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SOUTH AFRICA'S NUCLEAR CAPABILITIES
(GC(XXXV)/RES/567)

1. Last year, in resolution GC(XXXV)/RES/567, the General Conference took note of South Africa's accession to the Treaty on the Non-proliferation of Nuclear Weapons (NPT) and of the fact that the South African Government had signed an NPT safeguards agreement with the Agency and committed itself to early and full implementation of the agreement.

2. Also in that resolution, the Director General was requested to verify the completeness of the inventory of South Africa's nuclear installations and material and to report to the General Conference at its thirty-sixth regular session.

3. The attached "Report on the completeness of the inventory of South Africa's nuclear installations and material" is submitted to the Conference in response to that request. The same report was submitted to the Board of Governors in document GOV/2609.

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REPORT ON THE COMPLETENESS OF THE INVENTORY OF SOUTH AFRICA'S NUCLEAR INSTALLATIONS AND MATERIAL

Introduction

1. On 16 September 1991 the Government of South Africa concluded with the IAEA a comprehensive safeguards agreement (INFCIRC/394) in connection with the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). Subsequently, in General Conference Resolution GC(XXXV)/RES/567 the Director General was requested "to verify the completeness of the inventory of South Africa's nuclear installations and material and to report to the Board of Governors and to the General Conference". A similar request to the Secretary General was made at the General Assembly of the United Nations in November 1991 (A/RES/46/34A).

2. Following the receipt by the Agency of South Africa's Initial Report on all nuclear material subject to safeguards under the agreement, a team of senior members of the Department of Safeguards was appointed. During the period December 1991 to August 1992 members of the team had three meetings with officials of the Atomic Energy Corporation of South Africa (the AEC) in South Africa and two meetings in Vienna. At the request of the team the historical operating and accounting records of those South African facilities selected by the team were audited by Agency inspectors during their inspections of these facilities.

Co-operation received from the South African Authorities

3. The team's activities were carried out with the co-operation of the South African authorities, who provided access to all the facilities and locations in South Africa that the team requested to visit, including decommissioned facilities and locations involved in current research projects. In addition to the Initial Report the AEC produced a "Report on the Completeness of the Inventory of South Africa's Nuclear Installations and Nuclear Material as of 30 September 1991", which provided an extensive summary of historical flows and balances, production, and transfers of nuclear material in South Africa's

uranium enrichment, conversion and fuel fabrication plants, as well as information on imports of enriched and depleted uranium.

4. The initial assistance offered by South Africa, namely, the submission of operating records of the decommissioned Pilot Enrichment Plant, was welcomed but was not considered to be sufficient by the Agency team. Accordingly South Africa also agreed to provide:

- the accountancy and operating records of the decommissioned Pilot Enrichment Plant including electricity consumption. The data on electricity consumption was available for the years since 1980.
- the accountancy and operating records of the Semi-Commercial Enrichment Plant before September 1991;
- the historical flows of nuclear material, including all imported material; and
- historical values of material unaccounted for (MUF), as determined by the AEC for the purposes of financial control.

5. Although comprehensive safeguards agreements require that records are preserved for only five years, many of the records of the South African plants go back to the middle of the 1970s and, fortunately, had not been destroyed. In view of the large amount of data, the team made an overall consistency check on a random basis and carried out detailed reviews of specific periods of the plants' operation when fluctuations in production had taken place.

General approach

6. The team concentrated its activities on those South African facilities which had been used for the production of high enriched uranium, 20 % or greater U-235 (HEU), and those facilities which were still being used for the production of low enriched uranium (LEU) or for the conversion and fabrication of HEU and LEU. The South African reactors, i.e. the Koeberg Nuclear Power Plant and the SAFARI Research Reactor, as well as the Hot-Cell Complex at Palindaba, were under INFCIRC-66/(Rev.2) type safeguards agreements since their construction (INFCIRC/98 of September 1967 and INFCIRC/244 of February 1977) and were therefore not included in the team's programme.

7. To confirm the completeness of the declared South African inventory of HEU and LEU, the team calculated U-235 balances and carried out an audit of the accountancy records of the plants used to produce, convert and fabricate enriched uranium and of the operating records of the Pilot Enrichment and Semi-Commercial Enrichment Plants. The flows of imported and domestic uranium in relation to the two enrichment plants are shown in the Figure at the end of this report. The correctness of the declared amounts of total uranium and uranium-235 in the various materials included in the Initial Report was verified by Agency inspectors as is required when a State concludes a safeguards agreement in accordance with the NPT (INFCIRC/153, paragraphs 71(a) and 72).

8. To confirm the completeness of the inventory of nuclear installations visits were made to the facilities stated by the South African authorities to be concerned with the production and use of enriched uranium on the AEC site at Pelindaba, to a number of other locations on the Pelindaba site and to a location in the immediate vicinity identified by the Agency, to the Vaalputs National Waste Repository of the AEC in the north western Cape Province, to the Nuclear Fuels Corporation (NUFCOR) ore concentrate conversion facility near Johannesburg, and to a location at Vastrap in the southern Kalahari Desert which was identified by the Agency and which is currently being used by the South African Air Force as a target range. A number of environmental samples were taken in and around the Pelindaba and Kalahari sites.

Description and status of the enrichment projects

9. The current South African enrichment programme consists of the Semi-Commercial Enrichment Plant, which produces LEU, and a laser enrichment research and development project. The Pilot Enrichment Plant, which was used to produce HEU and LEU, has been decommissioned and the centrifuge enrichment development programme has been abandoned.

10. The visit to the Pilot Enrichment Plant confirmed that the separation units in the high enriched stages of the plant had been dismantled and removed and that the rest of the plant had been decommissioned and partly dismantled.

The building made available by the dismantling of the high enriched stages was being prepared for use in the laser enrichment project as a demonstration module, to be commissioned in 1993/94. The decommissioned Pilot Enrichment Plant will continue to be visited by Agency inspectors to verify its status.

11. The team visited the Semi-Commercial Enrichment Plant which produces LEU for the fuel elements for the Koeberg Nuclear Power Station. The Facility Attachment for the Semi-Commercial Plant is being negotiated with the AEC and it is expected that it will enter into force by the end of this year.

12. The team visited the laboratories and other buildings used in the centrifuge development programme, which the AEC stated had been abandoned in 1991 to enable resources to be concentrated on the molecular laser isotope separation project (MLIS). The centrifuge development programme had included the use of aluminium components, maraging steel components and rotors, and carbon fibre rotors. The team saw a number of rotors, the associated test stands and other components and equipment and visited the hall where the proposed, but now abandoned, 48 centrifuge cascade was to have been installed. The team also visited a number of other locations on the Pelindaba site used in the past in the centrifuge programme either for the fabrication of aluminium components or for centrifuge testing. At all of the locations visited the centrifuge programme had been discontinued.

13. The AEC is now concentrating its enrichment development programme on the molecular laser route. The team visited various laboratories used for the project, as well as the site for the first demonstration module, which is planned to start operating early in 1993. A pilot plant is scheduled to be commissioned in 1997. The laboratories where laser enrichment is being developed and the demonstration module will be inspected in accordance with South Africa's NPT safeguards agreement.

Production of the enrichment, conversion and fabrication plants

14. The AEC provided the team with historical accounting and operating data relating to the production of enriched and depleted uranium by the Pilot Enrichment Plant. The AEC stated that commissioning of the plant had started at the end of 1974 as the various enrichment stages and buildings became

available, and that the production of HEU had started in January 1978 and ended in November 1989. The production of enriched uranium was suspended between August 1979 and July 1981 as a result of technical problems. Production thereafter fluctuated depending on the operational situation, e.g. the introduction of improved separating elements, withdrawal of LEU for the production of Koeberg fuel elements, and for a short period, feeding with depleted uranium. The operating records were examined by the Agency team and Agency inspectors and were found to be consistent with the AEC statements.

15. From the accounting data made available by the AEC the team calculated the U-235 balance of the Pilot Enrichment Plant. The team's calculations showed an apparent discrepancy in this balance. This may be the result of the material accountancy system, since while the methods used to account for the enriched uranium product were in line with contemporary safeguards accounting methods, no formal measurement control programme had existed for the depleted uranium product which was a major component of the U-235 balance. This situation, according to the AEC, reflected the low financial value put on the depleted uranium by the plant management. Examination of the records of transfers of material between facilities and the plant operating records (including data on electrical consumption; on plant, cascade and stage availability; plant operating parameters; and feed and product registers) showed these records to be internally consistent and consistent with the declared production of enriched uranium over the fifteen year lifetime of the plant. In addition to the examination of records the team carried out a large number of destructive and non-destructive analyses on the enriched and depleted uranium produced by the plant.

16. Some of the HEU produced in the Pilot Enrichment Plant was used to upgrade imported LEU and domestic natural uranium to the enrichment required for the Koeburg fuel, some was converted to uranium metal and some of this had been used to fabricate fuel for the SAFARI Reactor. This SAFARI fuel and the remainder of the HEU are present in the Initial Report in various chemical and physical forms and enrichments. The accounting records for the HEU conversion and fabrication plants were examined and a balance made.

The results show that the amount of HEU included in the Initial Report is consistent with the amount stated to have been transferred to the conversion and fabrication plants during the lifetime of the Pilot Enrichment Plant. The AEC stated that blending operations which will result in the downgrading of a certain amount of uranium from HEU to LEU enriched to less than 5% U-235 are to start in September 1992. These operations will be observed and verified by Agency inspectors.

17. The operating and accounting records relating to the production of LEU in the Semi-Commercial Enrichment Plant were examined by members of the team and by Agency inspectors. Commissioning of the plant started in June 1984 but full cascade operation did not start until August 1988. The plant was reported to have been in operation since that date, except for extended interruptions in production between January 1990 and January 1991. The U-235 balance for the plant as calculated by the team shows an apparent discrepancy. Given the degree of uncertainty in the measurements used at the time, this discrepancy may have arisen, as in the case of the Pilot Enrichment Plant, from the material accounting system.

18. Material balances used to be made by the AEC for the two enrichment plants and the results reported to the AEC Management Board. This was done in conjunction with financial audits and was principally aimed at the financial aspects of material transfers and losses with particular emphasis on the HEU product. The accuracy of the physical inventory was impaired by such factors as the non-availability of suitable instruments to measure process hold-ups, the unwillingness of the plant management to interrupt production in order to drain condensers or to transfer material to measurement points, and to the lack of comprehensive measurement control programmes. The calculated values of material unaccounted for (MUF) for each year of operation were provided to the team by the AEC, but were not taken into account in the evaluation of the U-235 balances in view of the uncertainties associated with their determination.

19. The accounting records relating to the conversion and fabrication of fuel for the Koeberg Nuclear Power Station from the LEU produced in the Pilot and Semi-Commercial Enrichment Plants were examined and a balance made. The results show that the amount of LEU included in the Initial Report is consistent with the amount recorded as transferred to these plants and the amounts stated to have been imported.

Exports and imports of uranium

20. The AEC informed the team that, prior to September 1991, with the exception of uranium in the form of yellow-cake, all exports of nuclear material had been notified to the Agency. These exports included gram quantities exported to the Agency as samples, irradiated fuel for the SAFARI Research Reactor returned to the United States of America, and fuel for the decommissioned Pelinduna Critical Assembly exported to the United States of America via the United Kingdom in 1971.

21. HEU fuel elements for the SAFARI Research Reactor were first imported in 1965 under INFCIRC/98; and low enriched Koeberg fuel was first imported in 1982 under INFCIRC/244.

22. The AEC provided information on a quantity of unsafeguarded LEU which had been imported in 1981 for use in Koeberg fuel elements. They stated that some of the imported LEU had been upgraded by blending with HEU produced in the Pilot Enrichment Plant and with LEU produced in the Semi-Commercial Plant. The blended material was subsequently fabricated into Koeberg fuel elements. The records examined by the Agency supported the AEC's statements. The remainder of the imported uranium hexafluoride was included as such in the Initial Report. The team found no evidence, through the analysis of samples, that imported LEU had been used as feed for the enrichment plants.

23. A quantity of natural uranium was imported for use as feed for the Pilot Enrichment Plant during the period up to 1979. Similarly a quantity of depleted uranium was also stated by the AEC to have been imported for a variety of nuclear and non-nuclear uses.

24. The AEC wished to keep confidential the identity of the suppliers of previously unsafeguarded imported depleted, natural and low enriched uranium and, as a consequence, the shipping documents were not made available to the team for examination.

Locations other than the Pelindaba site

25. The team visited the ore concentrate conversion facility near Johannesberg operated by the Nuclear Fuels Corporation (NUFCOR). The plant converts ammonium diuranate slurry from South African gold mines into impure uranium oxide (yellow-cake). A smaller ore concentrate plant belonging to the Palabora Mining Company at Phalaborwa, Transvaal, was not visited by the team. The nuclear material at these facilities is subject to safeguards under the South African NPT safeguards agreement, but neither the facilities nor the material are required to be included in the facilities list or the Initial Report because, pursuant to Article 34 of INFCIRC/394, the full safeguards procedures of reports and inspections are not applied to material at this stage of the fuel cycle.

26. The team visited the the National Waste Repository of the AEC at Vaalputs in the north western Cape Province. The facility is not yet used for the storage of uranium waste and is currently used for the storage of low-level and intermediate-level wastes from the Koeberg Nuclear Power Station and from other locations (e.g. hospitals). A small quantity of depleted uranium metal contained in an item of geological equipment is also stored there. Uranium - containing wastes from Pelindaba will be transferred to Vaalputs in the near future, and consideration is being given to the construction at Vaalputs of a long-term store for spent fuel elements from Koeberg.

27. On the basis of information received, the team requested a visit to a location at Vastrap in the Kalahari Desert which is owned by the South African Defence Force and currently used by the South African Air Force as a target range. At the location the team saw a building with square cross-section approximately twenty metres wide and constructed of corrugated metal on a concrete floor. The team was told that the building was used by the Air Force for storage and as a workshop. On the floor at one side of the building was a

large concrete ramp which appeared to have been cast in situ. A number of environmental samples were taken in and around the building. The team found no evidence that the location has been or is being used for the testing of nuclear explosive devices.

28. Similarly a location, Building 5000, on the south western part of the Pelindaba site was visited. The building was stated to have been used as a general purpose critical facility by the AEC's Reactor Development Group which was disbanded several years ago. According to the AEC the facility itself was abandoned in the early 1980s. This was evident from the condition of the building which was found to be unoccupied and appeared to have been out of use for many years, except for the storage of a small quantity of radio-active waste and redundant equipment all of which was stated to have originated from elsewhere on the Pelindaba site. A number of environmental samples were taken in and around the building.

29. The AEC stated that in the past a site had been selected for the construction of a research reactor in the area of Mosselbay, Cape Province, and that the project had later been abandoned. Since no construction work had taken place the team did not visit the site.

General conclusions

30. With the co-operation of the South African authorities the team was able to visit all the locations it asked to see, (see Annexes A and B). On the basis of these visits and the information made available to it, the team found no evidence that the list of facilities and locations outside facilities provided by South Africa in its Initial Report, as required by the Safeguards Agreement, was incomplete. Moreover the Secretariat is not in possession of any other information suggesting the existence of any undeclared facilities or nuclear material. The South African authorities have indicated their willingness, corresponding to their stated policy of transparency, to facilitate, as in the past, access to any locations that the Agency may

specifically request. Naturally, if relevant information were obtained suggesting the need for access to any facilities, locations or data, the Agency would request such access.

31. The team evaluated the historical accounting and operating records of the two enrichment plants and the accounting records of the conversion and fabrication plants provided by the AEC. A large number of non-destructive and destructive measurements were made on various types of material. The amount of enriched and depleted uranium included in the Initial Report is considered to be consistent with these historical records taking into consideration the inherent difficulties associated with the evaluation of historical data extending over a period of fifteen years and the quality of the nuclear material accountancy system in use during that time. The team found no evidence that the inventory of nuclear material included in the Initial Report was incomplete.

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ANNEX A

NUCLEAR FACILITIES AND LOCATIONS OUTSIDE FACILITIES INCLUDED IN THE INITIAL REPORT (30 SEPTEMBER 1991) AND REPRODUCED IN THE AGENCY'S ANNUAL REPORT FOR 1991

1. Power Reactors (Owned and operated by Eskom)

   Koeberg Nuclear Power Station (2 Units)

2. Research Reactor (Owned and operated by the AEC)

   SAFARI-1

3. Conversion Plants (Owned and operated by the AEC)

   Uranium Conversion Plant *

4. Fuel Fabrication Plants (Owned and operated by the AEC)

   PWR Fuel Fabrication Plant *
   MTR Fuel Fabrication Plant *

5. Enrichment Plants (Owned and operated by the AEC)

   Semi-Commercial Enrichment Plant *

6. Other Facilities (Owned and operated by the AEC)

   Decommissioned Pilot Enrichment Plant *
   Hot Cell Complex
   Decontamination and Waste Recovery Plant *
   Natural and Depleted Uranium Processing Plant
   Molecular Laser Isotope Separation Laboratory *
   Central Analytical Laboratory
   Nuclear Waste Technology Laboratory

7. Separate Storage Facilities (Owned and operated by the AEC)

   Waste Storage Facility (Radiation Hill) *

   Vaalputs National Waste Repository *

* Facilities and installations visited by the team

ANNEX B

OTHER INSTALLATIONS VISITED BY THE AGENCY TEAM

1. Laboratories, Workshops and Stores (Owned and operated by the AEC)

Facility for the production of separating elements for the Semi-Commercial Enrichment Plant
Stores: Enrichment Plant Components
Electrical Maintenance Workshop
Mechanical Production Workshop
Laser Research Laboratory
Decommissioned Centrifuge Laboratory and Demonstration Cascade
Centrifuge Component Stores
MLIS Demonstration Facility (under construction)
Building 5000 used for the abandoned general purpose critical facility

2. Uranium Ore Concentration Plant (Owned and operated by NUFCOR)

NUFCOR Works

3. Location in the Kalahari Desert (Target Range currently operated by the South African Air Force)

Vastrap, North of Upington

URANIUM FLOWS