AN OVERVIEW OF NORM REGULATION IN SOUTH AFRICA

M Khoathane, Division of Nuclear Technology and Natural Sources, NNR
T.D Sekano, Division of Nuclear Technology and Natural Sources, NNR

1 ABSTRACT

Lessons learned from the regulation of Natural Occurring Radioactive Material arising from the Mining and Minerals Processing industries in South Africa are discussed. The nature and radioactivity of wastes arising from these facilities are discussed and regulatory requirements for management of the wastes are described.

2 INTRODUCTION

Gold has been extracted from the sedimentary deposits of the Witwatersrand Basin in South Africa for more than century. To date, more than 5 billion tons of ore have been mined by well over 100 underground mines, yielding more than 45 000 tons of gold. The mean depth of workings below the surface is 1600 m and the maximum depth is about 3 500 m.

Largely the reef geometry, the great depth of workings, and the extreme rock hardness and abrasiveness determine the mining methods used. Also, the reef is often displaced through major and minor faulting. Consequently, despite many efforts to introduce greater mechanization, the operation is very labour intensive. The average number of employees, including contractors, at work in the industry is about 124 037 of which about work 114 319 underground.

The authorizing of Mining and Minerals processing activities involving radioactive ores commenced in 1990. The authorizing process started with 13 mines that were, or had been, producers of uranium and with operations involving monazite-bearing ores.

The potential radiation hazards associated with the mining and processing of radioactive ore are present to both workforce and the public. The hazards to the workforce are generally separated into those arising underground and those associated with the operation of process plants on the surface. Public exposure may arise from discharge or migration of contaminated effluents into the environment.

Control of radiation hazards within the mining and minerals processing facilities in terms of the authorization process has been underway for a period of around ten years. Substantial collective exposures arise from the facilities and within certain

activities conditions have been such that individual dose limits have been exceeded. Waste management, closure and rehabilitation of mine remain areas were a considerable amount of effort is required.

3 TYPES OF INDUSTRIES REGULATED AND ASSOCIATED HAZARDS

At the end of 1999/2000 financial year, the number of mining and minerals processing facilities and users of small quantities of radioactive material authorized by the NNR was:

- Mining and Minerals Processing facilities
  - Underground operations
  - Surface operations
- Scrap recyclers
  - Smelters
  - Processors
- Small users
  - Primarily laboratories

4 CATEGORIES OF WASTES ARISING FROM REGULATED INDUSTRIES

The following is a waste categorization of waste associated with mining and minerals processing facilities, based on regulatory requirements.

4.1 Homogeneous process waste

Any process waste, which is in bulk, or homogeneous for, e.g. slimes material, calcine, pyrite, badelyte etc.

The categorization of homogeneous process waste, as described below, is based upon NNR approved sampling and radioactivity analysis programme.

- Category I Homogeneous Process Waste

  Homogeneous process waste with specific alpha (U-238, U-234, Th-230, Ra-226, Po-210, Th-232 and Th-228) activity not exceeding 100bq/g is classified as “Category I homogeneous process waste”

- Category II Homogeneous Process Waste

Homogeneous process waste with a specific alpha (U-238, U-234, Th-230, Ra-226, Po-210, Th-232 and Th-228) activity not exceeding 1000 Bq/g is classified as “Category II homogeneous process waste”.

- Category III Homogeneous Process Waste

Homogeneous process waste with a specific alpha (U-238, U-234, Th-230, Ra-226, Po-210, Th-232 and Th-228) activity exceeding 1000 Bq/g is classified as “Category II homogeneous process waste”.

4.2 Discrete Process Waste

Any process which is homogeneous in nature. For example, scrap metal, timber, plastics, rubber etc.

5 REGULATORY CHALLENGES

5.1 Developing governmental regulation

The standards that place requirements on the authorizees, the NNR is authorized by government legislation to establish safety standards. The new NNR act requires new safety standards to be put in place and these are currently under consideration.

5.2 Developing national infrastructures

The essential parts of the infrastructure are legislation and regulations. The NNR is the Regulatory Authority empowered to authorize and inspect regulated activities and enforce legislation and regulations. The NNR provides and assist for the education and training of radiation protection officers in radiation protection.

5.3 Overlapping national legislation

Four governmental bodies, the Department of Minerals and Energy (DME), National Nuclear Regulator (NNR), Department of Water Affairs and Forestry (DWAF) and Department of Environmental Affairs and Tourism (DEAT) all place legislative requirements on South African industry.

Due to the consequent overlap resulting from legislation, the National Constitution and the National Nuclear Regulator Act requires that cooperative governance be undertaken to minimise duplication of regulatory effort.

At present the NNR and the DWAF cooperate under a memorandum of understanding, whereby water related radiation issues are regulated by the NNR.

The DME under similar agreement with the DEAT and the DWAF is the lead agent for environmental protection related to conventional (non radiation) pollutants.

The NNR is currently discussing with the DME and the DEAT to conclude cooperative governance agreements.

5.4 Developing guidance for the regulated

The NNR publishes licensing guides to supplement licence document, and they are less formal (not legally binding) and contain more explanatory background information that is useful for the interpretation of licence documents.

6 ACHIEVEMENTS SINCE REGULATING THE MINES

When the NNR started regulating the mines in 1991, there were no persons qualified in radiation, no instrumentation to measure radiation and no procedures to control radiation hazards apart from COM Codes of Practice which were not being implemented. This resulted in long lead-times before the proper assessment and control of radiation hazard could commence.

Achievement 1: Authorization requirements to assess and control radiation hazards on mines have been established

Authorization requirements are contained in a Authorization and nine associated Authorization documents. Eight licensing guides were prepared as guidance to comply with these requirements (See list in Attachment 1).

Achievement 2: A radiation protection competence has been established on all licensed mines

The NNR was instrumental in the establishment of courses to train mine personnel in radiation protection:

- Chamber of Mines two-day training course for Radiation Protection Monitors (Persons who are responsible for taking measurements).
- Chamber of Mines six-week training course for Radiation Protection Officers (Persons who are responsible for supervising Radiation Protection Monitors and implementing radiation protection programmes).

To date, 130 Radiation Protection Officers have successfully completed the Radiation Protection Officers' course.

As part of the Authorization requirement to have adequate, competent, qualified and trained radiation protection staff, all licensees had to acquire the services of Radiation Protection Specialists (Professional persons who are responsible for overseeing radiation hazards assessments and designing radiation protection

programmes on behalf of licensees. To date 16 RPS's have been recognised by the NNR).

Today all licensees have a NNR-approved radiation protection function consisting of Radiation Protection Monitors, Radiation Protection Officers and Radiation Protection Specialists.

Achievement 3: Instruments to measure radiation have been acquired and laboratories for radiochemical analyses have been accepted

All licensees have acquired instruments which are operated and calibrated in accordance with NNR-approved procedures.

Procedures from four different laboratories have been accepted for radiochemical analyses of solid and water samples.

Achievement 4: The assessment of radiation hazards to workers and members of the public had been completed

Workers:

The radiation hazards to all workers on mines have been assessed. Underground workers constitute by far the majority of the workers on mines. The distribution of the doses to underground workers is shown in attachment 4.

Public:

All licensees have submitted project plans for the assessment of radiation hazards to members of the public living off the mine site. All these assessment are scheduled for completion by July 2002.

Achievement 5: The control of radiation hazards to workers has improved significantly

The internationally accepted approach to radiation protection is that radiation hazards should be controlled to maintain doses As Low As Reasonably Achievable (ALARA) and to keep them below dose limits (currently the limit recommended by the International Commission on Radiological Protection is 100 mSv over 5 years with a maximum of 50 mSv in any one year).

The initial focus in the control of radiation hazards was on areas where the dose limit could be exceeded. These included:

- **Maintenance of sulphuric acid plants**

Past practice was to conduct an annual maintenance shutdown on sulphuric acid plants on mines. Measurements taken during 1992 indicated that external doses as high as 60 mSv could be received in a single month.

Since that time, all such maintenance activities were conducted in accordance with NNR-approved control programmes. Doses during such activities were controlled to As Low As Reasonably Achievable and well below dose limits (See example in Attachment 3).

- **Demolition of uranium and sulphuric acid plants**

Although there was, due to a lack of control in the past, no records available of doses that workers received during such demolitions, the potential for exceeding the dose limit was recognised.

Since the NNR started regulating the mines, all such demolitions were conducted in accordance with NNR-approved control programmes. Doses during such demolitions were controlled to As Low As Reasonably Achievable and well below dose limits. (See example in attachment 2)

- **Certain operating surface plants**

During the hazard assessment phase, it was discovered that workers in a number of operating surface plants could exceed the dose limits. NNR-approved control programmes were implemented at these plants.

- **Certain areas in underground mines**

During the hazard assessment phase, it was discovered that workers in a number of underground areas could exceed the dose limit. A number of mines have successfully reduced the levels in these areas and others are in the process of doing so. In older mines this still poses a significant challenge. This is because the mines are very extensive and were not designed taking radiation hazards into account. In some mines, where levels had been reduced, the situation has substantially deteriorated requiring repeated pressure to be brought to bear on the operation's management. Attachment 5 contains some examples in this regard. This is why it is important that the situation be monitored properly on an ongoing basis.

Achievement 6: Control over the transport of radioactive material has been established

Before 1991, control over the transport of radioactive material was limited to shipments of uranium concentrate. NNR-approved procedures have now been established to ensure that all radioactive material is being transported in accordance with the International Atomic Energy Agency's Transport Regulations.

Achievement 7: Control over radioactive waste has been established

After the discovery of radioactively contaminated scrap metal from South Africa in the UK during 1993, the NNR invested a considerable effort to establish the necessary controls in this regard. Studies into the hazards associated with the release of scrap metal from mines were conducted. A number of scrap processors and melters have been authorized by the NNR and all authorizees have implemented NNR-approved procedures for the release of their scrap metal. Difficulties are still being experienced to prevent the theft of scrap metal in mining areas where there is still large quantities of scrap metal and where the social and economic circumstances have deteriorated significantly due to the closing or downsizing of mines.

In the past there was no control over the highly radioactive waste material originating from, for instance, uranium and sulphuric acid plants during maintenance and demolition activities. This type of waste is now being stored in designated storage facilities. The disposal of this waste will depend on the outcome of discussions about the National Radioactive Waste Management Policy.

Achievement 8: Physical security arrangements have been implemented

Since the NNR started regulating the mines, strict control have been exercised to control the movement of persons into and out of redundant acid and uranium plants. Such controls were previously lacking.

Achievement 9: Programmes to provide the assurance that radiation hazards remain under control, have been established

By far the majority of authorizees have implemented NNR-approved quality management programmes. The NNR audits compliance with these programmes on a regular basis.

7 REGULATORY TOOLS

7.1. Compliance assurance

The prime function and objective of the mining and minerals processing department is to determine whether authorizees are complying with the conditions laid down in the Nuclear Authorizations granted by the NNR. To facilitate this

objective section 41 of the National Nuclear Regulator Act confers particular rights upon NNR inspectors.

The compliance assurance tools identified are the schedule of licensing activities, inspections/audits and reports. The schedule is used to monitor the progress of authorizees with regard to the authorization activities and for the submission of documentation required in terms of the authorization conditions. The schedule also assists the regulatory authority in determining a compliance period of a particular authorizee.

Regulatory inspections are primarily conducted to verify compliance with authorization conditions. This is done through a planned and systematic inspection programme. It must be noted that prior to setting up an inspection programme for a facility its compliance objective is be determined. Thus inspections programmes are facility specific.

Reports are required from authorizees to provide the regulatory authority with the assurance that compliance with certain aspects of the approved radiation protection programmes is achieved. This reports are also used to determine developing trends with regard to the activities being carried out by the authorizee.

7.2 Conditions of authorization

The licensing process was introduced many years into the lifetime of a large number of facilities involved in the mining and minerals processing. The process has had to be introduced retrospectively and in a phased manner. The conditions of authorization are structured in a standard format addressing ten particular areas.

1. The scope of activities covered by authorization

In view of the varied nature of the various mining and minerals processing activities and the potential for radiation hazards, together with the extensive nature of many mining operations, which can cover surface areas of tens of square kilometers, it has been deemed necessary explicitly define the scope of activities covered by the authorization.

2. Quantitative hazard assessment

Authorizees are required to conduct a quantitative safety assessment of the radiation hazards associated with their operation to, as appropriate, the underground workforce, surface workers and to the public and submit to the NNR for approval. To ensure that safety assessments are conducted in accordance with approved methodologies inspections are conducted.

3. Operational limitations

Specific operational limitations are placed on authorizations, and as the hazard assessment is conducted, any additional operational limitations identified to be necessary are established.

4. Operational radiation protection

On the basis of the hazard assessment, operational radiation protection programmes are established, commensurate with the nature, extent and magnitude of the hazard. As an authorization condition, the programmes must ensure compliance with the radiation dose limitation system which is embodied in the authorization.

5. Radioactive waste management

The authorization requires the establishment of a waste management programme which systematically identifies, characterizes, processes and disposes of wastes generated by the activity. The programme addresses operational waste arisings and the decommissioning and closure of mining and minerals processing facilities and sites.

6. Transportation

Products, wastes and components arising from the licensed activity which fall within the scope of the International Atomic Energy Agency Regulations for the Safe Transport Radioactive Material should be transported within the public domain in accordance with the regulations.

7. Physical security

A physical security system must be in place to prevent unauthorized access to radiologically hazardous areas and to prevent the diversion of radioactive material.

8. Occurrences

A system to identify, categorize and report occurrences ranging from those indicating a breakdown in required controls to events of unacceptable significance must be established.

9. Quality management

Authorizees are required to establish formalized quality management systems in order to provide an assurance of ongoing compliance with conditions of authorization.

10. Scheduling

In view of the retrospective nature of the process, authorizees are required to establish schedules within which the various components of the hazard assessment are to be conducted and the control programmes established and implemented.

8 REFERENCES

1. Khoathane, M (2001) Occupational exposure in underground Gold Mines in South Africa; Proceedings of the IAEA Technical Committee Meeting on the Assessment of Occupational Protection in Workplaces with High Levels of Exposure to Natural Radiation.

2. Metcalf, P (1990) Licencing of Activities Involving Radioactive Materials: Dust and Radon: considerations for the future. Mine Ventilation Society of South Africa Symposium: Kimberley.

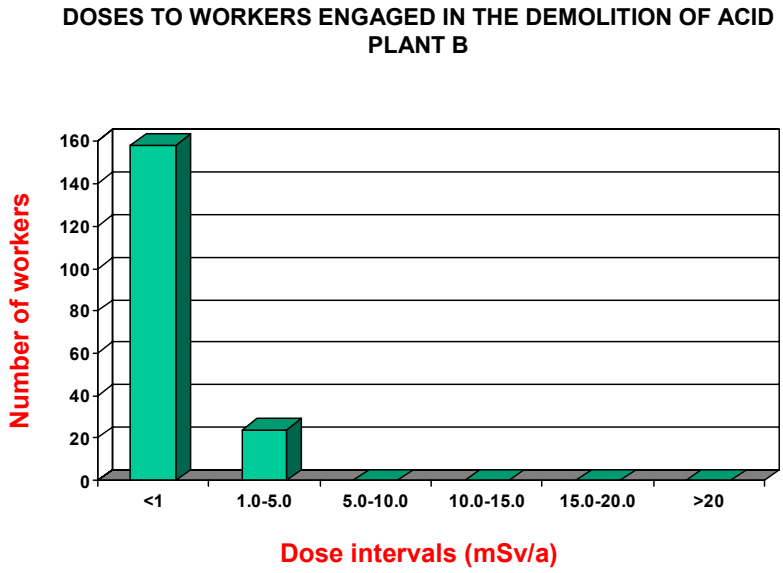
3. Van der Woude, S (1998) What has been achieved since the NNR started regulating the mines? Presentation made as part of the development of the National Nuclear Regulator Act.

ATTACHMENT 1

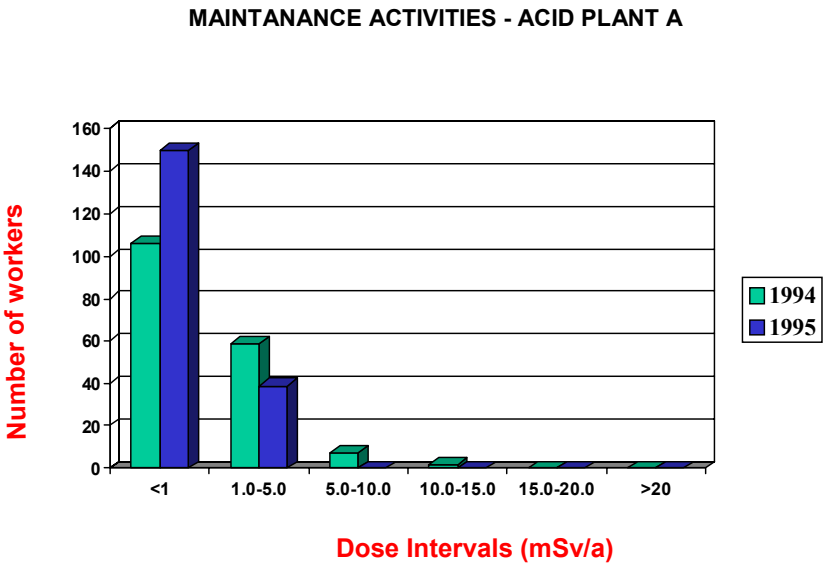
List of licensing guides produced

LG- NO.	TITLE	
LG-1027	**A GUIDE TO THE REQUIREMENTS FOR THE SUBMISSION ON THE RADIATION PROTECTION FUNCTION FROM MINING AND MINERALS PROCESSING FACILITIES**	
LG-1028	**A LICENCE GUIDE ON THE TECHNICAL ASPECTS ASSOCIATED WITH CLEARANCE OF FORMER MINE LAND FOR DEVELOPMENT**	
LG-1029	**LICENSING GUIDE ON THE ASSESSMENT OF RADIATION HAZARDS FROM SURFACE OPERATIONS TO WORKERS AND VISITORS: MINING AND MINERALS PROCESSING**	
LG-1030	**A GUIDE TO THE QUALIFICATIONS, TRAINING AND EXPERIENCE REQUIREMENTS FOR RADIATION PROTECTION OFFICERS IN THE MINING AND MINERALS PROCESSING INDUSTRY**	
LG-1032	**GUIDELINE ON THE ASSESSMENT OF RADIATION HAZARDS TO MEMBERS OF THE PUBLIC FROM MINING AND MINERALS PROCESSING FACILITIES**	
LG-1033	**LICENCE GUIDE ON THE RELEASE OF SCRAP METAL: MINING AND MINERAL PROCESSING**	
LG-1034	**LICENSING GUIDE ON THE MEDICAL SURVEILLANCE AND CONTROL OF PERSONS OCCUPATIONALLY EXPOSED TO RADIATION: MINING AND MINERALS PROCESSING**	
LG-1035	**LICENSING GUIDE ON REPORTING OF OCCURRENCES: MINING AND MINERALS PROCESSING**	

ATTACHMENT 2



ATTACHMENT 3



ATTACHMENT 4