

NIGERIAN NUCLEAR REGULATORY AUTHORITY

DRAFT

Radiation Safety Regulations for Nuclear Well Logging Practice in Nigeria

Radiation Safety Regulations for Nuclear Well Logging Practice in Nigeria
Arrangements of Regulations

PART I - GENERAL

1. Interpretation
2. Objective
3. Scope
4. Application

PART II – GENERAL REQUIREMENTS

5. Radiation Safety Requirements
6. Authorization of the Practice
7. Requirement for authorizations
8. Duration of authorization
9. Responsibilities of the Licensee
10. Management and Organizational Requirements
11. Appointment of Well Logging Supervisors
12. Responsibilities of the Well Logging Supervisors
13. Responsibilities of the Radiation Safety Adviser
14. Training and Education
15. Obligations of the Licensee
16. Record of Training
17. Safety Assessments
18. Verification of Safety
19. Policy Statements

PART III - INDIVIDUAL MONITORING OF WORKERS

20. Statutory (Legal) Dosimeters and Dose Records
21. Radiation Surveys and Records
22. Protection of Personnel Dosimeters during Use
23. Storage of Personnel Dosimeters
24. Loss of Personnel Dosimeters
25. Investigation of Doses
26. Reading of dosimeter
27. Personnel Monitoring

PART IV - WORKPLACE MONITORING

28. Maintenance of workplace monitoring
29. Survey Meters
30. Maintenance and Calibration
31. Use of Radiation Survey Meters

PART V – SECURITY OF RADIOACTIVE SOURCES

32. Security and control of radioactive sources
33. Storage of Nuclear Well Logging Sources
34. Accounting for Radioactive Sources
35. Central Records of Radioactive Sources
36. Source Movement Records
37. Radioactive Source Audits

PART VI – REQUIREMENTS FOR NUCLEAR WELL LOGGING EQUIPMENT

38. General Requirements
39. Nuclear Well Logging equipment
40. Requirements for Sealed Sources
41. Requirements for exposure container
42. Maintenance Requirements

PART VII – REQUIREMENTS FOR NUCLEAR WELL LOGGING

45. Preparation for Nuclear Well Logging
46. Documents and Records Required at Field Stations
47. Design, Performance and Certification for Sealed Sources used in Downhole Operations
48. Utilization Records

PART VIII – PRECAUTIONARY PROCEDURES IN LOGGING AND SUBSURFACE TRACER OPERATIONS

49. Security
50. Handling Tools
51. Subsurface Tracer Studies
52. Designation of Controlled Area
53. Radiation Survey Instruments
54. Leak Testing of Sealed Sources
55. Defence-in-Depth during Nuclear Well Logging
56. Boundary of Controlled Area
57. Temporary Job Sites
58. Warning Notices and Warning Signals
59. Labeling
60. Patrolling and Monitoring of Controlled Area
61. De-designating the Controlled Area

PART IX – TRANSPORTATION OF RADIOACTIVE SOURCE

62. General Requirements
63. Receipt of Radioactive Materials
64. Dispatch of Radioactive Materials

65. Unused Sources
66. Transportation Routes
67. Details of Consignment
68. Security for the Consignment
69. Quarterly Inventory

PART X- EMERGENCY PLANNING AND PREPAREDNESS

70. Programme for Emergency Planning and Preparedness
71. Consultation for emergency plan
72. Implementation of emergency plan
73. Initial Safety Assessment
74. Sealed Sources
75. Development of Emergency Plans
76. Features of emergency plan
77. Emergency Equipment
78. Inspection and Maintenance of Emergency Equipment.
79. Training: Subjects to be included in Training Courses for Logging Supervisors
80. Audit of Training Intervals
81. Emergency Exercise
82. Periodic Reviews of Emergency Plans
83. Notification of Incidents, Abandonment and Lost Sources
84. Details of the accident report

PART XI- OFFENCES AND PENALTIES

85. Offences and Penalties.
86. Appeal

PART XII - CITATION

87. Citation

SCHEDULE: 1. Dose Limits.

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

**Radiation Safety Regulations for Nuclear Well Logging
Practice in Nigeria**

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: 2008

PART I- GENERAL

Interpretation

1. For the purpose 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;

“consignee” means any person, organization or government which receives a consignment

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

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

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

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

“employer” means a legal person with recognized responsibility, commitment and duties towards a worker in his or her employment by virtue of a mutually agreed relationship. 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:

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

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

“local rules” means rules and instructions made and set down in writing as are appropriate to the radiation risk and nature of operations undertaken in that area.

“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;

“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;

“practicable” means social, technical, economic factors taken into consideration

“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 generator” means a device capable of generating radiation, such as X rays, neutrons, electrons or other charged particles, which may be used for practices within the scope of the regulation;

“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 purposes of application of the regulations;

“radioactive waste” means a material, whatever its physical form, remaining from practices or interventions and for which no further use is foreseen (i) that contains or is contaminated with radioactive substances and has an activity or activity concentration higher than the level from regulatory requirements, and (ii) exposure to which is not excluded from the regulations;

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

“registrant” means a licensee or registrant

“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, should 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;

“well-owner”

“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 nuclear well logging operations 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.

Scope

3. The regulations shall specify the minimum requirements for radiation protection and safety for all users of ionizing radiation in nuclear well logging operations and specify the radiation safety requirements for persons using licensed materials in these operations.

Application

4 (1) These Regulations shall apply to all existing ionizing radiation and nuclear regulations, such as radioactive waste management regulations, radioactive material transport regulations e.t.c. in force at the commencement of these regulations.

(2) These Regulations shall apply to:

all sources of ionizing radiation used for the above purposes, with possible exemption prior to authorization by the authority;

facilities where sources of ionizing radiation are installed, used or stored;

the operation of sources of ionizing radiation;

the duties and responsibilities of the users, their internal safety organization and working procedures related to radiation protection;

the monitoring of persons occupationally exposed (external, internal dosimeter) and of work places;

medical examinations of persons occupationally exposed;

radioactive sources or materials in storage or in transit;

handling of wastes and radioactive release from the above uses;

handling of radiological emergencies or accidents;

preparedness in cases of release of radioactive materials to the environment;

import or export requirements;

quality control of equipment and calibration of instruments, etc;

program for education, training and development;

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 Nigeria Basic Ionizing Radiation Regulations shall be applied to nuclear well logging operations.

Authorization of the Practice

6. (1) A legal person intending to carry out nuclear well logging or any of the following associated activities shall notify the Authority of his intention and obtain an authorization for:

- (a) importation, purchase, sale, hire, manufacture, repair of or modification to, radiation generators and sealed sources used for nuclear well logging including ancillary equipment, which incorporates radioactive materials such as depleted uranium source containers etc;

- (b) transportation, storage, use of radiation generators and sealed sources for nuclear well logging including ancillary equipment, which incorporates radioactive materials;
- (c) construction of facilities for nuclear well logging and any temporary or permanent decommissioning of these facilities;
- (d) disposal of any sealed sources including ancillary equipment, which incorporate radioactive materials;
- (e) transfer of ownership of any radiation generator or sealed source including ancillary equipment which incorporates radioactive materials or any facility used for nuclear well logging.

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

(3) AGREEMENT WITH WELL OWNER OR OPERATOR.

(a) A licensee may perform well logging with a sealed source only after the licensee has a written agreement with the employing well owner or operator. This written agreement must identify who will meet the following requirements:

(1) If a sealed source becomes lodged in the well, reasonable effort in line with best practice in the industry will be made to recover it.

(2) A person may not attempt to recover a sealed source in a manner which, in the licensee's opinion, could result in its rupture or could lead to danger to health, safety and environment.

(3) The radiation monitoring will be performed from the commencement of logging operation till the end of logging operation or the end of abandonment.

(4) If the environment, any equipment, or personnel are contaminated with licensed material, they must be decontaminated before release from the site or release for unrestricted use; and

(5) If the sealed source is classified as irretrievable after reasonable efforts at recovery have been expended, the following requirements must be implemented within 30 days:

(i) Each irretrievable well logging source must be immobilized and sealed in place with a cement plug.

(ii) A means to prevent inadvertent intrusion on the source, unless the source is not accessible to any subsequent drilling operations; and

(iii) (a) A permanent identification plaque, constructed of long lasting material such as stainless steel, brass, bronze, or monel, must be mounted at the surface of the well, unless the mounting of the plaque is not practical. The size of the plaque must be at least 17 cm [7 inches] square and 3 mm [¹/₈-inch] thick. The plaque must contain—

(A) The word "CAUTION";

(B) The radiation symbol;

(C) The date the source was abandoned;

(D) The name of the well owner or well operator, as appropriate;

(E) The well name and well identification number(s) or other designation;

(F) An identification of the sealed source(s) by radionuclide and quantity;

(G) The depth of the source and depth to the top of the plug; and

(H) An appropriate warning, such as, "DO NOT RE-ENTER THE WELLBORE TO THE SOURCE POSITION."

(b) The licensee shall retain a copy of the written agreement for 3 years after the completion of the well logging operation.

(c) A Well-Owner or Operator shall apply, on a case-by-case basis, for authorization to abandon an irretrievable well logging source.

(d) A written agreement between the licensee and the well owner or operator is not required if the licensee and the well owner or operators are part of the same corporate structure or otherwise similarly affiliated.

Requirement for authorizations

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

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

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

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

Duration of Authorization

8 (1) Authorization 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 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:

- (1) notify the Authority of all the activities stated in these regulations;
- (2) notify the Authority of any intentions to introduce modifications to any practice or source for which they are authorized;
- (3) 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;
- (4) appoint one or more well logging supervisors who shall serve as the Radiation Safety Officers to oversee the implementation of the radiation safety programme and provide such Radiation Safety Officers with appropriate authority and adequate resources;
- (5) consult and appoint Radiation Safety Advisers where necessary;
- (6) perform the required Safety Assessments as contained in these regulations;
- (7) ensure that workers are adequately trained in;
 - (a) radiation protection and safety;
 - (b) the operating procedures, local rules and emergency plans appropriate to the specific types of equipment used within the organization;
- (8) provide workers with personal dosimeter and appropriate health surveillance;
- (10) ensure that all equipment used for the practice is suitable for its intended and actual uses and is properly maintained;
- (11) provide workers with appropriate survey meters that are maintained in good working order and tested regularly;
- (12) ensure that adequate radiation monitoring is carried out and that records are kept;
- (13) provide emergency plans (contingency plans) for all reasonably foreseeable radiation accidents and incidents;
- (14) make provisions for the safe disposal or return to the supplier of existing radioactive sources that are no longer required;
- (15) when applying for a new authorization for the importation, use or storage of any radioactive source including ancillary equipment that incorporates depleted

uranium shielding, provide for a program for the safe disposal or return of sources to the supplier when they are no longer required;

- (16) 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 Licensee shall provide the human and material resources necessary to ensure safe working conditions and compliance with License conditions.

(2) The Licensee 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;
- c) 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.
- (d) the Authority shall be notified of these appointments.

Appointment of Radiation Safety Officer

11 (1) The Licensee shall appoint at least one Radiation Safety Officer whose functions and duties are clearly defined and documented.

(2) The minimum requirements and qualities for a Radiation Safety Officer shall include:

- a. theoretical knowledge and practical training in radiation protection and safety related to well logging operations;
- b. sufficient management authority within the operating organization to effectively supervise and control the well logging work to ensure that the license conditions are met;
- c. the Radiation Safety Officers shall have the authority to stop work that is not being undertaken in a safe manner.

Responsibilities of the Radiation Safety Officer

12 (1) The Radiation Safety Officer's responsibility shall include:

- supervising the work to the extent necessary to ensure that procedures including local rules and all License terms and conditions are complied with;
- preparing and reviewing written administrative procedures that define the means of complying with regulatory or license requirements;
- preparing and reviewing operational procedures including local rules to ensure that exposures to radiation are kept as low as reasonably achievable;
- ensuring that operation manuals for the well logging equipment are provided and are understood by the workers;
- ensuring that safety assessments and emergency plans are prepared;
- ensuring that engineering controls and other equipment designed to protect persons against ionizing radiation are maintained;
- identifying designated areas and establishing necessary safeguards for controlling access to such areas;
- arranging for and supervising the use of personnel dosimeter and ensuring that appropriate dose records are maintained;
- ensuring that there is adequate monitoring of workplaces in order to prevent unnecessary exposure and to demonstrate compliance with the Regulations and Licence conditions;
- investigation of accidents including abnormal high exposures in routine work and overexposures, proposing, implementing remedial actions and accident preventive measures;
- to determine the additional requirements for protection of any female staff engaged in the work with ionizing radiation who may be pregnant;
- carry out a prior examination from a radiation safety standpoint of any plans for new fixed well logging facilities or modifications to existing ones;
- maintain inventories of radioactive sources;
- perform regular safety inspections of all well logging work;
- identify situations where a Radiation Safety Adviser should be consulted.

(2) In cases where more Radiation Safety Officers are appointed, i.e. multiple job sites, the reporting structure and individual duties of each shall be well defined, with one Radiation Safety Officer having general oversight an

13 (1) Licensee shall appoint an authorized Radiation Safety Adviser, to advise in many areas, such as design of new facilities, maintenance of safety systems etc. to ensure compliance with regulatory and license requirements.

(2) The scope of advice and the services provided by an authorized Radiation Safety Adviser shall be agreed with the Licensee and clearly documented.

(3) Licensee shall provide the Radiation Safety Adviser with appropriate information and access to facilities in order for the Adviser to carry out the agreed services.

Training and Education

14 (1) Licensees shall ensure that well logging is carried out only by qualified personnel.

(2) Formal training of Radiation Safety Officers and other personnel shall be carried out in a systematic manner and shall involve accreditation to a recognized local, national or international standard and periodical training is essential to maintain the required level of competence.

(3) Licensees shall only employ qualified Radiation Safety Officers who have received formal training which include:

- (a) sufficient educational background;
- (b) specialized formal training in radiation protection and safety;
- (c) familiarity with the organization's local rules and License requirements;
- (d) practical training in techniques and radiation protection and safety requirements including emergency procedures specific to the equipment used within the organization.

Obligations of the Licensee

15 The Licensee shall also ensure that Radiation Safety Officers and all workers know and understand the following:

- (1) the conditions and limitations of the License held by the licensee;
- (2) the organization's radiation protection and safety programme;
- (3) the operation and maintenance of the equipment used by the licensee;
- (4) hazards identified by the Safety Assessment;
- (5) local rules and other operating procedures;
- (6) the detailed procedures to be followed in the event of emergencies, training for which shall include training exercises carried under realistic condition.

Record of Training

16 (1) The licensee shall prepare and maintain a record of training of all the personnel involved in well logging and these records shall include the following information:

- (a) name of the person who received the instruction or training;
- (b) name of the institution or person who delivered the training;
- (c) dates and duration of the instruction or training;
- (d) a summary or list of the topics addressed;
- (e) copy of any training certificates;
- (f) the result of any professional examination taken.

(2) The licensee shall provide copies of the training records to individual workers especially if they change their employers.

Safety Assessments

17 1) Licensees shall ensure that a safety assessment is carried out at the following stages:

- (a) when applying for a new licence or for modification to an existing license;
- (b) at the design stage, prior to the operation of well logging;
- (c) when making significant changes to working practices or modifications to well logging facilities;
- (d) when operating experience, or other information about accidents, failures, errors or other events that could lead to potential exposures indicates that the current assessment might be invalid.

(2) Licensee shall ensure that the safety assessment is fully documented and is prepared in consultation with the Radiation Safety Officers and Radiation Safety Adviser.

(3) The safety assessment shall include a systematic and critical review of:

- (a) the nature and magnitude of potential exposures and the likelihood of their occurrence;
- (b) the limits and technical conditions for operation of radiation sources;
- (c) the ways in which structures, systems, components and procedures related to radiation protection or safety might fail, singly or in combination, or otherwise lead to potential exposures, and the consequences of such failures;

- (d) factors which could give rise to the unintended operation of any radiation source and the measures available to prevent, identify and control such occurrences;
- (4) Where the safety assessment shows there is a risk of a radiation accident, Licensees shall take all practicable steps to:
- (a) prevent such accident;
 - (b) limit the consequences of such accident, should the accident occur;
 - (c) provide workers with training in emergency procedures.

Verification of Safety

18 Licensees shall carry out regular audits of normal well logging operations to ensure that a satisfactory standard of radiation safety is being maintained.

Policy statement

19 (1) Licensees shall develop a policy statement that specifies the following:

- (a) person responsible for organizing and carrying out the safety audits;
- (b) the time interval between audits;
- (c) person responsible for preparing the audit report and making recommendations;
- (d) person to whom the audit report is to be sent;
- (e) person responsible for implementing any corrective measures that are identified during the audit.

(2) Each audit shall be done according to a structured plan and the time scale set for implementing corrective measures shall ensure that any deficiencies which present a significant radiological hazard are dealt with promptly and the agreed corrective measures shall be followed-up to ensure that the audit process is completed.

Part III- INDIVIDUAL MONITORING OF WORKERS

Statutory (Legal) Dosimeters and Dose Records

20 (1) The Licensee shall assess the occupational exposure of all 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 OSL badges or a thermo-luminescent dosimeter as appropriate;
- 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. the statutory personal dosimeter shall only be used by the person to whom it is assigned;
- e. the Licensee shall maintain a dose record for each individual in the manner specified in the regulations;
- f. before a well logging supervisor starts work, the licensee shall obtain a copy of the workers' dose record from previous occupational exposure;
- g. licensee shall draw up 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 Radiation Safety Officers and other radiation workers;
 3. collects them and dispatches them to the dosimeter processing laboratory;
 4. reviews and maintains the dose records.

Radiation Surveys and Records.

21 (1) Radiation surveys and personnel exposure calculations shall be made and recorded for each area where radioactive materials are stored.

(2) Radiation surveys and personnel exposure calculations shall be made and recorded for the radiation levels in occupied positions and on the exterior of each vehicle used to transport radioactive material. Such surveys and calculations shall include each source of radiation or combination of sources to be transported in the vehicle.

(3) After removal of the sealed source from the logging tool and before departing the jobsite, a survey meter shall be used to assure that the logging tool is free of contamination.

(4) Radiation surveys shall be made and recorded at the jobsite or well-head for each tracer operation, except those using tritium, carbon 14 and sulfur 35. These surveys shall include measurements of radiation levels before and after the operation. If radiation levels, post operation, exceed twice background, the area shall be decontaminated or restricted until radiation levels reach twice background.

(5) Records required pursuant to this section shall include the dates, the identification

of individuals making the survey, the identification of survey instruments used and an exact description of the location of the survey. Records of these surveys shall be maintained for inspection by the Authority for 2 years after completion of the survey.

Protection of Personnel Dosimeters during Use

22. In order to ensure the protection of the personnel dosimeters, the licensee 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

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

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

individual dosimeters shall not be stored in source stores, near exposure containers, near radioactive luminous items or in any other area where there are raised dose rates.

Loss of Personnel Dosimeters

24 (1) For the loss of any dosimeter, the Licensee shall take all reasonable steps to recover it.

(2) If the dosimeter cannot be located, the Licensee 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

25 (1) Results of personal dosimeters shall be reported to the well logging supervisor 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 well logging supervisor shall set investigation levels of doses above which a formal investigation and written report shall be prepared.

Reading of Dosimeter

26 (1) Direct reading dosimeters (e.g. quartz fibre electroscopes) shall be used to supplement the OSL badges or as appropriate, whenever it is important to have an immediate indication of exposure, for example during well logging 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.

Personnel Monitoring.

27 No licensee shall permit any individual to act as a Radiation Safety Officer or to assist in the use of sources of radiation unless such individual wears an optically stimulated luminescent device (OSLD), or a thermoluminescent dosimeter (TLD). Each OSLD, or TLD shall be assigned to and worn by only one individual.

PART IV- WORKPLACE MONITORING

Maintenance of Workplace Monitoring

28 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

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

(2) A survey meter shall be used at all time during storage, handling, use and transportation of well logging sources to confirm that the sources are in their assigned position or location. 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 $1 \mu\text{Svh}^{-1}$ 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

30 (1) The licensee shall inspect the operation of the radiation survey meter at the start of each working shift.

(2) This inspection shall include:

battery condition;

any other instrument checks (e.g. high voltage setting);

background radiation level is as expected;

response against a gamma or neutron source as appropriate or other suitable check source.

(3) Every radiation survey meter used during nuclear well logging shall be checked regularly:

normal tests as in proceeding paragraph;

any specific inspection of instrument specified by the manufacturer;

inspection of indicated gamma or neutron dose rate versus actual dose rate at a range of dose rates to establish linearity of response;

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

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

31 (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 area classification and assess exposures;

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

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

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

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

(2) In the following situations:

after every use and handling of gamma or neutron source to confirm that the source is in its fully shielded position or assigned location;

to check the dose rates at the controlled area barriers during site nuclear well logging;

when transferring radioactive sources between containers;

when dealing with emergencies involving gamma or neutron sources.

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

location;

date;

name of person performing survey;

survey meter type and serial number;

radiation source details, e.g. type of source, activity, etc;

locations of measuring points;

dose rate in $\mu\text{Sv h}^{-1}$.

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

PART V- SECURITY AND STORAGE OF RADIOACTIVE SOURCES

Security and Control of Radiation Sources

32 (1) The licensee in whose custody the sources are at any material time shall establish physical controls and administrative procedures to prevent damage to, theft, loss or unauthorized removal of radioactive sources.

(2) In order to ensure this, the licensee shall take into consideration the following:
controls and procedures to prevent entry by unauthorized persons into radioactive source stores and controlled areas during site well logging procedures;

control of source is not relinquished without prior notification of the Authority;

a radioactive source shall not be transferred, unless the receiver possesses a valid authorization;

that all workers shall be informed of the need and importance of radioactive source security

permanent and purpose designed radioactive source stores are to be made available;

temporary stores are established where necessary at sites where well logging procedures are undertaken;

identification of the potential ways in which sources can be lost or stolen, in particular the risks of theft during temporary storage and transporting radioactive sources;

an effective system for accounting radioactive sources shall be implemented and to be fully complied with by all workers and the system shall be capable of detecting losses quickly during each logging or tracer application, the logging supervisor or other designated employee shall maintain direct surveillance of the operation to protect against unauthorized or unnecessary entry into a restricted area.

Storage of Nuclear Well Logging Sources

33 Sealed sources used in well logging work shall be stored in secured exposure containers or source changers and these in turn shall be kept in suitable stores that will meet the following minimum requirements:

- (1) it shall be designated as a controlled area;
- (2) it shall be properly secured, to prevent removal or tampering with the radioactive sources;
- (3) the keys shall be made available to the well logging supervisor only and key holding shall be properly documented;
- (4) it shall protect the equipment from damage and harsh environmental conditions;
- (5) it shall provide protection against fire and shall not contain or be located in proximity to flammable, corrosive or oxidizing materials, or explosives;
- (6) the entrance door to the store shall be labeled clearly and durably with a radiation trefoil symbol, the words: ***“Danger Radioactive Material”*** in an understandable language;
- (7) if the store is located at a place not on the licensee’s site, the name, address and telephone number of the licensee shall be displayed so that he can be contacted in an emergency situation.

Accounting for Radioactive Sources

34 (1) Licensee shall ensure that the location of their sources is known at all times and a formal accountability system shall be established that records the location of the following radioactive sources:

sealed sources used in well logging;

other sources such as those used to test radiation survey instruments and calibration

transport containers or source shield incorporating depleted uranium shielding, even when these containers do not contain a gamma or neutron source.

(2) The accountancy procedures shall be documented and consist of a number of elements which together provide defence in depth to ensure that records are complete and accurate.

Central Records of Radioactive Sources

35. (1) Licenses shall maintain a central and definitive record of all their radioactive sources.

(2) This shall be established for each source as soon as it is delivered to the organization and shall contain the following documents and details, which shall be updated when the sources are moved between storage locations or exposure containers, for each sealed source:

details of the source supplier;

date of receipt into the operating organization;

manufacturers' serial number;

radionuclide and activity on a stated date;

normal storage location;

type and serial number of the exposure container in which source is located;
local identifier ;

original manufacturers' leak test certificate;

copy of any subsequent leak test certificate;

original suppliers' special form certificate if one is issued and any updated certificates;

date, method and destination for final disposal or transfer to another party as authorized by the Authority.

(3) For each source container incorporating depleted uranium;
details of the container supplier;

date of receipt by the licensee;

manufacturers' serial number;

container type or model number or other descriptor;

transport code (e.g. Type A, Type B, etc);

maximum activity of source allowed to be used in the container;

the quantity of depleted uranium in kg (if used as shielding material);

date, method and destination for final disposal or transfer to another party as authorized by the Authority.

(4) These records shall be securely kept by the licensee and copies of the records shall be transported with each source in a suitable file or other document holder so that they can be readily inspected by the Authority.

(5) When sources or exposure containers are finally disposed of, the central records for each source or container shall be stored in a secured place for such period as may be specified in the License conditions or Regulations.

Source Movement Records

36. (1) Source movement records shall be maintained for every radioactive sources, source containers that incorporates depleted uranium and the records shall be recorded as follows:

an identifier that is sufficient to allow the source container to be related to the central records which also contain the records of the sealed source inside the container;

the radionuclide (e.g. Cs-137, Ba-133);

date and time the exposure container or source is removed from the store;

name and signature of the Radiation Safety Officer removing the source;

the place where it will be taken;

date and time it shall be returned to the source store;

name and signature of the Radiation Safety Officer returning the source;

(2) The source movement shall be recorded every time the source is moved and the Radiation Safety Officer shall regularly inspect them, to ensure that these records are accurately completed and the licensee shall retain the source movement records for a period specified by the Authority.

Radioactive Source Audits

37 (1) Licensees shall ensure that monthly audits are made of the source accounts and movement records.

(2) The physical location of each source and any exposure containers incorporating depleted uranium shall be verified.

(3) The audit shall include the following:

(a) identification from the central record of which sources are currently held by the licensee;

(b) preparation of a checklist of these sources;

(c) confirmation by physical inspection that every source and depleted uranium source container is accounted for using a radiation survey meter if there is any doubt whether the source is present;

- (d) confirmation that source movement records are accurately completed;
- (e) a written record that the audit results are satisfactory, this might take the form of the signature of the Radiation Safety Officer in the record or a separate record sheet retained by the Radiation Safety Officer.

PART VI- REQUIREMENTS FOR NUCLEAR WELL LOGGING EQUIPMENT

General Requirements

38. Equipment used for well logging shall be subject to the following general requirements:

- (1) any modification of an exposure container, sealed source, or any ancillary equipment used in well logging work shall be undertaken only by a qualified expert who is satisfied that the modification does not adversely effect the safety of the equipment. and significant modifications shall only be carried out following authorization from the Authority;
- (2) well logging equipment shall not be used in conditions or environments for which it was not designed and such equipment shall be stored in a suitable manner.

Nuclear Well Logging Equipment

39 To ensure adequate protection of persons during well logging the sealed source shall be housed in a shielded container except when in downhole.

Requirements for Sealed Sources

40 (1) Sealed sources used for well logging shall be designed, manufactured and tested to meet the requirements of the International Standard Organization or Standard Organization of Nigeria.

(2) In addition:

- (a) they shall be certified as meeting the requirements of 'special form' radioactive material according to the International Atomic Energy Agency transport regulations, TS-R-1;
- (b) each radioactive source shall have demonstrated its integrity by completion of a satisfactory leak test in accordance with the international standard organization;
- (c) any new source shall be supplied with a leak test certificate and to ensure the ongoing integrity of the source capsule.
- (d) leak tests shall be carried out at intervals prescribed by the Authority or license conditions or the regulations;
- (e) operating organizations shall require that source suppliers provide certification with all new sources;

- (f) source assemblies shall be designed, fabricated and tested to meet the requirements of the International Standard Organization (ISO);
- (g) source assemblies shall be compatible with the exposure container, ancillary equipment such as guide tubes and any source changer;
- (h) source assemblies shall be marked with the radiation trefoil sign and a legend “**radioactive**”;
- (i) they shall also be durably marked with the manufacturer’s serial number.

Requirements for Source or transport containers

41 The licensee shall have a good understanding of the type and safe use of the source or transport containers or any other container authorized by the Authority shall be used and further requirements shall include:

- (1) containers that incorporate depleted uranium shall be treated as radioactive sources even when empty and they shall be properly stored, accounted for and disposed of only in a manner authorized by the Authority;
- (2) knowledge of which of the containers incorporate depleted uranium and check that the containers are durably marked to identify this;
- (3) Whichever type of source or transport container is used, it shall meet the minimum requirements of the International Standard Organization or equivalent to the requirements of the Standard Organization of Nigeria.
- (4) any source or transport container shall bear a durable and clear label with the following details:
 - (a) the ionizing radiation trefoil symbol;
 - (b) a cautionary warning e.g. “**DANGER – RADIOACTIVE MATERIALS**”;
 - (c) chemical and mass number of radionuclide (e.g. “Am-241Be”, “Cs-137”);
 - (d) maximum source activity permitted for the container;
 - (e) model and serial number of the container;
 - (f) licensee name and address;
- (5) the container shall be supplied with an operational and maintenance manual;
- (6) licensee shall request that suppliers of source or transport containers and ancillary equipment to provide these manuals in an appropriate language.

Maintenance Programme

42 The licensee shall ensure that:

(1) the radiation generators, ancillary equipment, and safety systems are regularly inspected and maintained in good working order and this will require a formal programme of inspection and maintenance that shall take into account the recommendations of the equipment manufacturer and supplier.

(2) This program as a medium shall incorporate;

- (a) routine checks to be carried out at the beginning of each well logging operation and which all logging supervisors are trained;
- (b) periodic inspection and servicing of equipment that can be done by the Licensee;
- (c) periodic inspection and servicing of equipment that shall only be done by a qualified expert either from the equipment supplier or agents approved by the equipment supplier;
- (d) any service arrangements made between the operating organization and the equipment supplier or approved agent shall be specified in writing and the operating organization shall monitor these arrangements to ensure that the agreed work is actually carried out;
- (e) any equipment found to be defective shall be marked unserviceable, and cannot be used until repaired. Any such defect shall be promptly notified to the Radiation Safety Officer.

PART VIII- REQUIREMENTS FOR NUCLEAR WELL LOGGING

Preparation for Nuclear Well Logging

43 The licensee shall:

- (1) obtain a license as required by the Authority;
- (2) carry out a site-specific safety assessment;
- (3) provide a secure store for sealed sources and radiation generators;
- (4) ensure that a suitable, tested and functioning radiation monitor is available at the site;
- (5) exchange necessary information and co-operate with the site operator in so far as it is necessary to ensure the safety of all persons on the site in respect of the nuclear well logging;

Documents and Records Required at Field Stations.

44 Each licensee or registrant shall maintain, for inspection by the Authority, the following documents and records for the specific devices and sources used at the field station:

- (1) Appropriate license or certificate of registration;
- (2) Operating and emergency procedures;
- (3) A copy of these regulations;
- (4) Records of the latest survey instrument calibrations;
- (5) Records of the latest leak test results pursuant to license conditions;
- (6) Quarterly inventories;
- (7) Utilization records;
- (8) Records of inspection and maintenance and
- (9) Survey records.

Design, Performance and Certification Criteria for Sealed Sources Used in Downhole Operations.

45 (1) The licensee shall ensure that the sealed source, except those containing radioactive material in gaseous form, used in downhole operations shall be certified at the time of manufacture, to meet the following minimum criteria:

- (a) Is of doubly encapsulated construction;
 - (b) Contains radioactive material whose chemical and physical forms are as insoluble and nondispersible as practical; and
 - (c) Has individually passed external pressure testing to at least 24,656 pounds per square inch absolute (170 MN per m²).
- (2) Sealed sources, except those containing radioactive material in gaseous form of a certificate from a transferor certifying that an individual sealed source meets the requirements of (1) (a) and (b), above, shall not be put into use until such determinations and testing according to (1) (c), above, have been performed.
- (3) Certification documents shall be maintained for inspection by the Authority for a period of 2 years after source disposal. If the source is abandoned downhole, the certification documents shall be maintained for 100 years.

Utilization Records.

46 Each licensee using radioactive materials shall maintain utilization records, which shall be kept available for inspection by the Authority for 2 years from the date of the recorded event, showing the following information for each source of radiation:

- (1) Make, model number and a serial number or a description of each source of radiation used;
- (2) The identity of the well logging supervisor or field unit to whom assigned;
- (3) Locations where used and dates of use; and
- (4) In the case of tracer materials and radioactive markers, the utilization record shall indicate the radionuclide and activity used in a particular well.

PART IX- PRECAUTIONARY PROCEDURES IN LOGGING AND SUBSURFACE TRACER OPERATIONS

Security.

47 During each logging or tracer application, the logging supervisor or other designated employee shall maintain direct surveillance of the operation to protect against unauthorized or unnecessary entry into a restricted area.

Handling Tools.

48 The licensee shall provide and require the use of tools that will assure remote handling of sealed sources except for low-activity calibration sources that result in a gamma exposure rate at contact of less than 100 milliroentgens (2.58×10^{-5} μC per kg) per hour.

Subsurface Tracer Studies.

- 49** (1) Protective gloves and other appropriate protective clothing and equipment shall be used by all personnel handling radioactive material. Precautions shall be taken to avoid ingestion or inhalation of radioactive material.
- (2) No licensee shall intentionally inject radioactive material into any fresh water aquifers unless the necessary Authority determines that such injection will not endanger the public health, safety and welfare.
- (3) No licensee shall inject radioactive material into any well unless it can be demonstrated to the Authority that the procedure will not result in any liquids or gases distributed to the public.

Designation of a Controlled Area

50 (1) A controlled area shall be designated, without exception, during well logging;

(2) In order to determine the extent of the controlled area, Licensees shall take account of the nature and frequency of well logging at a specific site as well as occupancy.

(3) The boundary of the controlled area shall be physically demarcated at all positions where access is possible.

Radiation Survey Instruments.

51 (1) The licensee shall maintain sufficient calibrated and operable radiation survey instruments at each field station and temporary jobsite to make physical radiation surveys. Instrumentation shall be capable of measuring 0.1 milliroentgen (0.001 mSv) per hour through at least 50 milliroentgens (0.5 mSv) per hour.

(2) Radiation survey instruments used to establish dose rates shall be calibrated:

- (a) At energies and geometries appropriate for use;
- (b) At intervals not to exceed 6 months, and after each instrument servicing;
- (c) Such that accuracy within plus or minus 20 percent can be demonstrated; and
- (d) For linear scale instruments, at two points located approximately 1/3 and 2/3 of full-scale on each scale; for logarithmic scale instruments, at midrange of each decade, and at two points of at least one decade; and for digital instruments, at appropriate points.

(3) Records of survey instrument calibrations shall be maintained for 3 years after the calibration date for inspection by the Authority

Leak Testing of Sealed Sources.

52 (1) A licensee using sealed sources containing radioactive material shall have the sources tested for leakage. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Authority for 3 years after the leak test is performed or until transfer or disposal of the sealed source.

(2) The licensee shall ensure that tests for leakage shall be performed only by persons specifically authorized to perform such tests by the Authority.

(3) The licensee shall ensure that the test sample be taken from the surface of the source, source holder, or from the surface of the device in which the source is stored or mounted and on which contamination might be expected to accumulate and analyzed for radioactive contamination, and the analysis shall be capable of detecting the presence of 0.005 microcurie (185 Bq) of radioactive material on the test sample.

(4) Interval of Testing. Each sealed source containing radioactive material shall be tested at intervals not to exceed 6 months. In the absence of a certificate from a transferor indicating that a test has been made prior to the transfer, the sealed source shall not be put into use until tested. If, for any reason, it is suspected that a sealed source may be leaking, it shall be removed from service immediately and tested for leakage as soon as practical.

(5) Leaking or Contaminated Sources. If the test reveals the presence of 0.005 microcurie (185 Bq) or more of leakage or contamination, the licensee shall immediately withdraw the source from use and shall cause it to be decontaminated, repaired, or disposed of in accordance with these regulations. The licensee shall check the equipment associated with the leaking source for radioactive contamination, and if contaminated, have it decontaminated or disposed of in accordance with these regulations. A report describing the equipment involved, the test results, any contamination which resulted from the leaking source and corrective action taken shall be filed with the Authority within 5 days of receiving the test results.

(6) Exemptions. The following sources are exempted from the periodic leak test requirements:

- (a) Hydrogen 3 sources;
- (b) Sources containing radioactive material with a half-life of 30 days or less;
- (c) Sealed sources containing radioactive material in gaseous form;
- (d) Sources of beta-emitting or gamma-emitting radioactive material with an activity of 100 microcuries (3.7 MBq) or less; and
- (e) Sources of alpha-emitting radioactive material with an activity of 10 microcuries (0.370 MBq) or less.

Defence-In-Depth during Nuclear Well Logging

53. During well logging, licensees shall ensure that defence in depth is achieved by providing multiple layers of safety that include:

- (1) carrying out a prior site-specific safety assessment;
- (2) establishment and demarcation of a controlled area;
- (3) restriction of access to the controlled area;
- (4) use of survey meters before and after every exposure;
- (5) use of personal alarming dosimeters;
- (6) use of warning signals before and after the exposure;
- (7) properly and well implemented operating procedures;

Boundary of Controlled Area

54 (1) A controlled area shall be designated, without exception, during all well logging procedures and the contour demarcating the area of safe dose shall be set at a value ensuring that outside the controlled area the annual dose limits for the public is not exceeded.

(2) The controlled area shall include the complete periphery of the contour and where necessary demarcate areas above and below the working level.

Temporary Jobsites.

55 Each licensee or registrant conducting operations at a temporary jobsite, which is a location to which radioactive materials have been dispatched to perform wireline service operations or subsurface tracer studies, shall have the following documents and records available at that site for inspection by the Authority

- (1) Operating and emergency procedures;
- (2) Survey records for the period of operation at the site;
- (3) Evidence of current calibration for the radiation survey instruments in use at the site; and
- (4) When operating, a copy of the appropriate license, certificate of registration or equivalent documents.

(5) (a) A Radiation Safety Officer must be physically present at a temporary jobsite whenever licensed materials are being handled or are not stored and locked in a vehicle or storage place. The RSO may leave the jobsite in order to obtain assistance if a source becomes lodged in a well.

(b) During well logging, except when radiation sources are below ground or in shipping or storage containers, the RSO or other individual designated by the logging supervisor shall maintain direct surveillance of the operation to prevent unauthorized entry into a restricted area.

Warning Notices and Warning Signals

56 (1) Warning notices shall be displayed around the controlled area boundary at suitable positions, and shall bear the international radiation trefoil symbol, warnings and appropriate instructions in English language and or local language (e.g. Danger Radiation, Controlled Area And Keep Out) and the meaning of the warning signals shall be clearly stated.

- (2) A notice should also include a phone number for use in case of emergencies.

57. Labeling.

(1) Each source, source holder or logging tool containing radioactive material shall bear a durable, legible and clearly visible marking or label, which has, as a minimum, the standard radiation caution symbol with the conventional color requirement, and the following wording:

DANGER (OR "CAUTION")
RADIOACTIVE

(2) Each transport container shall have permanently attached to it a durable, legible and clearly visible label which has, as a minimum, the standard radiation caution symbol and the following wording:

DANGER (OR "CAUTION")
RADIOACTIVE.
NOTIFY THE AUTHORITY IF FOUND

Patrolling and Monitoring of Controlled Area

58. Before the commencement of any nuclear well logging work:

The area shall be cleared of all people except for authorized personnel;

The boundary shall be clearly visible, well illuminated and continuously patrolled to ensure that unauthorized people do not enter the controlled area;

Prior to carrying out the well logging work, the well logging supervisor shall perform a test exposure to ensure that dose rates at the boundary do not exceed authorized limits;

dose rates at representative points at the boundary shall be checked during operations to ensure that the barriers are correctly positioned, particularly if the position of the equipment or direction of the radiation beam is changed.

De-designating the Controlled Area

59. On completion of well logging or at the end of a working period if the work is long-term the controlled area shall be de-designated and the following steps shall be taken:

- (a) confirmation that all radioactive sources are fully shielded and in their shielding container;
- (b) after all source containers have been removed, a final check shall be made with a survey meter to ensure that no radioactive sources have been inadvertently left behind;
- (c) check that all warning notices have been removed.

PART X- TRANSPORTATION OF RADIOACTIVE SOURCES

General Requirements

60 The transportation of sealed sources shall comply with International Atomic Energy Agency for Safe Transport of Radioactive Materials, TS-R-1 and Nigeria Transportation of Radioactive Sources Regulations 2006 and proper packaging shall be used for all transportation, and the manufacturer's instructions followed for proper preparation of exposure containers before transportation.

Receipt of Radioactive Materials

61 (1) Prior to each shipment of radioactive sources, 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

62 (1) The licensee shall return packages or containers to the source supplier after receipt of a consignment of radioactive sources

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

Unused Sources

63 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.

Transportation Routes

64 (1) The licensee and consignee shall agree on the transportation route and the responsibility for each stage of the journey shall lie with the licensee.

(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 Authority.

Details of Consignment

65 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

66 The licensee shall put in place necessary arrangements for the following;

- (1) ensure that the package is securely attached to the vehicle and that the vehicle is correctly labeled;
- (2) provide security for the consignment during transportation, particularly during delays or overnight stops.

Quarterly Inventory.

67 Each licensee shall conduct a quarterly physical inventory to account for all sources of radiation. Records of inventories shall be maintained for 2 years from the date of the inventory for inspection by the Authority and shall include the quantities and kinds of sources of radiation, the location where sources of radiation are assigned, the date of the inventory and the name of the individual conducting the inventory

PART XI- EMERGENCY PLANNING AND PREPAREDNESS

Programme for Emergency Planning and Preparedness

68 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

69 (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 well logging 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

70 (1) The responsibility for adequately implementing each of the six stages contained under this Regulation lies with the licensee 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

71 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

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

- (a) a theft or loss of a source, or container;

- (b) damage to a source or a container, e.g. mechanical or fire damage, including during transport or downhole operations
- (c) radioactive contamination resulting from a damaged or faulty source;
- (d) malfunction or deliberate defeat of the safety and warning system.

Development of Emergency Plans

73 Operating and Emergency Procedures. The licensee's operating and emergency procedures shall include appropriate instructions in at least the following:

- (1) Handling and use of sources of radiation to be employed so that no individual is likely to be exposed to radiation doses in excess of the established standards
- (2) Methods and occasions for conducting radiation surveys;
- (3) Methods and occasions for locking and securing sources of radiation;
- (4) Personnel monitoring and the use of personnel monitoring equipment;
- (5) As applicable, the transportation of radioactive sources to temporary job sites and field stations, including the packaging and placing of such sources in vehicles, placarding of vehicles and securing the sources during transportation;
- (6) Minimizing exposure of individuals in the event of an accident;
- (7) Procedure for notifying proper personnel in the event of an accident;
- (8) Maintenance of records;
- (9) As applicable, inspection and maintenance of source holders, logging tools, source handling tools, storage containers, transport containers and injection tools;
- (10) As applicable, procedures to be followed in the event a sealed source is lodged downhole; and
- (11) An applicable, procedures to be used for picking up, receiving and opening packages containing radioactive material.

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

74 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

75 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.

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

Training: Subjects to Be Included in Training Courses for Logging Supervisors.

77 The following subjects must be included in training courses for logging supervisors:

- (1) Fundamentals of radiation safety, including:
 - (a) Characteristics of radiation;
 - (b) Units of radiation dose and, if appropriate, quantity of radioactivity;
 - (c) Significance of radiation dose, including:
 1. Radiation protection standards; and
 2. Biological effects of radiation dose;
 - (d) Levels of radiation from sources of radiation; and
 - (e) Methods of minimizing radiation dose, including:
 1. Working time;
 2. Working distances; and
 3. Shielding.
- (2) Radiation detection instrumentation to be used, including:
 - (a) Use of radiation survey instruments, including operation, calibration and limitations;
 - (b) Survey techniques; and
 - (c) Use of personnel monitoring equipment.
- (3) Equipment to be used, including:
 - (a) Handling equipment, if appropriate;
 - (b) Sources of radiation;
 - (c) Storage precautions, if appropriate, and control of equipment; and
 - (d) Operation and control of equipment.
- (4) The requirements of these regulations: the Nuclear Safety and Radiation Protection Act, the Nigeria Basic Ionizing Radiation Regulations, the Nigeria Safety and Security of Radioactive Sources Regulations, the Nigeria Transportation of Radioactive Sources Regulations, the Nigeria Radioactive Waste Management Regulations and the Nigeria Radiation Safety in Nuclear Well Logging Regulations
- (5) The licensee's or registrant's written operating and emergency procedures.
- (6) The licensee's or registrant's record keeping procedures.

78 (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

79 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

80. 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.

Notification of Incidents, Abandonment and Lost Sources.

81 (1) Notification shall be made of radiation incidents and radioactive sources lost in other than downhole logging operations.

(2) Whenever a sealed source or device containing radioactive material is lodged downhole, the licensee shall:

(a) Notify the NNRA immediately;

(b) Monitor at the surface for the presence of radioactive contamination with a radiation survey instrument or logging tool during logging tool recovery operations; and

(c) Notify the Authority immediately by telephone or e-mail if radioactive contamination is detected at the surface or if the source appears to be damaged.

(3) When it becomes apparent that efforts to recover the radioactive source will not be successful, the Well-Owner shall:

(a) Advise the Source-Owner and the Authority of an appropriate method of abandonment, which shall include:

1. The immobilization and sealing in place of the radioactive source with a cement plug,
2. The setting of a whipstock or other deflection device, and
3. The mounting of a permanent identification plaque, at the surface of the well, containing the appropriate information required by this section;

(b) Notify the Authority by telephone or email, fax or letter, giving the circumstances of the loss, and request approval of the proposed abandonment procedures; and

(c) When efforts to recover the radioactive source are not successful, the Well-Owner shall do the following:

i. notify the Authority by telephone, e-mail, fax of the circumstances that resulted in the inability to retrieve the radioactive source and obtain the Authority's approval to implement the abandonment procedures or that the Well-Owner implement abandonment before receiving the Authority's approval because the Well-Owner can demonstrate that

- (1) there was an immediate threat to public health and safety
- (2) nothing can be done further
- (c) File a written report with the Authority within 30 days of the abandonment, setting forth the following information:
 1. Date of occurrence and a brief description of attempts to recover the source;
 2. A description of the radioactive source involved, including radionuclide, quantity and chemical and physical form;
 3. Surface location and identification of well;
 4. Results of efforts to immobilize and set the source in place;
 5. Depth of the lodged radioactive source;
 6. Depth of the top of the cement plug;
 7. Depth of the well; and
 8. Information contained on the permanent identification plaque.
- (4) Whenever a sealed source containing radioactive material is abandoned downhole, the Well-Owner shall provide a permanent plaque, as described below, for posting the well or well-bore. This plaque shall:
 - (a) Be constructed of long-lasting material, such as stainless steel or monel, and
 - (b) Contain the following information engraved on its face:
 1. The word "CAUTION";
 2. The radiation symbol without the conventional color requirement;
 3. The date of abandonment;
 4. The name of the well operator or well owner;
 5. The well name and well identification numbers or other designation;
 6. The sealed sources by radionuclide and quantity of activity;
 7. The source depth and the depth to the top of the plug; and
 8. An appropriate warning, depending on the specific circumstances of each abandonment which may include:
 - a. "DO NOT DRILL BELOW PLUG-BACK DEPTH";
 - b. "DO NOT ENLARGE CASING"; or
 - c. "DO NOT REENTER THE WELLBORE TO THE SOURCE POSITION", followed by the words, "before contacting the Authority ".
- (5) The Source-Owner shall immediately notify the Authority by telephone or e-mail, and subsequently by confirming letter, if the licensee knows or has reason to believe that radioactive material has been lost in or to an underground potable water source. Such notice shall designate the well location and shall describe the magnitude and extent of loss of radioactive material, assess the consequences of such loss and explain efforts planned or being taken to mitigate these consequences.
- (6) In order to learn from the incident 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 incident or accidents shall be prepared by the Radiation Safety Officer with the assistance of a Radiation Safety Adviser and the reports shall be submitted to the Authority.
- (7) At each stage of the abandonment, the Source-owner shall notify the Authority accordingly.

Details of the Incident Report

82 The Incident 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 XII- OFFENCES AND PENALTIES

Offences and Penalties

83 (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 corporate body 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

84 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 XIII- CITATION

Citation

85 These regulations may be cited as the Nigerian Radiation Safety Regulations for Nuclear Well Logging Practice.

SCHEDULE 1

DOSE LIMITS

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

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

an effective dose of 50 mSv in any single year;

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

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:

an effective dose of 6 mSv in a year;

an equivalent dose to the lens of the eye of 50 mSv in a year; and

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 of2008

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