Practices and regulations for the safe transport of radioactive materials in Sudan

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ABSTRACT: In this report, we investigated whether transport of radioactive materials in Sudan are carried out according to relevant national and international regulations. Case studies were taken during transport of five radioactive sources from their port of first entry to the end user. Information concerning source type, physical characteristics and packaging type were reported on specially designed forms. Also included in the form are dosimetric parameters as required by relevant international standards. Source information and dosimetric parameters were recorded during the transport of ^{137}Cs (gamma source,1.7 Ci), ^{192}I (gamma source,107.8 Ci), ^{131}I (gamma source, 20 GBq), AmBe (neutron source, 10 Ci) , and ^{252}Cf (neutron source, 37.4 mCi). Radiation doses during transportation were measured using calibrated area survey meters. Measured dose rate from gamma sources were: 0.04 – 1 mSv/h at the container surface, 1 -150 µSv/h at1 m from the source. For ^{252}Cf neutron source, the measured dose rate was: 1 mSv/h and 150 µSv/h at the container surface and at1 m from the source, respectively. Recommendations were made concerning security, emergency plans during transport of radioactive materials within the country.

Keywords: Transport of radioactive materials; Transport safety; Security of radiation sources

1. Introduction

In almost all cases, the radioactive materials are generated in locations other than those where used, and the resulting radioactive wastes are usually moved to other locations. In the transportation, the radioactive materials are often placed outside of controlled facilities, in the public domain, and often entail movement between countries. To fulfill it's mandate of the basic Safety standard, the International Atomic Energy Agency (IAEA) has projects and produced publications to enhance the safe transport of radioactive material [1,2].

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In Sudan, many types of radioactive materials are employed in a variety of useful and steadily increasing applications. In the period from 2005 to 2008, 750 sealed radioactive materials were transported within the country. In this report we investigated whether transport of radioactive materials carried out according to relevant national and international standard. It was also the objective of this study to provide insight to the transport practice within the country and issue recommendations to enhancing transport safety in order to minimize adverse effect of ionizing radiation.

2. Development of nuclear and radiological regulation in Sudan

The regulations for ionising radiation started on a limited scale in 1967. In 1971, a law entitled "Regulation of the Use of Ionizing Radiation, 1971" established a committee responsible for licensing medical radiation practices. The "Atomic Energy Committee Act, 1973" established, under the supervision of the Chairman of the National Research Council, a committee with a mandate to promote the use of nuclear techniques and to oversee safety in all activities involving the use of ionizing radiation. However, the two laws did not provide for the establishment of a regulatory framework or a technical authority for radiation protection.

The regulatory control of radiation sources were first addressed in the "Sudan Atomic Energy Commission (SAEC) Act, 1996" which created three levels of Responsibility to meet the increasing nuclear applications and radiation safety requirements [3, 4]:

- *THE BOARD:* The Council of Ministers appoints the Board from among high-level officials and scientists; The Board is empowered to issue regulations, to promote the use of radiation and nuclear techniques and to ensure radiation safety.
- *THE REGULATORY AUTHORITY - THE RPTC:* The RPTC is a national committee whose members are drawn from major institutes and departments connected with the use of ionizing radiation and from bodies responsible for the safety and security of humans and the environment in Sudan.
- *THE IMPLEMENTING TECHNICAL BODY:* The RPTC has designated the Department of Radiation Protection and Environmental Monitoring (DRPEM) of the SAEC as its technical body.

Efforts are currently under way to establish a "New Nuclear Law". Main features of the new regulation are discussed elsewhere [4].

3. National regulations for the Safe transport of radioactive materials in Sudan

The national regulations set the standards for packaging, transporting, and handling radioactive materials, including labelling, shipping papers, placarding, loading, and unloading requirements. SAEC or RPTC regulations also specify training needed for personnel who perform handling and transport of hazardous materials. Under these regulations, the first shipment of any package requiring RPTC approval, the consignor must ensure that copies of each applicable regulatory authority certificate applying to that package design have been submitted to the regulatory authority of the country through or into which the consignment is to be transported[5]. This general license applies only to a licensee who:-

- Has a copy of the specific license, certificate of compliance, or approval by the regulatory authority.Complies with the terms and conditions of the license, certificate, or other approval by the regulatory authority, and the applicable requirements.
- Appropriate training must be provided to all workers involved in the transport, loading and unloading of radioactive materials
- Appropriate placards should be placed on the vehicle and has a quality assurance program.
- Radioactive shipments must be properly documented and the shipping document must be carried with the shipment in the driver's compartment.

General specifies the information that is required to be listed on the shipping document for each type of package transported are shown Table 1 .

Table 1.Standard shipping form

Container number:	.....	Maximum activity :	.....
Shipping name	.....	Physical/chemical form:	.....
Class 7:	.....	Radiation label (I-White, II-Yellow, III-Yellow)	.....
UN number:	.....	Transport index:	.....
Radionuclide	.....	Exclusive use:	.....
Total activity of shipment(as multiple of A2 value):	.....		

4. Case studies

Case studies were taken during transport of five radioactive sources from their port of first entry to the end user. Information concerning source type, physical characteristics and packaging type are shown on Table 2.

Ambient equivalent radiation doses were measured using calibrated survey meter at five locations: at the surface of source, at 1 m from the source, at the surface of the vehicle, at the driver seat, and at one meter from the vehicle the results are presented in Table 3.

Based on the results obtained from the case studies presented in Tables 2 & 3 , Bering in mind the national regulations for the safe transport of radioactive materials the following observations were made:

- Transport of radioactive materials is properly coordinated with the national Customs corporation which assure that only source of valid licence are permitted for transport. Sudan Custom officers received regular training organised by radiation safety institute to equipment them with the knowledge necessary to protect themselves and the general public from the adverse effect of ionising radiation.
- Radiation sources transported (Table 2) are of relatively low activity and dose not impose significant radiological thread
- Concerning cases studies, ambient dose equivalent rates measured at different locations (Table 3) are high especially at the vehicle surface. This highlight the need for national regulation for the to enhancing radiations safety issues in the transport of radioactive materials.
- It was observed that there is no dedicated Conveyance to the transport of radioactive materials as recommended by the relevant international standards.
- There are limited emergency plans to deal with any radiological accident in transport radioactive materials

Table 2. Source information and data

Radiation Source	I	II	III	IV	V
Transport License No.	10-TS-TS154 10-TS-TS155	10-IS-TS163	TS-179	10-MU-IM071	10-MU-IM070
Type of Source (s)	Cs^{137} & $Am^{241}Be$	Cf^{252}	Ir-192	I-131	Mo-99
Activity	1.7 Ci (Cs^{137}) & 10 Ci ($Am^{241}Be$)	37.4 mCi	107.84Ci	20 GBq	20 GBq
Physical form	Solid	Solid	Solid	Solid	Liquid
Means of transportation	Car	TRACK	Car	car	car
Package Type	OVERPACK TYPE A	A-drum	GAMMA MAT	TYPE A	TYPE A
Category type	4	5	2	4	4
Time to destination	6 h	5 h	10 h	½ h	3 h

Table 3. Dosimetric data

	Source data		Ambient dose equivalent rates (μSv h^{-1})					sources
	Source	Activity	Source surface	1 m from the source	driver seat	vehicle surface	1m from the vehicle	
I	Cs^{137} & $Am^{241}Be$	1.7Ci & 10 Ci	< 10	< 10	< 10	< 10	< 10	
II	Cf^{252}	34 mCi	79 38	1.02 3.2	0.78 0.63			n, γ n
III	Ir-192	107.84Ci	92.5	4.80	2.58	10	1.5	γ
IV	I-131	20 GBq	1 000	150	4.80	20	5.4	γ
V		20 GBq	150	150	1.5	9.2	3.1	γ

5. Recommendations

6. In general the regulatory frame work for the transport of radioactive material in the country is not well developed there for the responsibilities for regulating; licensing and inspection should be more clearly separated from the operational and promotional function.

- ❖ It is therefore necessary to updating regulations taking into account new requirement for transport as well as development in technology and radiation protection practice. Emergency preparedness should commensurate with the level of risk posed by ionising radiation this should cleared address in the new regulations
- ❖ Cases studies indicated that there is lack of control of radioactive material during transportation from one site to another. This shortcoming concerns source security, lack of appropriate transport means and lack of emergency plan and preparedness.
- ❖ The development of radiation protection programmes and the refinement of risk-assessment methods, together with implementation of radiological protection principle in safe transport of radioactive materials are of paramount important feature of the new regulatory framework to be considered.

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