levels may damage electrical equipment, the product boxes and the product positioning system. When such damage is likely to occur, an appropriate pool water cooling system shall be provided. Reducing evaporation losses from the pool could also facilitate maintaining the conductance of the water below 1000 □ S/m for a longer time before regeneration or replacement of deionizer resins is required.

In-pool Piping

92 Since pipes are used in source storage pools for the water level and water quality systems, 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. All pool water circulation suction pipes shall have intakes no lower than 300 mm below the normal make-up water level.

Pool Guard and Cover

93. A physical barrier, such as a railing and/or a metal cover, shall be installed to prevent personnel from accidentally falling into the source storage pool. This physical barrier may be removed during maintenance or service operations.

Fire Protection

94. Heat and smoke sensing devices with visible and audible alarms shall be provided to detect combustion in the radiation room. The triggering of the devices shall cause the source to automatically become fully shielded and the product positioning and ventilation systems to shut down. The design of the GIF shall be such that fire damage to any component part cannot inhibit the source from returning to the fully shielded position.

(2) A fire extinguishing system must be provided in the radiation room. When a water sprinkling system has been installed, provision shall be made to control any overflow of water that might arise from its use. Chemicals and corrosive substances that could adversely affect the integrity of the sealed source shall not be used in fire extinguishing systems.

Power Failure

Electrical

95. Means shall be provided to ensure that, if an electrical power failure occurs, the source will automatically be returned to the fully shielded position and the GIF shut down. The safety control system shall not be compromised in the event of a power failure. Such electrical equipment shall be designed to appropriate standards as may be specified by the Standard Organization of Nigerian (SON).

Non-electrical

96. Means shall be provided to ensure that failure of non-electrical power (e.g. pneumatic or hydraulic power) which is used to control or operate any GIF safety feature or device shall cause the source to automatically become fully shielded and the GIF to shut down.

Ventilation

97. 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 of ……. prescribed by the Ministry of Environment of WHO regulations.

(2). The GIF shall be designed to prevent the migration of the ozone produced in an GIF into areas that may be occupied and where the concentration could potentially build up to exceed the currently accepted limit. This can 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 such that failure of the system will automatically terminate irradiation.

(4). A large capacity continuously 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

98. There shall be a clearly visible sign at the personnel access door to the radiation room bearing the radiation symbol and Warnings according to NiBIRR.

(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

99. Clearly visible irradiation status indicators shall be provided at the control console to indicate:

(a) When the irradiation is terminated (source down);

(b) When the irradiation is in progress (source up);

(c) When the irradiation is in preparation (source in transit position).

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

Audible Signals

100. Each audible signal designed into the GIF control system shall be distinct and loud enough to gain 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

101. The following colours are recommended for use when illuminated or colour coded controls are used:

Condition	**Colour**
Emergency:- (stop buttons or lights)	Red
Warning: - hazard	International trefoil or red
Critical Information:- (irradiation in malfunction)	Red
Caution:- (not an emergency, but some function taking place to be aware of)	Yellow or orange

Normal:- (irradiation not in use, or function safe) Green

Information Blue

Labeling

102. Category I gamma GIFs shall have clearly visible labels identifying the contained radionuclides, their activities and the dates to which the source activities relate. The GIF shall bear the radiation symbol and warnings as may be specified by NNRA.

(2). The GIF shall also bear a label or labels with the following information:

- Name and address of manufacturer,
- Model and serial number of GIF;
- Approval number if appropriate;
- Maximum source activity of GIF.

(3). If a separate control panel or console is utilized it shall be easily identified as being part of the GIF.

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

Importation of Sources

103 Operating Organizations shall plan all importation properly by obtaining information on NNRA requirements and use such information in ordering their sources. 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.

(2) Requests for import licenses must be accompanied by transport schedules to enable the NNRA ascertain that the importation of such source does not violate the provisions of NiBIRR and the international regulations.

(3) The Operating Organization shall make sure that all documents concerning the source design are made available to the NNRA. Also, the Operating Organization shall submit the schedule for installation, commissioning and use of the source prior to actual importation of the source.

(4) The document to be presented must include evidence on what to do with the source when it is no longer in use or is depleted. This could 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 GIF

Commissioning of the GIF

104. Commissioning programme can be divided into two phases, cold commissioning and hot commissioning. The cold commissioning involves installation of the GIF accessories, testing them and certifying their functionality. It also includes staff training and certification on operation of the GIF system. 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 RSOs.

(2) In order to avoid dose rates in excess of doses experienced in normal operations of the GIF during loading and unloading, an evaluation of procedures must be made beforehand to ensure that the exposure of persons is kept as low as reasonably achievable (ALARA).

(3). An assessment shall also be carried out of any safety hazards associated with the loading and unloading work. Any necessary contingency plans shall be incoRSOrated into the written instructions for operation of the GIF.

(4). It is imperative that the integrity of the safety control systems must not be compromised by the source loading and unloading procedures.

(5). The loading and unloading of the radioactive source on arrival at the GIF or on dispatch from it are potentially hazardous operations and shall be undertaken under the close supervision of the RSO.

(6). Operating Organizations obtain from the supplier all information needed for the safe transport of the source as given in Ref [4].

(7). Results of tests carried out and duly signed by a qualified personnel representing the Operating Organization must be made available to the NNRA for the puRSOse of authorizing the operation of the GIF. This is of course after showing that the operators are well trained and certified. Further certification would have to be made by NNRA or where possible, approve the certification of operators and RSOs.

Decommissioning of the GIF

105 The procedure for decommissioning must be submitted and approved by the NNRA before decommissioning work starts. The Operating organization must 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

106. If an actual or suspected source leak has occurred, the use of the GIF shall be terminated and 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. The affected area shall be isolated and contact shall be established with the following, as appropriate, for the puRSOse of obtaining assistance:

(a) The NNRA

(b) The RSA

(c) The manufacturer of the device

(d) The supplier and the installer of the source (if different from the manufacturer of the device).

(2). 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 NNRA.

Part IX- Transportation of Radioactive Sources

General Requirements

107(1**)** The transportation of sealed sources shall comply with International Atomic Energy Agency for Safe Transport of Radioactive Materials, TS-R-1 and Nigeria Safe Transport of Radioactive Materials Regulations and proper packaging shall be used for all transportation, and the manufacturers instructions followed for proper preparation of exposure containers before transportation.

(2)The following steps shall be taken:

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

b) gamma radiography sources are transported only in Type B packages that must have a valid certificate. The licensee shall have a valid copy of the certification;

c) gamma radiography sources are locked in their shielded position and any key removed;

d) all shipping plugs or caps are fitted correctly and, where possible, locked in place;

e) the package is in good condition, is fit for transport and is labeled correctly;

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

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

h) 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;

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

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

k) appropriate transportation papers must accompany the shipment (e.g.: consignor's statement and information for the carrier, such as emergency contact details);

Receipt of Radioactive Materials

108 (1)**.** Prior to each shipment of radioactive, the licensee shall make necessary arrangements with the source supplier, to receive all relevant information. This information 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 International Atomic Energy Agency (TS-R–1) for other packages;
(f) details of any special arrangements required, including multilateral approvals, where necessary;
(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 above items are complied with. The supplier and licensee shall agree on the transportation route and responsibility for each stage of the journey.

(3) Arrangements shall also be made for the following where necessary:

(a) checking of radiation dose rates from the package or container;

(b) checking 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;

(e) security of the consignment during transport, particularly during delays or overnight stops.

Dispatch of Radioactive Materials

109. The licensee shall return packages or containers to the source supplier after receipt of a consignment of radioactive material. All requirements in the Nigeria Safet Transport of Radioactive Materials and International Atomic Energy Agency (TS-R–1) concerning packaging, labeling, placarding where necessary, consignor responsibilities and all authorizations and approvals must be met before dispatching radioactive materials.

Empty Packages

110. With regard to returning empty packages the licensee shall:

(1) 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 and it can therefore be treated as an empty package or container;

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

(3) examine the package or container to ensure that it is in good condition, and then close it securely, referring to any procedures provided by the source supplier;

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

(5) complete a transportation document;

(6) contact the source supplier and agree on the transport route and responsibility for each stage of the journey. Inform the source supplier of the proposed date of dispatch.

Unused Sources

111. With regard to returning unused sources, the licensee shall provide the following information to the consignee for each package or container:

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

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

(3) special form approval certificate;

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

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

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

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

Dispatch of Consignment

112. The licensee shall not dispatch the consignment, unless they have received confirmation from the consignee that they are prepared to accept it.

Transportation Routes

113(1**)** The licensee and consignee should agree on the transportation route and the responsibility for each stage of the journey.

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

Details of Consignment

114. In order to prepare the consignment for dispatch, the licensee shall:

(1) load the sources into the package, verifying the details to be provided to the consignee e.g., serial numbers and comparable information to be entered on the transport document;

(2) close it securely and then examine the package or container to ensure that it is in good condition, referring to any procedures provided by the source supplier;

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

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

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

(6) complete a transportation document.

Security for the Consignment

115. Arrangements shall also be made for the following;

(1) ensure that the package is securely attached to the vehicle and that the vehicle is correctly labeled;

(2) deal with border controls;

(3) provide security for the consignment during transportation, particularly during delays or overnight stops.

PART X- EMERGENCY PLANNING AND PREPAREDNESS

Programme for Emergency Planning and Preparedness

116. 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

117(1**)** A Radiation Safety Adviser shall be consulted when drawing up emergency plans.

(2)Emergency planning and preparedness should be regarded as comprising the following stages:

(1) identification of potential accidents and other unplanned events during industrial radiography and an evaluation of the risks associated with these;

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

(3) specification and acquisition of emergency equipment;

(4) training to implement the emergency plan, including necessary training in the use of the emergency equipment;

(5) exercises at appropriate intervals to test the implementation of the emergency plan;

(6) periodic reviews and necessary updates of the emergency plans.

Implementation of emergency plan

118 (1**)** The responsibility for adequately implementing each of the six stages contained under Regulation 83(2) lies with the licensee of the industrial radiography organization and the resulting emergency plans and associated arrangements shall form a part of the license application to the Authority.

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

Initial Safety Assessment

119. At this 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 and local circumstances shall be taken into account.

Sealed Sources

120. Each of the following events involving sealed sources shall be recognized as constituting a potential event necessitating implementation of an emergency plan:

(1) failure to fully retract a source;

(2) a source struck outside the shielded container, whether within the collimator, the guide tube or close to entrance to the container;

(3) disconnection of the source from the wind-out cable;

(4) a theft or loss of a source, container or exposure;

(5) damage to a source or a container, e.g. mechanical or fire damage, including during transport;

(6) radioactive contamination resulting from a damaged or faulty source;

(7) malfunction or deliberate defeat of the safety and warning system.

Radiation Generators

121. The identifiable potential events involving radiation generators shall be recognized to include the following:

(1) an automatic exposure timer fails to terminate an exposure;

(2) unintentional energizing of an X-ray tube;

(3) an operator fails to terminate a manually controlled exposure;

(4) a malfunction of any critical safety or warning system, including deliberate action to override;

(5) physical damage causing an equipment malfunction or damage to shielding;

(6) a failure of the associated safety and warning system, or the operator fails to heed a warning that is being given.

Development of Emergency Plans

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

Features of emergency plan

123. The emergency plans should develop the following components:

(1) identification of persons authorized to implement the various stages of the plans;

(2) 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;

(3) advice on when to implement the emergency plans;

(4) procedures specific to each identified emergency situation, to be followed at various stages, as applicable:

(a) initial stage, to contain the situation;

(b) planning stage, to plan and practice the recovery stage;

(c) recovery stage;

(d) post accident stage, to return working situation to normal;

(e) preparation of accident report;

(5) special procedures to follow in life threatening situations;

(6) availability of emergency response equipment;

(7) notification to the Authority

Emergency Equipment

124. Licensees shall ensure that all necessary equipment is available to deal with emergency situations. Emergency equipment shall include:

(1) appropriate and functioning survey meters, personal alarming dosimeters and direct reading dosimeters (QFE or electronic);

(2) additional personal dosimeters, thermo luminescent dosimeters or film badges;

(3) barrier materials and warning notices;

(4) bags of lead shot, spare lead sheet and lead tunnel;

(5) suitable tool kit and source recovery equipment long handling tongs, pliers, screwdrivers, bolt cutters, adjustable spanner, hacksaw and torch light;

(6) emergency shielded storage container, spare source container and communication equipment (e.g. mobile phones, walkie-talkies);

(7) spare batteries for survey meters, personal alarms and torch;

(8) stationery supplies and incident logbook;

(9) equipment manuals.

Inspection and Maintenance of Emergency Equipment.

125. Licensees shall carry out regular audits to ensure that all emergency equipment is available and is functioning correctly.

Training

126(1**)** All persons nominated to participate in the emergency plans shall be adequately trained to ensure efficient and effective implementation of their roles and this shall include 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

127. 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.

Periodic Reviews of Emergency Plans

128. Formal reviews of emergency plans shall be undertaken annually to ensure:

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

(2) emergency equipment is available and is maintained.

Accident Report

129. In order to learn from the accident situations that have occurred within the organization or elsewhere, and to 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 and the reports shall be submitted to the Authority.

Details of the Accident Report

130. The Accident Report shall include the following:

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

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

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

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

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

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

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

Part XI- Offences and Penalties

Offences and Penalties

131(1) Any person who contravenes any of the provisions of these regulations commits an offence.

(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, imposing 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,

who commits an offence shall be liable to prosecution in the court of law and upon conviction be liable to pay fines not exceeding N1,000,000 for an individual and not exceeding N10,000,000 for a corporate body or be given a jail term not exceeding ten years or both.

Appeal

132. 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.

PART XI - CITATION

Citation

133. These regulations may be cited as the "Nigerian Radiation Safety in Industrial Irradiator Regulations" and came into effect on ……..200?.

SCHEDULE 1

DOSE LIMITS

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

I. an effective dose of 20 mSv per year averaged over five consecutive years;

II. an effective dose of 50 mSv in any single year;

III. an equivalent dose to the lens of the eye of 150 mSv in a year; and

IV. 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:

I. an effective dose of 6 mSv in a year;
II. an equivalent dose to the lens of the eye of 50 mSv in a year; and
III. 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.

MADE at Abuja this……day of ……2006

PROFESSOR SHAMSIDEEN BABATUNDE ELEGBA

DIRECTOR GENERAL

EXPLANATORY NOTE

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

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