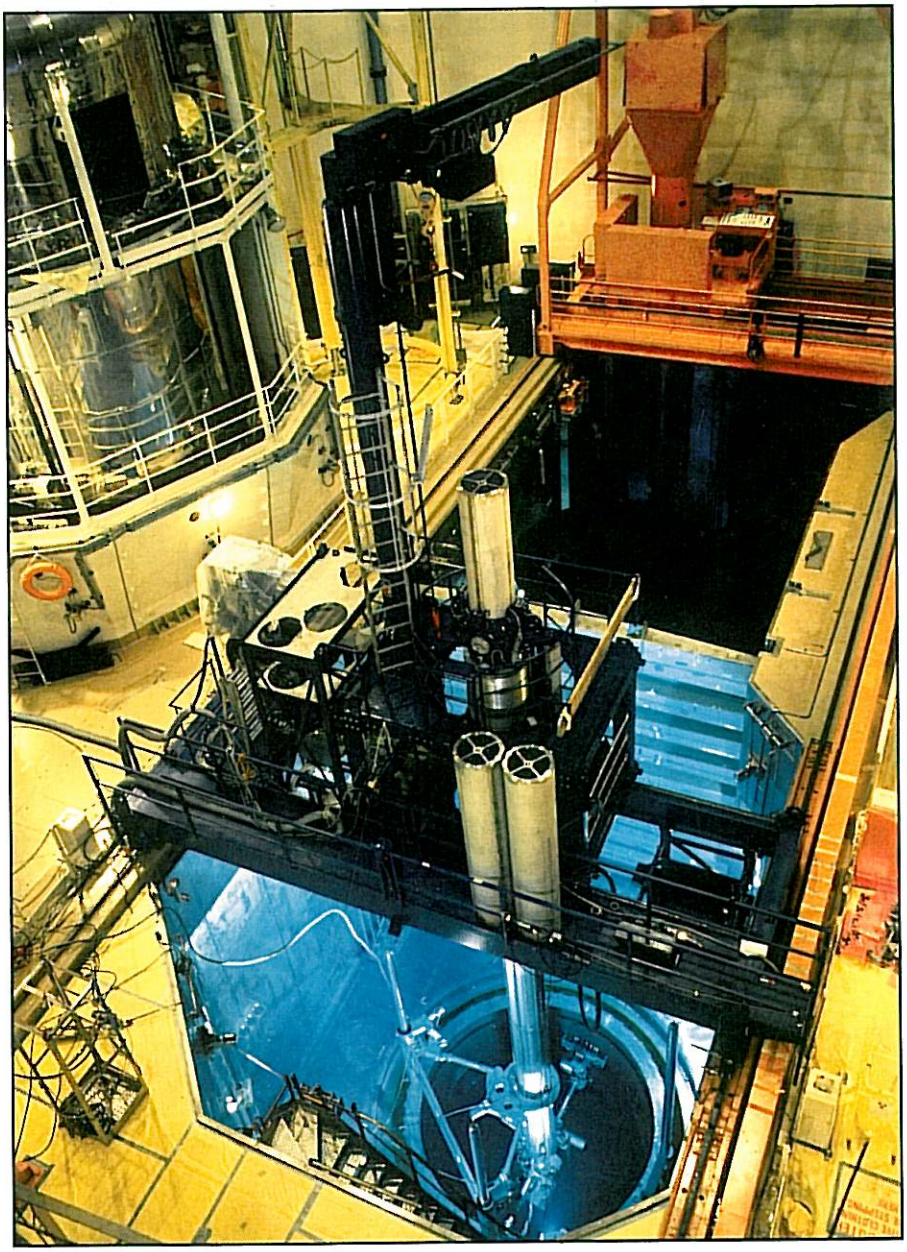

COUNCIL FOR NUCLEAR SAFETY

ANNUAL REPORT 1992 - 1993

Mission

It is the mission of the Council for Nuclear Safety to safeguard persons and their property against the risk of damage from the production or exploitation of nuclear energy and associated radioactive materials in the Republic of South Africa.

Strategy

To accomplish this mission through

- the exercise of responsible and effective regulatory control,
- the promotion of a quality and safety culture, both within and outside its own ranks, and
- the consistent endeavour to maintain the highest level of integrity, professionalism and independence,

applying the skills of its staff in developing and implementing sound regulatory practices embodying innovative techniques, and maintaining a standard that is comparable internationally.

Policy

The policy of the Council is:

- to address the risk of nuclear damage through the application of a quantitative risk assessment approach;
- to be cost effective in meeting its objectives and fulfilling its functions;
- to evaluate the extent to which it meets its objectives

Council for Nuclear Safety

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FRONT COVER PIC: REMOTE IN-SERVICE INSPECTION OF A REACTOR PRESSURE VESSEL

COURTESY ESKOM

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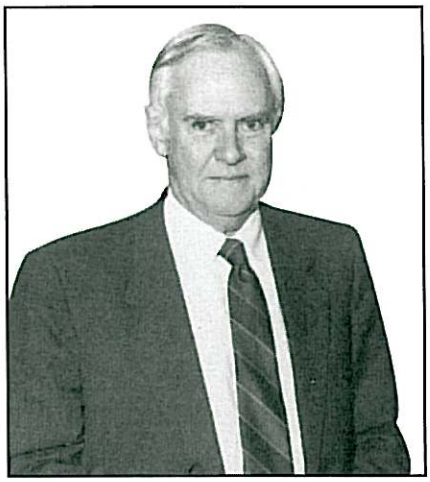


PROF J B MARTIN, CHAIRMAN

CHAIRMAN'S STATEMENT

In anticipation of proposed legislation which will come before Parliament later this year, the new Council, which was appointed by the Minister of Mineral and Energy Affairs in June 1992, was reduced from twelve members to nine members. Each of the nine appointees had been a member of the previous council. If the proposed legislation is accepted, current constraints on the choice of members will be removed, completing a process in which the role of the Council has altered from that of broad technical advisory function to that of the management of an independent statutory body independently staffed with its own technical expertise.

The fundamental principles regarding health and safety, and liability and compensation for nuclear damage, which are embodied in South African nuclear regulatory policy and its governing legislation remain as valid today as they were when the *Nuclear Installations (Licensing and Security) Act* was enacted thirty years ago. The application of these principles, however, must be adapted to accommodate developments in the nuclear and associated industries. While the South African industry is not large by international standards, it ranges across the whole of the fuel cycle, including part of the mining industry as well as various commercial and research facilities. Some necessary adaptations have been included in the draft legislation to which I have referred. Further refinements are in the process of formulation and discussion, aimed particularly at overcoming practical problems in the complex area of liability and compensation for nuclear damage, to ensure that adequate and equitable provision is made which satisfies the needs and requirements of the public, workers and the State.

CHAIRMAN'S STATEMENT

Decommissioning of nuclear plants and the long term disposal of radioactive waste continue to be subjects of worldwide concern. The decommissioning and closure of nuclear installations and sites are current issues for the Council, and they affect the whole of the industry,

including activities in the mining sector which are not strictly part of the fuel cycle. The development of a broad national policy addressing these matters has been receiving, and continues to receive, the Council's consideration.

South Africa is favourably placed in comparison with many other countries in having identified and developed at an early stage a site to accept low and intermediate level nuclear wastes generated from the nuclear power programme. However, after many years of discussion, progress has been made only recently in applying regulatory procedures in the mining and minerals processing industries, where increasing evidence for their justification is becoming apparent. Plans for the interim storage of spent reactor fuel in South Africa are also well advanced. Nevertheless, the absence of a coherent and acceptable policy on the final disposal of high level waste is a matter of concern to the Council and to similar regulatory bodies elsewhere.

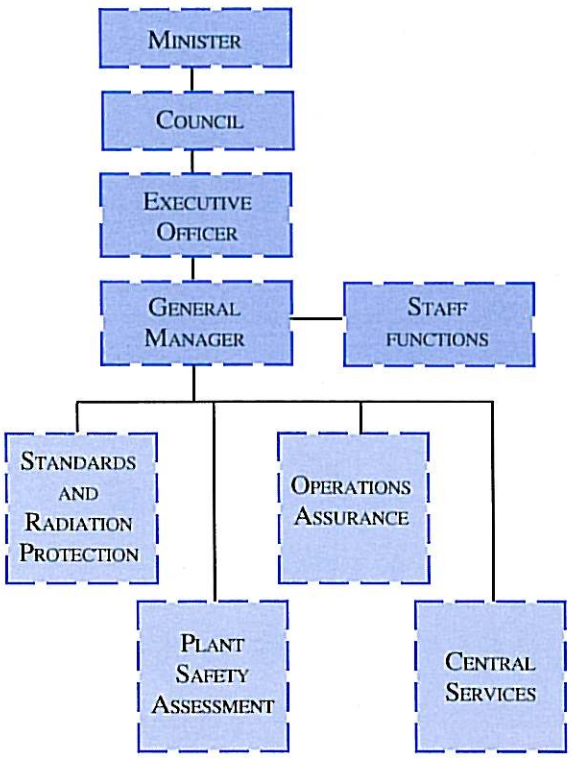
Issues surrounding the provision of information to the public regarding incidents with safety implications at nuclear installations and other facilities associated with the nuclear fuel cycle continue to receive the attention of the Council. Various systems for the classification of incidents are being developed internationally, and the Council is considering appropriate systems for adoption in South Africa.

We have, within the Council for Nuclear Safety, a cadre of expertise which has been developed over a number of years. It is pleasing to see that, following South Africa's accession to the Nuclear Non-proliferation Treaty, opportunities for our staff to interact with international agencies and other regulatory bodies have increased significantly. This is clearly of considerable importance to the Council in fulfilling is mission. Equally satisfying is the degree to which our staff are sought out to contribute their expertise in the international arena; this, also, is an independent measure of the Council's effectiveness.

A CADRE OF EXPERTISE EXISTS WITHIN THE COUNCIL

I would like to express my thanks and appreciation to the Minister of Mineral and Energy Affairs, the Minister of Finance, the Director-General and staff of the Department of Mineral and Energy Affairs, the members of the Council, and the Executive Officer and the staff of the CNS, for the part they have played over the past year in ensuring that the Council has continued to discharge its responsibilities effectively and efficiently.

DIAGRAM 1: COUNCIL STRUCTURE



Executive Officer's Review

Mr B C Winkler, Executive Officer

It is with a sense of accomplishment that we present highlights of the past year's work of the Council for Nuclear Safety and it is my pleasure to draw attention to the Council's mission statement, which is published here for the first time. To those of us who have been involved with nuclear regulation for a considerable time, this statement holds nothing new, but it does serve the important purpose of sharpening the focus of our activities for the benefit not only of our staff but also of our licensees and the public.

With South Africa's accession to the Treaty on the Non- Proliferation of Nuclear Weapons has come a welcome opening of doors that has made it possible for the Council and members of its staff to participate in and contribute to activities in a wider, and particularly an international, context. Such participation has been beneficial in broadening our outlook. More important than that, perhaps, is the noticeable improvement in our contact with other regulatory authorities, the furtherance of which will remain an ongoing objective which can only contribute positively to the functioning of the Council.

Safety is a concept that has been used with different connotations. Most generally it has been used to convey the notion of security and protection and to denote reliability, prudent caution and freedom from danger. In the nuclear industry safety has come to have the specific connotation of accident prevention which, in fact, does not mean prevention in the sense of total elimination, but rather a reduction of or limitation on the probability of accidents. Increasingly over the years those involved with safety have come to appreciate that safety and risks are inextricably interwoven and that safety assessment really boils down to risk assessment. Because a risk-based approach to licensing was adopted some 20 years ago, the Council to-day has considerable expertise and experience in this field which can be of benefit over a broad field of industrial and technological endeavour.

Executive Officer's Review

PRESENTATION OF REACTOR OPERATOR LICENCES: KOEBERG NUCLEAR POWER STATION

A final word on the importance of people in the achievement of safety. Safety is achieved by people. In the nuclear industry, as everywhere else, this means the staff of the Regulator and the staffs of its licensees. Each has a definite responsibility and a distinct role to play and it is only through the commitment of all the players to safety and the promotion of a safety culture that the objectives can be achieved. In this context I would like to express my deep appreciation to my staff for their diligence, loyalty and dedication and I can look back over the past year with confidence that the Council for Nuclear Safety has effectively carried out its duty, as the independent nuclear regulatory authority, to safeguard the public and the workforce.

I believe we can express a measure of satisfaction with what has been achieved over the past twenty three years, first by the Atomic Energy Corporation (and its predecessor, the Atomic Energy Board) through its Licensing Branch and thereafter by the Council for Nuclear Safety, but we must ever strive to do better.

THE COUNCIL AND ITS MEETINGS

The three year term of office for which Council members were appointed, under the provisions of the Nuclear Energy Act, ended on 16 June 1992. A new Council, reduced in numbers, but all of whose members had served on the outgoing Council, was appointed with effect from 17 June and the membership at the year end was as follows:

Chairman: PROF. J B MARTIN
Dean, Faculty, of Engineering, University of Cape Town

Vice-chairman: DR D REITMANN
Director, National Accelerator Centre, Foundation for Research Development

DR L A DREYER
Chief Director, Land Transport Management, Department of Transport
MR M DU TOIT
Deputy Director-General, Department of Regional and Land Affairs
MR S A GERBER
Chief Director, Environment Conservation, Department of Environment Affairs
PROF. R G HARLEY
Head, Department of Electrical Engineering, University of Natal
DR P R LE ROUX
Director, Radiation Control, Department of National Health and Population Development
PROF. A F STEYN
Head, Department of Sociology, Rand Afrikaans University
DR P D R VAN HEERDEN
Former President, S A Medical Research Council

The Council held four scheduled meetings during the year.

STRUCTURE AND STAFFING

The organisational structure, which was revised in 1991, has remained essentially unchanged, and is as shown in Diagram 1. One member of the staff retired and four members resigned during the year, and seven new staff were recruited to fill vacant specialist posts in the Plant Safety Assessment Department and also positions in the Standards and Radiation Protection Department devoted to licensing work related to control of radiation hazards within the mining industry. At the year end 73 of the 75 available posts were filled.

The Council's Koeberg site staff, previously accommodated in two separate offices within the power station site, were moved to new premises in Eskom's Duynefontein township. This has provided an im-

SAFETY AND A SAFETY CULTURE ARE ALL IMPORTANT

Risks must Remain Acceptable to Society

proved working environment and also an opportunity to upgrade the computer facilities and communications with the Council's head office in Verwoerdburg.

Projects coordination, formerly the responsibility of the Operations Assurance Department, has been divided between that department, which continues to handle the Koeberg project, and the Standards and Radiation Protection Department, which is responsible for the AEC projects and the mining industry.

The Council continued to provide the national communication link with the International Atomic Energy Agency (IAEA) in respect of the Agency's Incident Reporting System (IRS) and Power Reactor Information System (PRIS) and during the year assumed the additional role of National Member Organisation of the European Nuclear Society's Nuclear News Network (NUCNET). Members of the Operations Assurance Department staff received training in the use of the IAEA's Assessment of Safety Significant Events Team (ASSET) methodology for Root Cause Analysis.

Safety Standards

Fundamental Standards

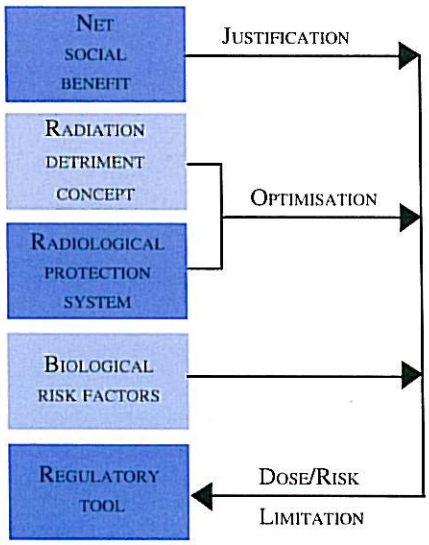
The Council continues to review the adequacy, coherence and appropriateness of its basic safety standards for nuclear installations and activities involving nuclear-hazard material. As societal values evolve it is vital to ensure that the risks imposed by these activities remain acceptable to society as a whole and that the resources expended to ensure compliance are adequate.

Safety Standards

To this end the Council has continued work on refining the standards and updating data bases on risks to which society is exposed in order to enable ongoing validation of the standards.

The international community has been active, during the past year, revising basic safety standards for radiation protection and nuclear safety to incorporate the 1990 recommendations of the International Commission on Radiation Protection (ICRP). The Council has participated actively in these developments which have been co-ordinated by the International Atomic Energy Agency in co-operation with its co-sponsors, the World Health Organization, the International Labour Office, the Food and Agriculture Organization of the United Nations, the Pan American Health Organization and the Nuclear Energy Agency of the OECD.

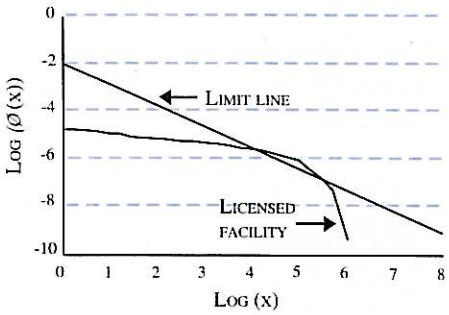
Much of this work is well advanced and it is envisaged that the standards will be completed towards the end of 1993, whereupon an implementation period in the region of five years will be recommended.



RADIATION RISK LIMITATION SYSTEM

Certain difficult issues have arisen in revising the basic safety standards, particularly those relating to the occupational exposure of persons to natural sources within the mining industry. Matters still to be finally resolved relate to the length of working lifetime used as a basis for limiting occupational exposure of persons and the limits for exposure to radon daughter products

Following the Chernobyl accident, various shortcomings were identified in the criteria used to apply mitigatory actions and this is one further area of refinement that has been given considerable attention. Somewhat allied is the establishment of intervention levels for so called pre-existing situations, where radiation levels from some previous activity still exist and the situation can only be improved by remedial action. It is recognized that in such circumstances the standards for introduction and control of new practices may not be totally appropriate and in revising the standards attention has also been focused on this area, with a view to ensuring coherence.



X = NUMBER OF CASUALTIES PER EVENT
Ø (x) = CUMULATIVE ANNUAL FREQUENCY OF EVENTS RESULTING IN X OR MORE CASUALTIES

COMPARISON WITH RISK AVERSION CRITERIA

DERIVED SAFETY STANDARDS

Having established fundamental safety standards it is necessary to derive criteria which can be used in the process of demonstrating compliance.

The establishment of derived standards from the fundamental standards has given rise to the need for careful consideration to be given to such matters as the disposal of radioactive wastes from the mining industry and the dispositioning of land which has been contaminated by residues from mining activities and which contains trace amounts of naturally occurring radionuclides which, from a radiation safety point of view, cannot be ignored.

In this regard, considerable attention has been given during the year to the management of radioactive waste arising from mining activities. The licensing work in this area has identified extensive arisings of contaminated wastes in categories ranging from marginal to excessive. Efforts have been expended in establishing appropriate categorization criteria, quantitative analytical methodologies and storage and disposal options. Much of this work has been carried out in co-operation with the mining industry and the Council has kept abreast of topical overseas developments in this area. In an effort to keep all parties apprised of developments, the Council organised a workshop devoted to the matter in November 1992. This was attended by some one hundred delegates from interested parties within the industry and from research organizations and government departments.

RADIOLOGICAL ASSESSMENT

ATMOSPHERIC DISPERSION

One of the major aspects of radiation impact assessment is that concerning the mathematical modelling of airborne releases of radio-

active materials under normal operating circumstances, as well as potential accidental releases. The Council maintains a state of the art capability in this regard which is continually reviewed for adequacy.

In recent years it has become increasingly apparent that shortcomings prevail in respect of certain aspects of meteorology involved in the determination of atmospheric dispersion characteristics. This has been found particularly in respect of meteorological classification schemes - in the determination of the height of the mixing layer, the quantification of vertical wind profiles and the diffusion coefficients.

The need to address this matter in some depth was clear and the Council convened a workshop on atmospheric dispersion modelling in March 1992, with the object of reaching consensus on the approach to be taken in dealing with the issues identified. The workshop was well attended by representatives of licensees as well as of universities and other major national institutions.

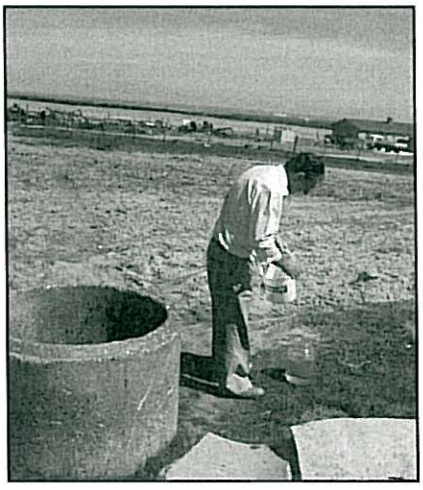
It was concluded that further work on the matter was indicated and a research project, co-sponsored by Eskom and Richards Bay Minerals, has been established, and is being undertaken by the Oceanography Department of the University of Cape Town. This project consists of a literature review of past research and operational programmes in all areas described, followed by analysis of existing meteorological data in an effort to determine inter-relationships between the dispersion parameters. Finally, a feasibility study will be performed to address the issue of validation of dispersion prediction models. The project will be undertaken within the forthcoming year.

Accident Consequence Assessment Benchmark

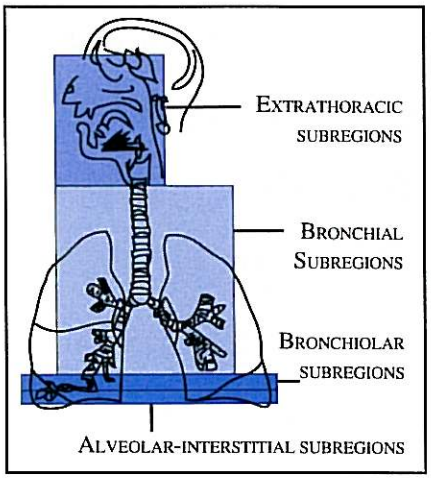
During the year the Council participated in an international benchmark exercise in the domain of theoretical Probabilistic Accident Consequence Assessment (PCA) codes. The results indicated that the

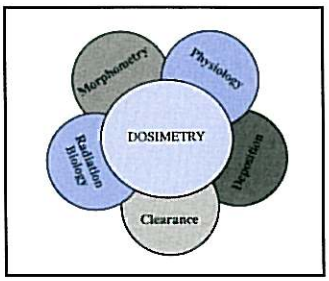
Attention has been given to Radioactive Waste Management

Environmental monitoring: Collecting samples, near Koeberg



Courtesy Eskom





TOP: PROPOSED ANATOMICAL MODEL FOR THE RESPIRATORY TRACT

ABOVE: ELEMENTS OF RESPIRATORY TRACT MODEL

performance of the Council's suite of computer codes is adequate. A sensitivity analysis has been performed to assess the changes in the model response as a result of changes in meteorological parameters.

ICRP LUNG MODEL

One of the major recent developments by the International Commission on Radiological Protection (ICRP) has been the revision of the respiratory tract deposition and dosimetry model. The model, originally developed in the 1960's, is used to assess the radiological consequences of incorporating radioactive material into the body by way of inhalation.

The original model had been deemed to be in need of refinement in order to take account of developments in the understanding of the basic deposition, transfer and radiation dosimetry processes.

The model is of particular relevance in respect of accident impact assessment because of the importance of the airborne pathway and, in underground mining environments, because of the variable presence of radon daughters. The work of the ICRP task group established to undertake the task in the 1980's resulted in a draft report being published in 1992 with a view to acceptance and publication of the final model in 1993.

In order to gain an insight into the new model, the Council sponsored the visit to South Africa of one of the leading contributors to its development, Dr A C James of Battelle Pacific Northwest Laboratories, in the United States, to present a summer-school on the topic. This was open to all interested parties and was well attended and provided the Council and other parties with a good insight into the new model.

KOEBERG
OCCUPATIONAL EXPOSURE TO RADIATION

The control of radiation exposures to personnel working at the Koeberg nuclear power station has been kept well below regulatory limits and Koeberg continues to maintain an enviable record in this area, which is internationally recognized.

During the 1992 - 1993 year the fifth refuelling outage for unit 1 was undertaken – an activity giving rise to the greatest potential for occupational exposure. The outage gave rise to 0.9 man-Sieverts, which reflects the excellent operational radiation protection programme at Koeberg.

PUBLIC EXPOSURE

Exposure of the general public arising from the operation of Koeberg is limited by controlling the discharge of potentially contaminated effluent streams both into the atmosphere and into the sea. This is achieved by the Council's specifying so called "Annual Authorised Discharge Quantities" (AADQs) for radionuclides in liquid and gaseous effluent streams, together with monitoring requirements. These are set to maintain exposure as low as reasonably achievable, which means that the operators have not only to control discharges to ensure that public dose limits will be respected, but also to implement further decontamination procedures to ensure optimum protection of the public.

During the year under consideration, on the basis of operational experience gained over the years, the Council finalized development of a revised radioactivity migration model for computing radionuclide discharges in effluents. This model has been used to determine a revised effluent processing regime, allowing considerable economic savings for Eskom. In parallel with the application of the revised discharge

KOEBERG NUCLEAR POWER STATION

KOEBERG HAS NOT INCREASED ENVIRONMENTAL DOSE RATE

figures, a programme has been instituted for purposes of verification of the operational parameters used in the revised CNS effluent model for Koeberg.

ENVIRONMENTAL MONITORING

The adequacy of control over effluent discharges and an assurance of the appropriateness of environmental pathway assessment modelling is achieved by way of comprehensive monitoring of environmental media. Continual review of all aspects of the programme by the Council, whilst identifying some areas in need of improvement, indicated that, overall, acceptable results have been obtained.

The areas of concern relate to some inconsistencies in ESL data and deficiencies in the calibration of detectors. Certain minor discrepancies between required minimum detection capabilities and reporting levels, which have been identified, are planned for resolution within the forthcoming year.

The level of artificial activity in Melkbosstrand sludge, which became an issue in 1991, has been reduced to extremely low levels and is no longer considered to be a licence issue; monitoring of the situation nevertheless continues .

Statistical analysis of dosimeters placed in the Koeberg environs indicated that the operation of Koeberg has resulted in no increase in the environmental dose-rate. These measurements were validated by the Council's confirmatory programme.

EMERGENCY PLANNING

Whilst the safety assessment for Koeberg indicates that the risk imposed by Koeberg is acceptable, it remains a condition of licence that a comprehensive emergency plan be maintained in a state of

KOEBERG OPERATIONAL DOSE STATISTICS

ANNUAL DOSE (mSv)	% OF RAD-WORKERS BELOW DOSE 1989	% OF RAD-WORKERS BELOW DOSE 1991
0.5	43.6	30.8
1.0	58.3	46.5
5.0	88.8	84.4
10.0	95.6	94.9
15.0	98.0	98.3
20.0	100.0	99.6
25.0	100.0	100.0
NO. OF RAD-WORKERS MONITORED	1 605	1 820

continual readiness to recognize and respond to any accident with potential off-site consequences that may arise.

The preparedness of the operating organization and of the off-site local authorities to respond to accidents is maintained by an ongoing programme of training and exercising.

An essential component of assuring the Council of the effectiveness of these arrangements is the major demonstration exercise conducted annually by the Council. Such an exercise took place during October 1992.

An important purpose of these exercises is to identify any shortcomings in the emergency plan, for example, in the performance of personnel, or of equipment, or services, and to effect improvements in these areas. Although various shortcomings were identified from the exercise, and the CNS continues to press for the resolution of these, the main objective of the Koeberg nuclear emergency plan, namely the protection of the public by timely protective action decision- making, was nevertheless demonstrated to be adequate.

As part of a policy of maintaining the Council's links with the international community in areas of nuclear safety, representatives of the Japanese and American governments were invited to observe the exercise as guests of the Council.

An area of ongoing concern, and central to the viability of emergency planning, is that of public notification. Such notification is effected by way of installed sirens and mobile vehicle-mounted units. Public notification exercises have given rise to concern over the reliability of these systems and, furthermore, the continued development of residential areas has resulted in the need for this matter to be subjected to careful scrutiny. These matters are being addressed by Eskom.

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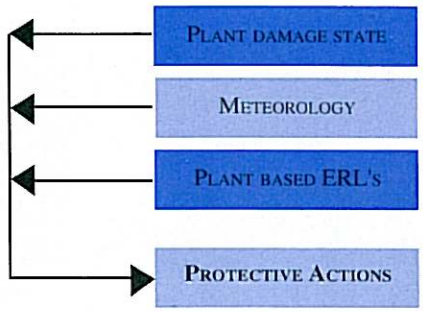
ANNUAL EMERGENCY EXERCISE:
RADIATION MONITORING



CONCEPTUAL BASIS FOR EMERGENCY RESPONSE

A further area of concern in respect of emergency planning is the ability of the operators to predict, rapidly, the possible extent and magnitude of radiological hazards that would arise from a particular accident sequence. Such predictions are necessary for decisions to be taken on the extent and type of mitigatory actions needed and the sooner the predictions can be reliably made, the more effective will those actions be. Conversely, it is vitally important to ensure that unnecessary actions with potentially severe social and economic consequences are not taken. It has been concluded that significant utility in emergency planning could be derived from the establishment of plant-based emergency reference levels which would initiate a pre-determined level of response, such as limited evacuation. This matter will be investigated further within the forthcoming year.

During the year under review three Emergency Planning Liaison Committee meetings were conducted under the chairmanship of the Council. These meetings were attended with keen interest by the various members representing the different organizations involved in the Koeberg emergency plan. Three routine meetings were also conducted with Koeberg staff to discuss matters relating to emergency planning.

Only limited progress on late phase nuclear emergency planning was possible during the year in view of the evolving situation regarding local government parties to be involved in such matters.

PLANT SAFETY ASSESSMENT AND OPERATIONS ASSURANCE

UNNECESSARY ACTIONS MUST BE AVOIDED

Further progress with the probabilistic risk assessment (PRA) for Koeberg has been made as a result of the in-house development of two computer codes, to extend the effectiveness of two previously acquired codes, and the implementation of these is expected to reduce dramatically the time taken to carry out licensing risk assessments. In order to carry out studies affecting the containment the Council acquired a

"Source Term Package" set of codes from the IAEA and these were used for a variety of applications, including:

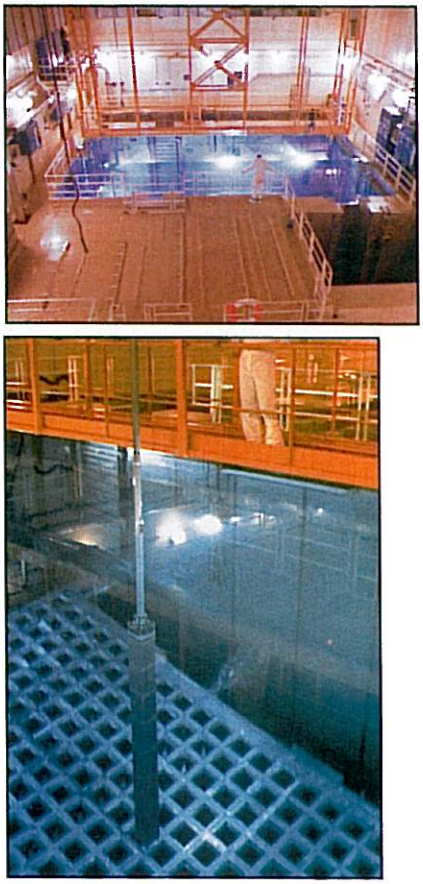
- assessing the Koeberg Operating Technical Specifications for shut-down conditions and outage management programmes;
- assessing the Koeberg operator training programme for severe accident analysis; and
- determining a suitable accident scenario for the annual emergency planning exercise.

As part of the Council's continuing trending activities comparisons between Koeberg operating experience and worldwide nuclear plant experiences are made regularly, using information supplied by the IAEA. Consequent benefits of these activities include, for example, the identification, following an analysis of the root causes of the high incidence of SCRAMS at Koeberg over a period of a year, of a number of procedural and instrumentation shortcomings on the secondary side of the plant. This led to a planned programme being implemented by Eskom which resulted in more acceptable plant behaviour in subsequent years.

Leak rates between the primary and secondary circuits were monitored in order to assess the continued integrity of the steam generators. Whilst these leak rates were within the limits of the Operating Technical Specifications they are expected to increase gradually during operations, to the full extent of the limits. With a view to prolonging the time before remedial action becomes necessary a proposal has been made by Eskom to operate the reactors at a reduced primary circuit temperature and the Council has been reviewing this proposal to assess the impact on design safety margins.

The phenomenon of cracking in one of the Inconel sleeves in the control rod drive mechanism in a French pressurised water reactor, which was discovered during the ten year hydro test on the reactor in

A REACTOR FUEL POOL AT KOEBERG NUCLEAR POWER STATION



COURTESY ESKOM

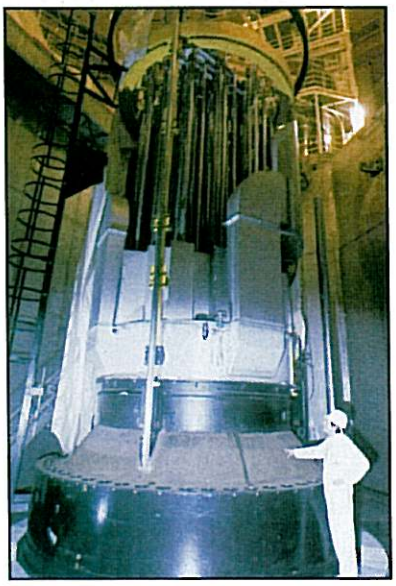
1991, was assessed in the light of the possibility of a similar effect at Koeberg. On the basis of a detailed safety case submitted by Eskom it was agreed by the Council that there was no immediate cause for concern in the case of Koeberg and that extensive inspections could be delayed until 1994, but that in the meantime a longer term strategy should be submitted for approval by the Council.

As is happening in other countries, the Council is involved in a number of studies to determine the potential degradation in engineering safety margins as the plant ages. A Plant Life Extension Report has been produced internally, recommending a particular strategy for monitoring the effects of plant ageing. In addition a related report on Operational Transient Monitoring Systems has been prepared, which is aimed at identifying activities required to provide data suitable for use in appropriate engineering safety assessments.

Flexible joints (such as Gimbel joints) in pipelines, are subject to possible corrosion, thus becoming rigid. To address this possibility and assess the resulting impact on piping integrity safety margins a sensitivity study was carried out for the essential services water system at Koeberg. Using the CAESER engineering code, together with a range of values for the bending stiffness of the postulated corroded joints, an appropriate piping model was developed and analysed. The results showed that even under the conservative assumptions of the combined maximum operating load and extreme earthquake loadings, the pipelines would not be expected to fail, even with the Gimbel joints corroded to the point of total seizure.

In order to attempt to quantify more realistically the fire hazard and its consequences in the plant, fire propagation studies have been continued throughout the year using the three dimensional computational fluid dynamics program PHOENICS. The studies to date have used only one basic model – that of the reactor charging pump room – where a postulated fire results from the ignition of oil in the sump. Refinements

REACTOR VESSEL HEAD AND CONTROL RODS



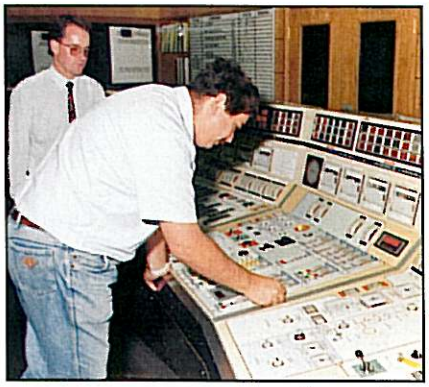
COURTESY ESKOM

have been progressively built into the program to create realistic, rather than conservative, assumptions for the propagation of, and the heat and smoke generation from, the fire with respect to time.

The purpose of these analyses is to be able to assess, realistically, the spread of a fire in any area and the time available before either sensitive or safety related equipment, at some specific distance from the fire source, is adversely affected, or mitigating actions may be taken to arrest the fire spread. This type of study will form a part of the revised fire risk studies for the plant, where the risk and consequences to equipment, and particularly to cabling, has been carried out by the licensee.

All occurrences reported from Koeberg since January 1986 have been recorded in a database, incorporating several query options, from which a wide range of reports can be generated and trends identified. At Koeberg, as at other nuclear power plants, the majority of reportable occurrences arose from human error. This fact lends weight to the significance of the quality of human performance in the execution of operational control tasks and to the need for stringent personnel selection measures, which include psychological assessment and monitoring of licensed operating staff. Furthermore, it is essential for all reactor operators and senior reactor operators to receive continuing training and periodic requalification after their initial qualification and licensing. Recognising the importance of this aspect, the Council arranged a special function at the Koeberg training offices early in 1992, at which the Executive Officer and the General Manager presented certificates to operators who had recently obtained their licences.

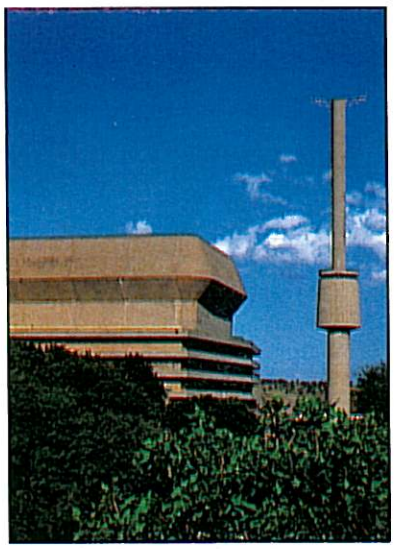
The full scope simulator at Koeberg is used by Eskom to give initial training to their candidate operators as well as continued training to their licensed operators. The Council's Operator Licensing Division staff similarly use the simulator for the testing of operators prior to their being granted their licences. The simulator, which was originally designed



COURTESY ESKOM

OPERATOR LICENSING: THE KOEBERG TRAINING SIMULATOR

REACTOR OPERATORS RECEIVE ONGOING TRAINING



COURTESY AEC

SAFARI-1 RESEARCH REACTOR BUILDING: PELINDABA

prior to the Three Mile Island incident in the USA, has been upgraded to bring it up to current world standards and was taken out of service, for training purposes, in mid-1992 in order to instal the new software and hardware.

No new operator licences were issued during the year under review.

ATOMIC ENERGY CORPORATION (AEC)

PELINDABA SITE

LICENSING PROJECTS

The nuclear licence for the Pelindaba site of the AEC covers all activities at the site which involve nuclear-hazard material. These are primarily the uranium conversion and enrichment facilities, the nuclear fuel fabrication plant, the hot cell complex, the Safari research reactor and various smaller production and research facilities. During the year under review, and following comprehensive safety assessment, the licence was varied to include additional activities in the hot cell complex, a waste volume reduction facility and a research project related to improved enrichment technology. The hot cell complex is a major facility whose prime function is to enable research work to be carried out on highly radioactive spent nuclear fuel, with a view to ensuring that the fuel performance is adequate. In addition the complex can handle other radioactive materials as part of the isotope production capabilities of the AEC. The safety assessment work for this complex has been undertaken in various stages and as the need to undertake additional functions arises, the associated assessments will be reviewed and the licence varied to include any additional controls required.

ATOMIC ENERGY CORPORATION

Early on in the process of licensing the facilities, it became clear that numerous changes, which had not been addressed in the original safety assessments, had been made to existing plants on the site. In view of this the AEC commenced a re-evaluation of the assessments

of the uranium conversion and enrichment facilities. This work has been progressing throughout the year and is scheduled for completion towards the end of 1993.

Much of the safety assessment work and the re-evaluation of existing assessment is aimed at demonstrating not only that the various facilities meet the required safety criteria, but also that the operational controls in place ensure that this will remain the case. Efforts have been made to consolidate the documenting of such controls and to revise the format of the licence so as to embody clear and unambiguous requirements for their implementation.

Radiation Protection

Extensive work has been carried out on the evaluation and formulation of operational programmes at the Pelindaba facilities in respect of operational radiological safety and effluent control. Specific issues that have received attention are those pertaining to portable instrument calibration and biological dosimetry. With respect to instrument calibration, the AEC has requested the Council's approval for it to perform a limited calibration service for the instrumentation used in radiation protection programmes within the mining and minerals processing industries. This prompted the formation of a tripartite working group consisting of members of the CSIR, the AEC and the Council to examine the standardization of calibration methodologies in those institutions approved for instrument calibration.

Occupational exposures have remained consistently low and well within limits, as have those to members of the public, as a result of radiological effluent discharges.

HOT CELLS IN THE AEC'S ISOTOPE PRODUCTION UNIT AT PELINDABA

COURTESY AEC

Waste Management

Activities conducted at the Pelindaba site have given rise to considerable quantities of radioactive waste, the majority of which has been stored in various configurations on the site. The AEC have been required to establish a programme for the final disposal of this waste. It is envisaged that this programme will be established within the forthcoming year.

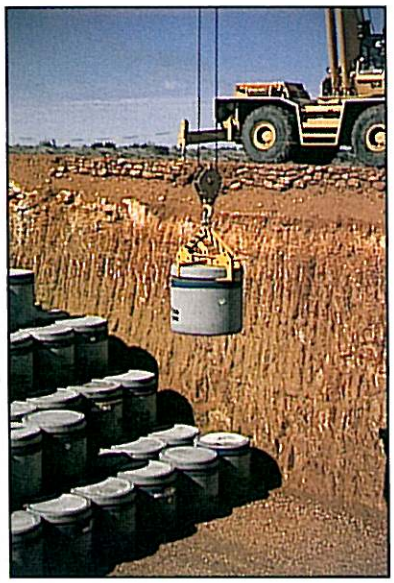
Environmental Protection

Whilst it is recognised that existing environmental monitoring programmes assess all relevant exposure pathways, efforts have been expended on the further formalization of monitoring procedures in the site environs.

Emergency Planning

During the year, progress has been made with the establishment of formalized emergency planning and preparedness procedures. These procedures are being based on the safety assessments for the various facilities and will be commensurate in their extent with the magnitude of possible accidents and likelihood of their occurrence.

The National Radioactive Waste Disposal facility at Vaalputs



Courtesy AEC

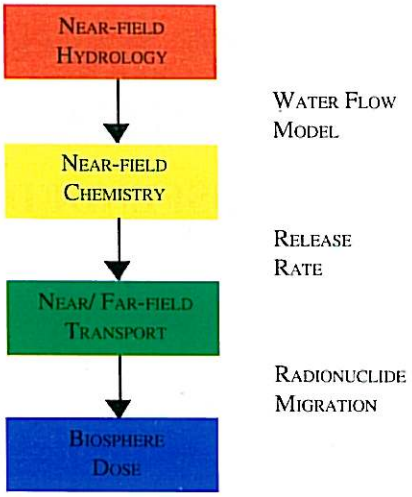
Vaalputs

Operation

Throughout the year Vaalputs has continued to accept low and intermediate level operational waste from the Koeberg Power Station operation. No issues of major significance have arisen with these operations.

Long Term Modelling

A considerable amount of work has been done on the reviewing of operational programmes for the Vaalputs facility and the Vaalputs safety assessment is currently being revisited in order to accommodate work on radionuclide migration in groundwater and human intrusion. At present the safety assessment report for Vaalputs only validates the adequacy of the site for the Koeberg operational wastes, but consideration is being given to extending the validity of the assessment to cover, in addition, the disposal of wastes arising from operations other than those at Koeberg. In particular, a need to accommodate certain mining wastes at the Vaalputs facility is foreseen and this matter is receiving attention.



Model chain for safety assessment

Mining Activities

Licensing Projects

Much progress has been made with the assessment of radiation hazards prevailing within various licensed mining and mineral processing activities. In all there are some twenty licensed facilities, thirteen being primary gold producers, all of which, at some stage, have also produced uranium as a by-product. The other operations all mine and/or process ore containing elevated levels of naturally occurring radionuclides. The assessment procedure is aimed at systematically quantifying all potential radiation hazards with a view to establishing an adequate radiation protection programme. The majority of mines, with the exception of two of the non-gold mining operations, made limited progress in respect of implementing radiation protection programmes.

Hazard Assessment

The hazard assessment programmes being implemented cover occupational exposure to the workforce, both underground and within

Mining Activities

SALE OF WASTE MATERIALS SUSPENDED

surface facilities, and exposure of the public arising from operational discharges from the various facilities and the disposal of radioactively contaminated wastes.

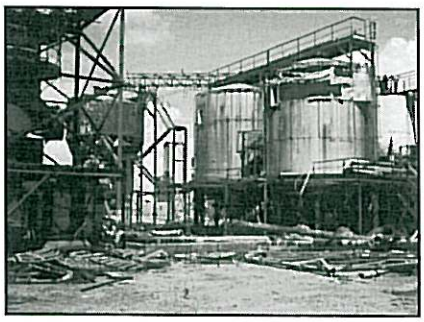
As indicated, the licensing process is being conducted on a systematic basis. Where significant hazards have been found, however, procedures have been put in place immediately to eliminate the causes of such exposure. In this respect, the maintenance of pyrite-burning sulphuric acid plants has been found to be particularly problematic and instances of overexposure have been found to occur in these operations. Major efforts have been expended to establish adequate radiation protection programmes to cover these activities. One of the factors compounding the problems associated with this type of activity was found to be the use of contractors and the employment of personnel on a casual basis. In view of the requirements to ensure that personnel employed on these activities are sufficiently trained in the nature of the hazards and the principles of protection, that their medical fitness is assured and that their integrated exposures are adequately monitored, special measures have had to be put in place.

The second major problematic area which has been identified is that of radioactively contaminated waste arisings. A very broad spectrum of waste materials arising from mining and minerals processing operations has been found to be radioactively contaminated and in the past a large proportion of these materials has been disposed of into the public domain. All licensees have been required to suspend the sale and disposal of such materials pending the establishment of acceptable waste management programmes. Such programmes involve mechanisms to quantify the nature and degree of contamination, establishment of waste treatment options complemented by storage and, finally, disposal options. The Council has expended considerable efforts to establish guidance on the various aspects of waste management programmes and the industry has been actively ad-

dressing practical mechanisms to establish and implement the programmes.

The Council convened a workshop during the later part of the year at which all aspects of the waste management issue were addressed by a cross section of all interested and affected parties.

Various disposal options are under investigation and it is becoming clear that the disposal of these wastes and the ultimate closure of the mining facilities concerned will create major difficulties from a radiation protection point of view.



DISMANTLING OF A SULPHURIC ACID PLANT

RESIDUALLY CONTAMINATED LAND

The Council has continued to co-operate with the Government Mining Engineer and various local authorities in the consideration of land, previously used for mining activities, which is being re-zoned for other purposes. Such considerations have involved the determination of residual levels of contamination and assessment of potential exposure levels that could be associated with property development on such land. The main problem is that of radon daughter product exposure within developed properties.

MINE CLOSURE

The licensing work to date has been mainly associated with operational activities. It is clear, however, that closure of the properties concerned will give rise to several radiation protection problems that are in need of resolution. This is a problem faced by many countries which have engaged specifically in uranium mining operations and other mining and minerals processing activities involving radioactive ores. To this end the Council has been involved with the International Atomic Energy Agency programmes in addressing the issues involved and, through its staff members, has provided consultancy services to

WASTE DISPOSAL OPTIONS ARE UNDER INVESTIGATION

Material	Specific activity (Bq/g)
Pyrite (FeS_2)	350
Calcine (Fe_2O_3)	2 000
Scale from equipment	80 000
Plastic saddles	55 000

Typical specific activity levels - acid plant material

that agency in respect of fundamental safety standards to be established internationally to deal with the matter.

Other

Users of Small Quantities of Nuclear-Hazard Material

During the year three new licences were issued and three were surrendered, leaving twenty-two such licensees. Inspections were conducted at eight of the premises and in the few cases in which shortcomings in practice were identified the licensees were required to upgrade the relatively straightforward control procedures involved.

Transport

In its role as the national competent authority for the transport of radioactive material, in terms of the International Atomic Energy Agency Regulations for the Safe Transport of Radioactive Material, the Council has issued several design approval certificates for radioactive material transport packages. These were for a container to transport enriched uranium hexafluoride for a local organization and to an overseas company for several package designs used in their export activities. In addition sealed sources manufactured by the AEC were approved as special form radioactive material.

Japanese Plutonium Shipment

The shipment of plutonium from France to Japan, around the South African coast, gave rise to extensive consideration of the safety issues involved, and received widespread media attention. The legal and procedural position was presented to the Japanese authorities. Such shipments have the right of innocent passage through South African territorial waters and a nuclear licence would only be required in the

event that the vessel concerned may wish to sojourn in these waters or to enter a harbour. Such a licence would not be granted until a detailed safety assessment had been carried out and accepted by the Council and emergency plans had been established. In the event, the shipment passed around the coast well outside of territorial waters and no request for a licence was received. Notwithstanding this, a generic consideration of the risks involved indicated that such vessels would in all probability be demonstrated to be acceptably safe. For the period of the vessel's passage around the coast, contingency plans were made with the harbour authorities and various institutions to respond to any untoward circumstances that might have arisen.

Legislation

Work on the drafting of a Nuclear Energy Bill continued throughout the year, in conjunction with the AEC. As far as the Council is concerned the Bill will provide, inter alia, for certain changes to its structure and functions as well as changes to certain provisions relating to nuclear licensing, and should be completed in time for submission to Parliament during 1993.

Participation in Meetings and Conferences

In order to keep up with developments in the nuclear field, with particular regard to safety and regulatory control matters, nine members of staff attended conferences, training courses and technical meetings in Austria, Finland, France, Germany, Spain, Sweden the United Kingdom and the USA on probabilistic safety assessment, human factors, operational safety and reliability, water chemistry, corrosion, accident sequences and liability and compensation for nuclear accidents.

In addition, during the past year the Council has been able to play a more active and contributory role in the international arena than was

INTERMEDIATE LEVEL WASTE DRUMS AND TRANSPORT VEHICLE

COURTESY ESKOM

previously possible and a number of staff members were invited to participate in specialist missions and committee meetings.

Mr A C Hall, Manager; Operations Assurance Department, was invited to address the Slovenian Nuclear Society on "*Nuclear Safety and Culture*" at their Annual Meeting in Bovic, Slovenia and also to provide consultant services to the IAEA on the production of a Technical Document on "*Safety Culture in Nuclear Power Plants*" for international distribution. He also participated in the IAEA's Assessment of Safety Significant Events Team (ASSET) and Assessment of Safety Culture in Operations Team (ASCOT) missions at the PAKS nuclear power plant in Hungary.

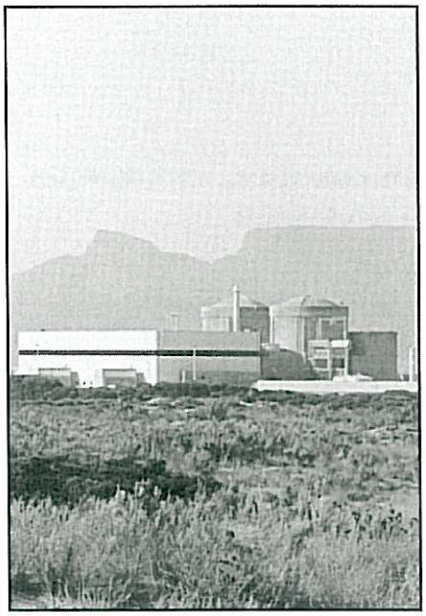
Mr P E Metcalf, Manager, Standards and Radiation Protection Department and Mr M S C Guy attended the Eighth International Congress of the International Radiation Protection Association, in Montreal, Canada.

Mr P E Metcalf participated in IAEA Technical Committee meetings on "*The impact of ICRP-60 on mining and minerals processing activities*" and on "*Basic safety standards*", in Vienna. He also participated in an IAEA consultants meeting on "*Safety standards for disposal of wastes from the mining and minerals processing industries*" and was a member of an IAEA mission to Jamaica to establish radiation protection regulations and regulatory mechanisms.

Mr B C Winkler, Executive Officer, as Vice-chairman of Committee 4 of the International Commission on Radiological Protection, attended the meeting of Committee 4 held in Cape Town during April 1992. He also attended the 16th meeting of the IAEA's Advisory Committee on Training in Nuclear Power Safety in Vienna.

Mr J Leaver, General Manager, attended the first International Symposium on Radiation Protection in the Mining, Milling and Downstream Processing of Mineral Sands, held in Bunbury, Western Australia.

KOEBERG NUCLEAR POWER STATION



COURTESY ESKOM

Report on the Financial Statements for the year ended 31 March 1993

The annual financial statements were approved by the Council and were signed on its behalf by Mr B C Winkler, Executive Officer and Mr E L Langford, Manager: Central Services Department.

Certification

The accounts of the Council for Nuclear Safety have been audited in terms of Section 5 of the *Auditor-General Act, No. 52 of 1989*, read with section 26(4) of the *Nuclear Energy Act, No. 92 of 1982*, and in my opinion the annual financial statements are a fair representation of the financial position of the Council as at 31 March 1993 and the results of its operations for the year then ended.

for Auditor-General
(Pretoria)

Financial Statements

BALANCE SHEET
AS AT 31 MARCH 1993

	Notes	1992/93 R	1991/92 R
Capital employed			
Income funds	2	**8 182 974**	10 157 891
Capital funds	3	**1 696 322**	180 799
		9 879 296	10 338 690
Employment of capital			
Fixed assets	4	**1 600 956**	2 402 570
Net current assets		**8 278 340**	7 936 120
Current assets		**8 881 824**	8 922 798
Debtors	5	**2 816 288**	1 793 284
Deposits and immediate claimable amounts		**4 000**	2 020
Bank balance and cash		**6 061 536**	7 127 494
Less:			
Current liabilities		**603 484**	986 678
Creditors and provisions	6	**603 484**	986 678
		9 879 296	10 338 690

INCOME STATEMENT
FOR THE YEAR ENDED 31 MARCH 1993

	Notes	1992/93 R	1991/92 R
Income		**14 615 543**	13 200 721
State contribution		**3 519 000**	4 270 000
Licence fees		**10 051 168**	7 571 996
Interest		**1 016 332**	1 313 553
Sundry		**29 043**	45 172
Less: Expenditure		**14 972 946**	12 859 648
Audit fees		**86 843**	70 963
Consultancy		**167 832**	226 385
Consumable stores		**57 613**	52 687
Depreciation	7	**852 162**	584 581
Personnel expenses		**8 885 889**	7 492 493
Postal, telex and telephone services		**141 261**	99 761
Provision for capitalisation of leave		**–**	200 000
Publications		**75 513**	57 165
Rent, accommodation		**782 848**	644 370
Research contracts		**207 065**	142 104
Service contracts and maintenance		**252 919**	181 416
Subsistence and transport expenses		**2 843 938**	2 447 827
Sundry expenditure		**619 063**	659 896
Income over expenditure for the year		**(357 403)**	341 073
Transfer to Capital Funds	8	**(1 515 523)**	–
Adjustment in respect of previous years	9	**(101 991)**	–
Income over expenditure – beginning of year		**10 157 891**	9 816 818
As reported previously		**–**	8 950 290
Adjustment of fundamental error	9	**–**	866 528
Income over expenditure – end of year (carried forward to the Income Fund)	2	**8 182 974**	**10 157 891**

CASH FLOW STATEMENT
FOR THE YEAR ENDED 31 MARCH 1993

	Notes	1992/93 R	1991/92 R
Cash (retained from) employed in operations		**911 439**	(1 443 242)
Cash deficit (surplus) generated from operations	10	**521 573**	187 899
Income interest		**(1 016 332)**	(1 313 553)
Employed to increase (decrease) operating capital	11	**1 406 198**	(317 588)
Cash generated by operations		**911 439**	(1 443 242)
Cash utilised in investing activities		**152 539**	591 343
Investment to maintain operations		**152 539**	–
Additions to fixed assets	12	**152 539**	591 343
		1 063 978	(851 899)
Cash effects of financing operations			
(Decrease) increase in cash on hand		**(1 063 978)**	851 899
Cash generated (utilised)		**(1 063 978)**	851 899

1. Accounting policy

The financial statements are, unless otherwise indicated, compiled on the historical cost basis in accordance with the undermentioned policy which was applied consistently in every material respect.

1.1 Income acknowledgement in general

Income is recognised on the accrual basis

1.2 State contributions received

State contributions are accounted for in the period with which the allocation is associated.

1.3 Fixed assets and depreciation

Fixed assets are shown at cost less accumulated depreciation and are written off over the expected useful life according to the fixed instalment method.

1.4 Expenditure for research and development

These expenditures are written off in the Income Statement for the year in which they were incurred.

1.5 Provision for the capitalisation of leave

Provision for the capitalisation of leave is partially provided on the basis of expected future cash payments to employees.

	1992/93 R	1991/92 R
2. Income Funds		
Accumulated funds	**8 182 974**	10 157 891
3. Capital funds		
Book value of assets taken over from the Atomic Energy Corporation		
Balance at the beginning of the year	**180 799**	180 799
Transferred to Income Fund	**180 799**	–
Balance at the end of the year	–	180 799

	1992/93 R	1991/92 R
Fund for the replacement of capital items		
Balance at the beginning of the year	–	–
Transferred from/ to retained income	1 696 322	–
Balance at the end of the year	1 696 322	–
Total capital funds	1 696 322	180 799

4. Fixed assets

	1992/ 93 R					1991/92 R
	Furniture	Computer equipment	Scientific and technical equipment	Office equipment	Total fixed assets	Total fixed assets
Cost	268 210	3 166 158	807 897	155 876	4 398 141	4 449 714
Accumulated depreciation	131 310	2 100 030	492 378	73 467	2 797 185	2 047 144
Book value	136 900	1 066 128	315 519	82 409	1 600 956	2 402 570

	1992/ 93 R	1991/ 92 R
5. Debtors		
Outstanding licence fees	**2 531 886**	1 499 769
Other debtors	**107 878**	112 768
Payments made in advance	**176 524**	180 747
	2 816 288	1 793 284
6. Creditors		
Trade creditors	**317 358**	589 035
Sundry creditors	**41 126**	137 643
Provision for capitalisation of leave	**200 000**	200 000
Provision for audit fees	**45 000**	60 000
	603 484	986 678
7. Depreciation		
Depreciation for the year	**852 162**	1 034 581
Excess depreciation in previous years written back	**–**	450 000
	852 162	584 581
8. Transfer to (from) funds		
Capital funds		
Book value of assets taken over from the Atomic Energy Corporation	**(180 799)**	–
Fund for the replacement of fixed assets	**1 696 322**	
Total transfer to (from) funds	**1 515 523**	–

9. Fundamental error adjustment

It was not possible to reconcile the value of the assets according to the asset register in respect of previous years with the financial records. The effect of the adjustment in respect of previous years is reflected in the income statement as an adjustment in respect of previous years. The effect of the adjustment could not be reflected by the restating of the comparative figures for 1991/ 92 and as an adjustment of the opening balance for the income over expenditure for the financial year 1990/ 91 because the necessary information could not be extracted from the financial records of the Council.

	1992/ 93 R	1991/ 92 R
10. Cash (deficit) surplus generated from operations		
Income over expenditure for the year	**(357 403)**	341 073
Adjustment for depreciation	**852 162**	584 581
Provision for the capitalisation of leave	**–**	200 000
Income interest	**(1 016 332)**	(1 313 553)
	(521 573)	(187 899)
11. Employed to increase operating capital		
(Decrease) increase in debtors	**1 023 004**	106 602
Decrease (increase) in creditors	**383 194**	(424 190)
	1 406 198	(317 588)
12. Additions to fixed assets		
Computer equipment	**81 644**	519 695
Scientific and technical equipment	**2 074**	14 946
Furniture	**27 943**	30 081
Office equipment	**40 878**	26 621
	152 539	591 343