THE TRANSPORT OF RADIOACTIVE MATERIAL IN SOUTH AFRICA

Abstract

This paper aims to present an overview of the activities related to the transport of radioactive material in South Africa. In particular, the applicable legislation, the scope of authority and regulatory functions of the Competent Authority (CA) is discussed. The categories of radioactive materials transported and the packaging requirements for the safe transport of these radioactive materials are also described.

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1.0 Introduction

The rapid development of South African industry has resulted in an ever-increasing demand for dangerous goods to be transported from where they are manufactured, processed or stored, to some location for subsequent use or disposal. Radioactive material accounts for a very small fraction of the total quantity of dangerous goods transported within South Africa and within the import/export markets.

The types of radioactive materials transported in South Africa today, may be broadly divided into two categories. Firstly, there are those materials associated with the nuclear fuel cycle such as, un-irradiated fuel, irradiated fuel, radioactive waste, and concentrates containing naturally occurring radionuclides such as uranium and thorium (NORM). Secondly, there are radioactive materials which are not part of the nuclear fuel cycle, such as those used for research, medicine and industrial processes. This category includes manufactured sealed radioactive sources.

The requirement to protect members of the public and the worker against the hazards of the use of radiatioactive materials is addressed in South African legislation. The control over the hazards associated with the transport of radioactive material in South Africa is exercised by two different regulatory bodies.

2.0 The Regulation of the Transport of Radioactive Material

2.1 The Department of Health

The Department of Health (DOH) administers the provisions of the Hazardous Substances Act, 1973, (Act No 15 of 1973). In this regard, the DOH is responsible for the regulation of radioactive material which is outside a nuclear installation and will be used for medical, scientific, agricultural, commercial or industrial purposes, and any radioactive waste arising from the use of such radioactive material.

2.2 The National Nuclear Regulator

The National Nuclear Regulator administers the provisions of the National Nuclear Regulators Act, (Act No.47 of 1999). This act requires that no person shall use, possess, produce, store, process, convey or dispose of radioactive material without a nuclear authorisation.

The objects of the Regulator are to-

(a) provide for the protection of persons, property and the environment against nuclear damage through the establishment of safety standards and regulatory practices;

(b) exercise regulatory control related to safety over-
(i) the siting, design, construction, operation, manufacture of component parts, and decontamination, decommissioning and closure of nuclear installations; and
(ii) vessels propelled by nuclear power or having radioactive material on board which is capable of causing nuclear damage, through the granting of nuclear authorisations;

(c) exercise regulatory control over other actions, to which this Act applies, through the granting of nuclear authorisations;

(d) provide assurance of compliance with the conditions of nuclear authorisations through the implementation of a system of compliance inspections;

(e) fulfill national obligations in respect of international legal instruments concerning nuclear safety; and

(f) ensure that provisions for nuclear emergency planning are in place.

Section 7 (h) of the National Nuclear Regulator Act (Act 47 of 1999) states that;

(h) for purposes of this Act, *[the NNR shall]* act as the national competent authority in connection with the International Atomic Energy Agency's Regulations for the Safe Transport of Radioactive Material;

2.3 Other National Regulatory Bodies Within South Africa

Our legislation also requires that the NNR concludes Co-Operative Governance Agreements with any national regulatory bodies where there may be an overlap of regulatory functions. As regards transport of Class 7 material, the NNR has concluded such agreements with the following national regulatory bodies having jurisdiction over transport;

- Department of Health
- Department of Transport
- South African Maritime Safety Authority
- South African Civil Aviation Authority
- Railway Safety Regulator

These Agreements define how these national regulatory bodies and the NNR are to co-operate on matters related to the transport of Class 7 dangerous goods.

In particular the agreements provide for the co-operation and working relationship between the NNR and the other regulatory bodies for the purpose of;

- Ensuring the effective monitoring and control of radiation hazards
- Co-ordinating the exercising of regulatory functions
- Minimising the duplication of functions and procedures in the exercising of functions
- Promoting consistency in the carrying out of functions.

2.4 Other African Regulators

The Forum for Nuclear Regulatory Bodies in Africa (FNRBA) was formally established in March 2009.

The aim of the Forum is to provide a platform for fostering regional cooperation, provide for the exchange of expertise, information and experience, provide an opportunity for mutual support and coordination of regional initiatives, and to leverage the development and optimisation of resources.

With regard to the transport of radioactive material within Africa the FNRBA has established a Working Group for which the Terms of Reference have already been adopted at the Plenary of the Forum which was held from 24-28 May 2010. The objective of the Working Group is to share information on regulatory standards and practices with the aim to:

- Increase knowledge transfer;
- Identify similarities and differences;
- Move towards convergence on regulatory standards;
- Increase stakeholder understanding of regulatory practices; and
- Enhance regulatory cooperation

One initiative which South Africa is attempting to address through the Forum is the lack of representation of Africa at the IAEA Transport Safety Standards Committee (TRANSSC) Meetings held in Vienna.

A quick look at a typical attendance register for a TRANSSC Meeting will reveal the following typical member representation;

Typical Representation at TRANSSC Meetings		
Continent or Geographical Region	**Number of Countries Represented**	**Number of Delegates**
North America	2	9
Europe	13	37
South America	2	2
South East Asia	2	2
Asia	1	4
Africa	1	1

Very often South Africa is the only African country represented at TRANSSC, not through any fault of the IAEA as many programmes and initiatives exist to assist member states in IAEA matters.

Through the FNRBA South Africa is trying to address this issue in finding out reasons for the lack of representation of the African continent and our intention is to help define ways and means of increasing African representation at TRANSSC.

3.0 Regulatory Approach of the NNR

The National Nuclear Regulator (NNR) is charged with the responsibility of ensuring that members of the public and workers are protected from nuclear damage by authorising nuclear installations and other activities such as the mining and processing of radioactive ores and the transport of the associated radioactive material.

The licensing process necessitates that an assessment of all potential radiation hazards associated with these activities be submitted to the NNR for review. The assessment must cover hazards to the workforce and the public and must take into consideration both normal operations and potential accidents. From the assessment, the NNR determines conditions of licence such that compliance with these conditions will provide the necessary assurance that the activities are being conducted safely.

3.1 NNR's Transport Regulations

Our Requirements related to the transport of Class 7 material largely follow the International Atomic Energy Agency Regulations for the Safe Transport of Radioactive Material No. TS-R-1 2009 Edition (hereafter referred to as TS-R-1) and hence we have not found the need to draft our own regulatory document.

We do however recognise that there are instances where the NNR requirements differ from TS-R-1. These instances are detailed, together with other regulatory aspects specific to the NNR, in an NNR publication;

One example of where our requirements differ from TS-R-1 is in the approval of Type B(U) packages of foreign design.

TS-R-1defines two Type B packages;

The Type B(M) package – Where the M implies “Multilateral Approval” which is defined in terms of paragraph 204 as;

204. *Multilateral approval* shall mean approval by the relevant *competent authority* of the country of origin of the *design* or *shipment*, as applicable, and also, where the *consignment* is to be transported *through or into* any other country, approval by the *competent authority* of that country.

The Type B(U) Package – Where the U implies “Unilateral Approval” which is defined in terms of paragraph 205 as;

Unilateral approval shall mean an approval of a *design* which is required to be given by the *competent authority* of the country of origin of the *design* only.

The usual interpretation of this is that if a user in one country wishes to use a Type B(U) Package designed in another country and Certified by the CA in the country of origin of the design, they need only notify their own CA of their intention to use the Type B(U) Package and they need not formally apply for Certification or Validation of the design Certificate.

However, paragraph 204.3 of IAEA Safety Guide TS-G-1.1 Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material

Recognises that some Member States may have in their national regulations the requirement for an additional approval to be given by their CA for a Type B(U) Package of foreign design to be used within their borders.

The NNR requires such additional approval of a Type B(U) Package of foreign design. The reason behind this approach is so that we, as CA, need to have an understanding and knowledge of which packages are being used within our country and of their inherent safety.

This particular departure from strict TS-R-1 is detailed in our document;

“Requirements Document RD-021

Transport of Radioactive Material at Nuclear Installations”, which is currently in draft form and undergoing internal review.

The above document RD-021 also spells out how issues of liability are to be interpreted for the various possible transport scenarios, both local and international.

By way of example;

In the case that one of the transport parties is on foreign soil, the question of liability for nuclear damage, arising from the transport, is internationally governed by the Vienna Convention on Civil Liability for Nuclear Damage of 21 May 1963 (as amended by the Protocol of 12 September 1997).

However, South Africa has not ratified the Convention

Hence in the event that nuclear damage is incurred, either in South Africa [OR in the foreign country] South Africa cannot exercise its jurisdiction in a foreign country. It would therefore be prudent for there to exist a written agreement between the parties as to where [when the risk for liability will pass from one party to the other] liability lies in the event of nuclear damage taking place in any event. Such written agreement is to be formulated and signed prior to the shipment [transportation] taking place.

This requirement is also detailed in RD-021.

The document also details the NNR submission and approval timelines and other requirements related to applications for any transport approvals for shipments.

Hence RD-021 supplements TS-R-1 with country specific requirements and does not try to improve TS-R-1.

In practice, therefore, the user is required by an Authorisation condition to comply with TS-R-1 and will additionally also need to comply with RD-021 once it has been formally approved.

3.2 Regulatory Approach

For any proposed transport of Class 7 material, from any user authorised by the NNR, there is a requirement, prior to first shipment, to submit, for evaluation, a site-specific document, or “Transport Procedure” detailing the proposed transport and how the licensee will ensure that the shipment will be compliant with TS-R-1, together with RD-021. Once approved this document is referenced in the nuclear licence and its requirements then become a condition of licence which must be complied with for all subsequent shipments.

Any proposed deviations from the Transport Procedure, for subsequent shipments, needs to be submitted to the NNR for consideration and approval prior to shipping.

3.3 Conditions of Licence

Conditions of licence directly applicable to the transport of radioactive material would include the following:

- The licencee is required to ensure that the transport of any radioactive material and any equipment or contaminated objects, from the licensed facility shall be subject to the relevant provisions of the International Atomic Energy Agency “Regulations for the Safe Transport of Radioactive Material, TS-R-1 2009 Edition), together with any other national requirements.
- The licensee is required to submit an annual report to the NNR which provides a summary of the number and type of consignments shipped during that year.
- The licensee is required to establish an emergency plan to make provision for any occurrence involving the transport of radioactive material.

3.4 Approval Certificates

In the hierarchy of packages, for the transport of Class 7 material, as defined in TS-R-1;

- Excepted Packages
- Industrial Packages
- Type A
- Type A(F)
- Type B(U)
- Type B(M)
- Type C

The NNR issues approval certificates for all packages containing fissile material (Type A(F)), all Type B(U) and Type B(M) packages, transport under special arrangements, and certain shipments. Each approval certificate is issued strictly according to the requirements of IAEA TS-R-1 with respect to the information required in the certificate.

4.0 Transport Requirements by Facility

4.1 Authorisation of Shippers

Although the NNR does not specifically exclude a shipper from being authorised to ship Class 7 material, by way of issuing them with a nuclear authorisation against which liability can be enforced, it has been found more practical not to issue nuclear authorisations to the shipper. The reason is that a nuclear authorisation is more than simply a piece of paper saying “You may ship” but carries with it a set of 20 authorisation conditions which must be complied with. This need for compliance places a regulatory burden on the NNR as regulator. There are so many potential shippers of Class 7 materials that regulatory control, by way of issuing nuclear authorisations, would be a major logistical problem.

Our answer to this dilemma is that since all shipments of these materials must be between authorised facilities, our requirements place the liability for nuclear damage during transport, either upon the consignor or the consignee. In this regard these two parties must agree this point in writing prior to first shipment, failing which the liability falls automatically upon the consignor.

4.2 NORM Transports

The generators of radioactive materials/waste are responsible for developing their own radioactive management programmes according to criteria laid down by the NNR.

4.2.1 Minerals containing Uranium/Thorium

One area where NORM requires to be transported is in the gold mining industry of South Africa. (Here shipments of Norm such as Uranium ore, calcine, pyrite and ammonium di-urinate (ADU) needs to be transported) Usually this transport is within the boundaries of an authorised site and therefore is exempt from TS-R-1 by virtue of paragraph 107(b).

In the past decade South Africa has become an important producer and supplier of both zircon and baddeleyite. Monazite containing thorium oxide is classified as LSA-1 radioactive material for transport.

Baddeleyite is a natural zirconium mineral, which is extracted as a by-product of copper mining. The ore body also contains low levels of uranium and thorium such that the baddeleyite ore concentrate also contains uranium and thorium and their decay products. The baddeleyite concentrate is therefore a low specific activity material of Group1 (LSA-1).

4.2.2 Low Specific Activity Material and Surface Contaminated Objects

Large amounts of Norm contaminated materials and equipment are continuously being generated by the South African mines, particularly the gold mines where Uranium is a by-product. The mining industry produces on average about 150 000 t/pa of scrap steel, of which about 10% is thought to be radioactively contaminated.

This steel forms a valuable input into the steel re-cycling industry. Radioactive materials and contaminated items containing uranium or thorium and their products on licensed mines may at times require to be transported on public roads. It has been estimated that the gold mining industry, alone, sends more than 200 000 items of potentially radioactively contaminated equipment to be repaired at off-mine facilities. It has been established that 10 to 15% of these items are contaminated to levels, exceeding that permitted in South Africa for unrestricted release and therefore are required to be decontaminated prior to shipment.

Following incidences in 1993 where certain mining facilities unknowingly exported radioactively contaminated scrap metal without sufficient prior screening, the NNR requirements on the release of such scrap from authorised mines has been severely tightened.

The routes for the release of contaminated material and objects arising from a licenced facility is briefly described in Table 1 below.

Table 1

Waste Category	Regulatory Limits	Disposal Option
Cleared Waste (surface contaminated)	Specific α Contamination: Not > 0.04 Bq/cm^2 Specific β/γ contamination: Not > 0.4 Bq/cm^2	• May be released to an un-licensed facility • May be stored on site • May be released to a licensed site
Conditionally Cleared Waste (surface contaminated)	Specific α Contamination: Not > 0.4 Bq/cm^2 Specific β/γ contamination: Not > 4.0 Bq/cm^2	• May NOT be released to an un-licensed facility • May be stored on site • May be released to a licensed site
Conditionally Cleared Waste (volumetrically contaminated)	Activity concentration prior to washing is less than 10 Bq per gram total activity	May be released ONLY to a licensed smelter
Restricted Waste (volumetrically contaminated)	Activity concentration > 10 Bq/g	MUST be stored onsite until decontaminated to < 10 Bq/g

Materials exceeding the limits specified in Table 2 for SCO-II are not transported whereas those which fall within the SCO-I and SCO-II limits are transported as such in accordance with the Transport Regulations.

The release criteria of 10 Bq/g volumetric contamination relates to scrap which is sent to a licensed metal smelter for smelting and subsequent re-introduction into the steel industry. The release criteria of 10 Bq/g total activity was arrived at after a detailed study which looked at international trends and, particularly considered all radiation dose pathways arising from the mixing of radioactively contaminated scrap from the gold mining industry, with uncontaminated scrap steel in the ratio 1 part contaminated scrap to 10 parts clean scrap, assuming unconditional release of the resulting steel.

In terms of the implementation of this criterion, all of the major steel smelters in South Africa, which receive scrap steel from the authorised mines, have gate monitors which check shipments of steel scrap as they arrive at the facility.

4.3 Nuclear Fuel

South Africa has one twin unit nuclear power plant, Koeberg which is located 30 km north of Cape Town and has an installed capacity of 920 MW(e) per unit. The fuel used at Koeberg is uranium dioxide. The Koeberg units began power operation in 1984/1985.

4.3.1 Fresh Fuel Imports

The nuclear power station requires approximately 53 fuel elements to be shipped into South Africa every 18 months (35 tonnes of fuel), usually in Type B(U) containers of foreign origin, which have been validated by the NNR as CA.

No consignments of irradiated nuclear fuel have been dispatched from Koeberg as all spent fuel is stored in the Koeberg spent fuel pools.

4.3.2 Waste

Koeberg produces about 400 drums of low and intermediate level waste per year. Low level waste is sealed into steel drums. Intermediate waste is solidified with a sand/cement mix which is poured into concrete drums. The drums are transported in accordance with the IAEA transport regulations to the waste disposal site at Vaalputs 600km north of the Cape Town for disposal.

4.4 South African Nuclear Energy Corporation (Necsa)

4.4.1 Production of Radioisotopes

Medical and industrial isotopes are increasingly replacing imported products? The South Africa Nuclear Energy Corporation (Necsa) is involved in the transport of some 4000 radioisotopes to various facilities throughout the country each year. This includes the production of ^{99}Mo/^{99m}Tc generators, ^{81}Kr/^{81}Rb, ^{192}Iridium, ^{131}I, and ^{60}Co. Necsa is also involved in the manufacturing and distribution of consumer products containing radioactive material such as luminescent signs.

4.4.2 Waste

Although the various Necsa projects do generate large volumes of radioactive waste, these are currently stored on site and therefore no off-site transport is involved.

However, South Africa's National Radioactive Waste Policy was published in 2005. In terms of this policy the radioactive waste facility situated at Vaalputs, is the chosen facility for the storage of Low and Intermediate Level Waste (LILW).

4.5 Wastes Generated From Other Sources

Institutions such as hospitals, universities, research laboratories and many industries also generate certain types of radioactive waste which has to be transported and disposed of in a controlled manner. The Department of Health is responsible for the implementation of regulations pertaining to the transport and disposal of radioactive waste arising from these industries in South Africa. However, it must be noted that the radioactive waste arising from such facilities are small in volume and activity compared to the nuclear fuel or mining industry.

5.0 Aspect of Security in Transport

South Africa aligns its national legislation, regulations and policies with the obligations of the Convention of Physical Protection of Nuclear Material 1980. SA's Physical Protection regime requires that materials in the nuclear fuel cycle should be subjected to stringent protection measures. This requirement extends to transportation of material within, to and from the country.

The NNR likewise incorporated the nuclear security requirements in its regulations and licence conditions. The licence condition for transportation includes employment of protection measures i.e national Intelligence threat and risk assessment, state security agencies oversight and co-ordination (both provincial and national), design of transport vehicles, access control, security clearance.

This is further evidenced by the amended National Key Point Act (currently a National Key Point Bill), which gives the state the right to assess and declare mobile assets, shipment as National Key Point. This Bill will ensure more stringent requirements for the transportation of nuclear material in line with the threat and the categorisation of the material.

SA acknowledges the increasing international recommendations related to nuclear security on transport, and thus reviewing its Regulations and has issued additional requirements in the form of regulatory documents.

6.0 Conclusion

South Africa, being a major force in world mineral supply, has had considerable experience in the transport of a wide variety of radioactive materials in the last 30 years.

The practice of transport of radioactive materials brings large segments of the workforce and public in close contact with radioactive materials, potentially exposing them to the effects of ionising radiation. The Transport Regulations, by requiring that packages demonstrate adequate containment, shielding and criticality control, are intended to ensure the safety of the workforce and the public under normal and accident conditions associated with the transport of radioactive materials.

The Transport Regulations are indeed detailed and cover all types of radioactive materials and all modes of transport. In this regard, it would appear that, on the basis of the experience to date, the current Safety Series TS-R-1 has fulfilled its purpose. The harmonisation of the approach to safety between countries has simplified the issue of international transport of radioactive materials.

In summary, on the basis of experience to date, the application of the IAEA Transport Regulations in South Africa has resulted in the application of standards of safety which are consistent with those applied to the regulation of radiological risk in other practices.

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