

**AUSTRALIAN SAFEGUARDS
AND NON-PROLIFERATION OFFICE**

**ANNUAL REPORT
1999-2000**

Director of Safeguards

**Director,
Chemical Weapons Convention Office**

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FOREIGN
AFFAIRS
AND TRADE

AUSTRALIAN SAFEGUARDS
AND NON-PROLIFERATION
OFFICE

26 September 2000

The Hon. Alexander Downer MP
Minister for Foreign Affairs
Parliament House
CANBERRA ACT 2600

Dear Mr Downer,

Pursuant to section 51 of the *Nuclear Non-Proliferation (Safeguards) Act 1987*, and to section 96 of the *Chemical Weapons (Prohibition) Act 1994*, I submit my Annual Report covering the operations of the Australian Safeguards Office and the Chemical Weapons Convention Office for the financial year ended 30 June 2000. This Report also covers the operations of the Australian Comprehensive Test-Ban Office for the same period.

As detailed in this Report, all relevant statutory and treaty requirements were met. In particular, all nuclear material and associated items in Australia were accounted for, all Australian Obligated Nuclear Material was accounted for, and full compliance with the Chemical Weapons Convention was demonstrated. In addition, an effective contribution was made to the development and strengthening of relevant international verification regimes.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'John Carlson'.

John Carlson
Director General

CONTACT DETAILS

R.G. Casey Building

John McEwen Crescent

Barton ACT 0221

Telephone: +61 2 6261 1920

Facsimile: +61 2 6261 1908

<http://www.asno.dfat.gov.au>

General enquiries relating to ASNO functions, activities or responsibilities should be directed to the Director General, Australian Safeguards and Non-Proliferation Office.

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SCOPE OF THE ANNUAL REPORT

The Director General, Australian Safeguards and Non-Proliferation Office (ASNO), combines the statutory office of Director of Safeguards with that of Director, Chemical Weapons Convention Office (CWCO). The Director General also performs the functions of the Director, Australian Comprehensive Test-Ban Office (ACTBO) on an informal basis, as the relevant legislation has not yet come into effect.

This report covers the activities of ASNO and is prepared pursuant to the requirements of section 51 of the *Nuclear Non-Proliferation (Safeguards) Act 1987* and section 96 of the *Chemical Weapons (Prohibition) Act 1994*.

Section 71 of the *Comprehensive Nuclear Test-Ban Treaty Act 1998* also requires preparation of an annual report. That Act will have effect at entry into force of the CTBT following ratification by the 44 States specified in the Treaty. Although the Treaty, and therefore the Act, are not yet in effect, the Treaty is being applied provisionally by the States Signatories, and ASNO's activities in this regard are included in this Report.

International Stakeholders



Minister for Foreign Affairs



Policy development and implementation

DFAT, including overseas posts

Other Commonwealth agencies

Domestic Stakeholders

- ANSTO
- DSTO
- chemical industry
- research and educational institutions
- R&D entities
- Commonwealth departments
- importers/exporters
- uranium industry
- CTBT facility operators

State and Territory Governments

Public

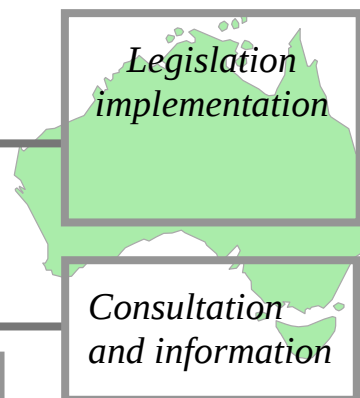


Figure 1—ASNO's operating environment

ASNO OUTCOMES AND OUTPUTS

OUTCOME 1

Australian and international security enhanced through activities which contribute to effective regimes against the proliferation of nuclear, chemical and biological weapons.

Outputs

- A. Operation of Australia's national system of accounting for, and control of, nuclear material and items subject to International Atomic Energy Agency (IAEA) safeguards, including promotion and regulation, within Australia, of effective measures for the physical protection of nuclear facilities and material.
- B. Development and implementation of bilateral safeguards measures that ensure nuclear material and items exported from Australia remain in exclusively peaceful use.
- C. Contribution to the development and effective implementation of international safeguards and non-proliferation regimes, including participation in international expert groups and conferences, and provision to the IAEA of consultancies, assessments, support in R&D and training; and evaluation of the effectiveness of IAEA safeguards and related regimes.
- D. Operation of the national authority for implementation of the Chemical Weapons Convention (CWC), including contribution to the effective international implementation of the CWC, particularly in Australia's immediate region.
- E. Operation of the national authority for implementation of the Comprehensive Nuclear-Test-Ban Treaty (CTBT), including development of CTBT verification and arrangements in support of Australia's CTBT commitments.
- F. Contribution to the development of new and strengthened WMD (weapons of mass destruction) non-proliferation regimes, such as the Protocol to strengthen the Biological Weapons Convention (BWC) and the Fissile Materials Cut-off Treaty (FMCT).
- G. Provision of high quality, timely and relevant professional advice to Government on non-proliferation matters.

OUTCOME 2

Public knowledge enhanced about Australia's efforts to prevent the proliferation of WMD.

Output

- H. Provision of public information on the development, management and regulation of WMD non-proliferation treaties, and Australia's role in these activities.

AUSTRALIAN SAFEGUARDS AND NON-PROLIFERATION OFFICE 1999-2000

MINISTER

Administration of the legislation under which ASNO operates, the *Nuclear Non-Proliferation (Safeguards) Act 1987*, the *Chemical Weapons (Prohibition) Act 1994* and the *Comprehensive Nuclear Test-Ban Act 1998*, is the responsibility of the Minister for Foreign Affairs, the Hon. Alexander Downer MP.

DIRECTOR GENERAL, ASNO

The position of Director General, ASNO, incorporates the functions of Director of Safeguards, Director, Chemical Weapons Convention Office, and Director, Australian Comprehensive Test-Ban Office. ASNO was established on 31 August 1998—the background to this is given in a media release of the same date, see page 106.

Outline of Safeguards Role

ASNO's predecessor, the Australian Safeguards Office was established in 1974. The position of Director of Safeguards was created in 1987 as a statutory office, appointed by the Governor-General, in order to ensure the independence and integrity of Australia's domestic and bilateral safeguards functions. The Director of Safeguards reports directly to the responsible Minister, who since 1994 has been the Minister for Foreign Affairs. The legislation requires the Director of Safeguards to prepare an Annual Report for presentation to Parliament.

Mr John Carlson was appointed as Director of Safeguards in 1989 and as the Director General, ASNO, on 31 August 1998 when ASNO was established. Mr Carlson was re-appointed on 7 June 2000 for a further term of three years.

Outline of CWC Role

The *Chemical Weapons (Prohibition) Act 1994* provides that the Minister may designate a particular office within a Department or agency for which the Minister is responsible, or a statutory office under legislation for which the Minister is responsible, as the office whose occupant is the Director, CWCO. On 11 March 1995 the Minister for Foreign Affairs designated the office of Director of Safeguards for this purpose.

The Director, CWCO, is required to prepare an Annual Report for presentation to Parliament, and to date this has been incorporated with the Annual Report of the Director of Safeguards.

Outline of CTBT Role

The Director, ACTBO, is likewise to be designated by the Minister under the *Comprehensive Nuclear Test-Ban Treaty Act 1998*. This Act will not commence until the CTBT enters into force—at present the CTBT is in provisional operation. Therefore the Director, ACTBO cannot as yet be formally designated. However, ASNO is already carrying out many of the tasks required of Australia's CTBT national authority and a report on these activities is included in this Report.

FUNCTIONS

The functions of the Director General, ASNO, include:

- ❑ ensuring the effective operation of the *Nuclear Non-Proliferation (Safeguards) Act 1987* and the *Chemical Weapons (Prohibition) Act 1994*, and fulfilment of Australia's obligations under the treaties these Acts implement;
- ❑ ensuring fulfilment of Australia's obligations under nuclear safeguards agreements, including the agreement with the International Atomic Energy Agency (IAEA) for the application of safeguards pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT);
- ❑ monitoring compliance with the provisions of bilateral nuclear safeguards agreements by Australia's treaty partners;
- ❑ undertaking, coordinating and facilitating research and development (R&D) in relation to nuclear safeguards;
- ❑ ensuring the timely and effective establishment of CTBT International Monitoring System (IMS) facilities in Australia, and undertaking preparations to meet the full range of Australia's obligations under the CTBT when it enters into force; and
- ❑ advising the Minister on nuclear non-proliferation and safeguards matters, and on issues related to CWC implementation and CTBT verification.

OVERVIEW OF SAFEGUARDS ROLE

In safeguards, ASNO has four main areas of responsibility:

- ❑ the application of safeguards within Australia;
- ❑ the physical protection and security of nuclear items in Australia;
- ❑ the operation of Australia's bilateral safeguards agreements; and
- ❑ contributing to the operation and development of international (IAEA) safeguards and the strengthening of the international nuclear non-proliferation regime.

IAEA safeguards are a key element in international action against the spread of nuclear weapons. Effective IAEA safeguards are of vital interest to Australia because of their contribution to global and regional peace and security. They are also important because they underpin Australia's stringent uranium export policies.

Key safeguards functions include:

- ❑ ensuring that nuclear material, associated material, equipment and technology in Australia is properly accounted for and controlled, and ensuring that requirements are met under Australia's safeguards agreement with the IAEA and bilateral agreements applying to nuclear material and items in Australia;
- ❑ pursuant to obligations under the Convention on the Physical Protection of Nuclear Material (CPPNM), and following IAEA guidelines, ensuring that appropriate security measures are applied to nuclear items in Australia;
- ❑ ensuring Australia's bilateral safeguards agreements are implemented satisfactorily, that is, to guarantee Australia's nuclear exports remain in exclusively peaceful use; ensuring that conditions which Australia places on the use of Australian Obligated

Nuclear Material (AONM), additional to IAEA safeguards, are met (these conditions are outlined on page 86);

- ❑ ensuring that all AONM is subject to IAEA safeguards, and verification of non-diversion is carried out by the IAEA;
- ❑ ensuring that any nuclear items other than nuclear material (i.e. associated material, equipment and technology) which are transferred to other countries are properly accounted for, and that the relevant records of Australia's partners are consistent with ASNO records;
- ❑ contributing to the development and effective implementation of IAEA safeguards through activities such as participation in expert groups and international meetings on safeguards, field testing of new safeguards methods in Australia, and presentation of regional training courses on safeguards techniques;
- ❑ managing Australia's Support Program for IAEA safeguards, which embraces R&D work and includes consultancy tasks for the IAEA;
- ❑ evaluation of the effectiveness of IAEA safeguards, and evaluation of non-proliferation aspects of nuclear fuel cycle developments, as a basis for advising Government;
- ❑ contributing to the development of Australia's policies in the area of disarmament and non-proliferation by colleagues in the International Security Division (ISD) of DFAT; and
- ❑ working closely on technical issues of common interest with agencies such as the Australian Nuclear Science and Technology Organisation (ANSTO), the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), the Defence Intelligence Organisation (DIO), and the Office of National Assessments (ONA).

OVERVIEW OF CWC ROLE

ASNO is the focal point in Australia for liaison between stakeholders, such as operators of declared facilities, the Organisation for the Prohibition of Chemical Weapons (OPCW), and the national authorities of other States Parties on issues relating to implementation of the Convention. ASNO's role here is primarily one of liaison and facilitation, to ensure that Australia's international obligations under the CWC are met while at the same time making certain that the rights of facility operators are protected. ASNO seeks to promote effective international implementation of the CWC, particularly in Australia's immediate region, by working with the OPCW and other States Parties in the resolution of outstanding technical implementation issues.

ASNO is also responsible for ensuring that the requirements of the *Chemical Weapons (Prohibition) Act 1994* are met, and may conduct national compliance inspections of relevant chemical facilities. While the Act makes provision for national inspectors to obtain mandatory access to sites, it is expected such powers will be exercised only in exceptional circumstances.

ASNO provides technical support to DFAT in development of a protocol to strengthen the Biological and Toxin Weapons Convention (BWC). Once the provisions of this protocol are settled, and as Australia moves towards protocol ratification, it is envisaged that ASNO will be expanded to embrace BWC responsibilities similar to those it holds under the CWC.

Key CWC functions include:

- ❑ identifying and gathering information on industrial chemical facilities and activities required to be declared to the OPCW;
- ❑ working with declarable facilities to prepare for the possibility of OPCW inspection;
- ❑ increasing awareness of the CWC and Australia's obligations by disseminating information on the Convention and the *Chemical Weapons (Prohibition) Act 1994* to the chemical industry and other domestic entities likely to be affected;
- ❑ administering and developing regulatory, administrative and logistical mechanisms to enable Australia to fulfil its CWC obligations;
- ❑ liaising with overseas counterpart organisations and with the Technical Secretariat of the OPCW in connection with technical and practical implementation issues;
- ❑ conducting research directed towards improving the effectiveness of the CWC's verification regime;
- ❑ assisting, upon request, other States Parties to implement the CWC, particularly in Australia's immediate region; and
- ❑ providing technical advice to support Australia's delegation at the negotiations to strengthen the BWC.

OVERVIEW OF CTBT ROLE

Although the CTBT has not yet entered into force, it is being applied on a provisional basis by those States that have signed it (States Signatories). The CTBT expressly provides (Article IV) that its verification system (the International Monitoring System—IMS) shall be capable of meeting the requirements of the Treaty at entry-into-force. The Preparatory Commission for the CTBT Organisation (CTBTO), with the CTBTO Provisional Technical Secretariat (PTS) and States Signatories, are therefore engaged in a very significant task even before the Treaty has come into force. This includes the establishment/upgrading of 337 monitoring facilities around the world, as well as the development of detailed procedures for the operation of these facilities and for the conduct of other verification activities such as On Site Inspections.

ASNO is the main point of contact between Australia and the Provisional Technical Secretariat in Vienna. Overall, the role is one of liaison and facilitation to ensure that the International Monitoring System is established efficiently and relevant domestic regulations are passed.

Key CTBT functions include:

- ❑ being the national point of contact for liaison on CTBT implementation;
- ❑ establishing and maintaining legal, administrative and financial mechanisms to give effect to the CTBT in Australia;
- ❑ developing arrangements for the operation of Australia's National Data Centre and preparing for possible on-site inspections in Australia;
- ❑ promoting an understanding in Australia of CTBT verification, including by acting as an interface between technical and policy specialists; and
- ❑ contributing to the work of the CTBTO Preparatory Commission and its working groups.

ADVICE TO THE GOVERNMENT

The staff of ASNO have substantial experience in international and bilateral safeguards, nuclear technology, CWC verification issues and CTBT processes and procedures. Drawing on this expertise and an international network of contacts in other governments and organisations, ASNO provides technical and policy advice to the Government and other bodies.

LEGISLATION

Nuclear Non-Proliferation (Safeguards) Act 1987

The *Nuclear Non-Proliferation (Safeguards) Act 1987* (the Safeguards Act) took effect on 31 March 1987. This Act establishes the statutory office of Director of Safeguards and forms the legislative basis for ASNO's nuclear safeguards activities.

The Safeguards Act gives effect to Australia's safeguards obligations under:

- ❑ the NPT;
- ❑ Australia's NPT safeguards agreement with the IAEA;
- ❑ agreements between Australia and various countries (and Euratom) concerning transfers of nuclear items, and cooperation in peaceful uses of nuclear energy; and
- ❑ the Convention on the Physical Protection of Nuclear Material (CPPNM).

Control over nuclear material and associated items in Australia is exercised under the Safeguards Act by a system of permits for their possession and transport. Communication of information contained in sensitive nuclear technology is controlled through the grant of authorities.

The Safeguards Act empowers the Minister to grant, vary or revoke permits or authorities, to make declarations or orders in relation to material, equipment or technology covered by the Act, and to appoint inspectors to assess compliance with the Act and with Australia's NPT safeguards agreement with the IAEA. The Minister has delegated most of these powers (with certain exceptions such as powers to make declarations and orders) to the Director of Safeguards.

Regulations and declarations under this Act are listed under the *Freedom of Information Act 1982* statements on page 92 of this Report.

Nuclear Non-Proliferation (Safeguards) (Consequential Amendments) Act 1988

The *Nuclear Non-Proliferation (Safeguards) (Consequential Amendments) Act 1988* took effect on 24 May 1988. It amended the *Patents Act 1952* to allow referral from the Patent Office to the Director of Safeguards of patent applications which might constitute 'associated technology' under the Safeguards Act. The amendments give the Director of Safeguards the power to direct that such a patent application lapse if the applicant does not hold an appropriate authority under the Safeguards Act to communicate sensitive information at the time of making the application for the patent.

Nuclear Safeguards (Producers of Uranium Ore Concentrates) Charge Act 1993

In conjunction with an amendment to the Safeguards Act, this legislation imposes an annual charge on uranium producers corresponding to a proportion of ASNO's operating costs. Further details are on page 23.

South Pacific Nuclear Free Zone Treaty Act 1986

The South Pacific Nuclear Free Zone Treaty (SPNFZ) Act 1986 prohibits the manufacture, production, acquisition, stationing and testing of nuclear explosive devices, and R&D relating to manufacture or production of nuclear explosive devices.

The SPNFZ Act establishes the framework for inspections in Australia by Treaty inspectors, and provides for appointment by the Minister for Foreign Affairs of authorised officers to accompany and observe international inspectors while they are in Australia. Inspectors appointed for the purposes of the Safeguards Act are also inspectors under the SPNFZ Act. These inspectors are to assist Treaty inspectors and authorised officers in carrying out Treaty inspections, and investigating possible breaches of the SPNFZ legislation in Australia.

Chemical Weapons (Prohibition) Act 1994

The *Chemical Weapons (Prohibition) Act 1994* was enacted on 25 February 1994. Division 1 of Part 7 of the Act (establishing the CWCO and the position of its Director), and sections 95, 96, 97, 99, 102, 103, and 104 were proclaimed on 15 February 1995. Other provisions of the Act which expressly relied on the CWC came into effect on 29 April 1997 when the CWC entered into force. The final parts of the Act, dealing with aspects of the CWC which came into effect in 2000, are to be proclaimed during 2000-2001¹.

In conjunction with other legislation (see under the following heading), the Act gives effect to Australia's obligations, responsibilities and rights as a State Party to the CWC. In particular, the Act:

- ❑ prohibits activities connected to the development, production or use of chemical weapons, including assisting anyone engaged in these activities, whether intentionally or recklessly—such offences are punishable by life imprisonment;
- ❑ establishes permit and notification systems to provide a legal framework for the mandatory provision of data to CWCO (ASNO) by facilities which produce or use chemicals as specified by the Convention, so that ASNO can lodge declarations with the OPCW;
- ❑ provides for routine inspections of declared facilities and challenge inspections of any facility or other place in Australia by OPCW inspectors to verify compliance with the CWC, and for inspections by CWCO to verify compliance with the Act; and
- ❑ provides for procedures should another State Party seek clarification concerning compliance with the Convention by any facility or other person or place in Australia.

Regulations under the Act prescribe procedures and details of other arrangements provided for in the Act. In particular, the Regulations define conditions that are to be met by holders of permits issued under the Act, and for granting privileges and immunities to OPCW inspectors when in Australia to carry out an on-site inspection.

1. The final parts of the Act were proclaimed in 17 August 2000.

The text of the CWC is reproduced in the Schedule to the Act. The manner in which any powers are exercised under the Act must be consistent with the Convention, and have regard to Australia's obligations under it.

The *Chemical Weapons (Prohibition) Act 1994* was amended on 6 April 1998. The amendments refine administration of the Act by simplifying compliance obligations for facilities requiring permits, clarifying the legislative basis for Australia to implement some of its obligations under the Convention, correcting drafting errors and improving certain procedures, including those related to secrecy. For consistency, concomitant Regulations were amended on 17 December 1998.

Other CWC related legislation

Other aspects of the CWC which required legislation have been, or are being, dealt with under existing legislation, in particular the:

- ❑ *Customs (Prohibited Exports) Regulations* and *Customs (Prohibited Imports) Regulations*, to enforce CWC obligations in relation to export and import controls on scheduled chemicals. The Customs (Prohibited Imports) Regulations were amended on 15 December 1999 to extend import licensing arrangements to cover all CWC scheduled chemicals; and
- ❑ *International Organisations (Privileges and Immunities) Act 1963*, to recognise the OPCW as an international organisation, and to grant appropriate privileges and immunities to its officers when in Australia for official purposes.

Comprehensive Nuclear Test-Ban Treaty Act 1998

The Act gives effect to Australia's obligations as a Party to the Comprehensive Nuclear-Test-Ban Treaty (CTBT). It prohibits the causing of any nuclear explosion at any place under Australian control and establishes a penalty of up to life imprisonment for an offence against the provision. The Act also prohibits Australian nationals from causing a nuclear explosion in any place outside Australian control.

The Act requires the Commonwealth Government to facilitate verification of compliance with the Treaty provisions, including the obligation to arrange for the establishment and operation of Australian monitoring stations and the provision of data from these. It provides the Commonwealth with the authority to establish IMS stations and to make provision for access to them for CTBT monitoring purposes. The Act also makes provision for the Minister for Foreign Affairs to enter into arrangements with the CTBT Organisation to facilitate cooperation in relation to monitoring stations under Australian control.

Australia is under an obligation, pursuant to Article IV of the Treaty, to allow CTBT Organisation inspectors to inspect any place in Australia or the external Territories in an on-site inspection. The Act provides comprehensive powers for inspection arrangements, including the right for inspectors to collect and remove samples and the right to undertake drilling. Access to facilities by inspectors for challenge inspections is by consent of the occupier or by warrant issued by a magistrate.

The Act establishes ACTBO (part of ASNO) as the Australian national authority for the CTBT. The Act grants ACTBO necessary legal capacity and provides for the power to make regulations with respect to privileges and immunities for the CTBT Organisation and its officials under Australian law in accordance with the Treaty.

The Act was assented to on 2 July 1998 but, as provided for in section 2 of the Act, will not come into effect until the CTBT enters into force.

Proposed legislative amendments

It is envisaged that amendments to relevant legislation will be introduced at a convenient time in order to formalise the amalgamation of ASO, CWCO and ACTBO into ASNO and to formally establish the position of Director General, ASNO.

NUCLEAR REGULATION IN AUSTRALIA

Australia has two nuclear regulatory agencies: ASNO and ARPANSA—the Australian Radiation Protection and Nuclear Safety Agency.

ASNO is responsible for nuclear safeguards and physical protection: ensuring that nuclear materials and nuclear items—facilities, equipment, technology and nuclear-related materials—are appropriately regulated and accounted for. An important part of this responsibility is ensuring that Australia's treaty commitments are met, particularly that nuclear activities are conducted for exclusively peaceful purposes.

ASNO's responsibilities cover nuclear materials—uranium, thorium and plutonium—not radioactive materials as such. ASNO's legislation applies to all persons or organisations in Australian jurisdiction having relevant materials, items or technology. Principally this applies to ANSTO, as Australia's only nuclear operator, but also covers a diverse range of other entities including the uranium mines and associated transport and storage operations, private sector laboratories, educational institutions, and patent attorneys. ASNO's activities are based on a number of constitutional heads of power, especially external affairs (meeting treaty requirements).

ARPANSA is a new Commonwealth agency (established in 1999), charged with responsibility for protecting the health and safety of people, and the environment, from the harmful effects of radiation (ionizing and non-ionizing). ARPANSA's responsibilities include:

- ❑ Promoting uniformity of radiation protection and nuclear safety policy and practices across jurisdictions of the Commonwealth, the States and the Territories;
- ❑ Providing advice to Government and the community on radiation protection;
- ❑ Providing advice to Government and the community on nuclear safety—reactors and visits by nuclear powered warships;
- ❑ Undertaking research and providing services in relation to radiation protection, nuclear safety and medical exposures to radiation;
- ❑ Regulating radiation protection and nuclear safety aspects of all Commonwealth entities involved in radiation or nuclear activities or dealings; and
- ❑ Approval of imports of radioactive material.

The limitation of ARPANSA's general regulatory powers to Commonwealth entities reflects the situation that in Australia the primary constitutional responsibility for radiation health and safety matters rests with the State governments.

THE YEAR IN REVIEW

KEY RESULTS FOR ASNO:

- ❑ **All relevant statutory and treaty requirements met:**
 - **All nuclear material and associated items in Australia accounted for.**
 - **All Australian Obligated Nuclear Material accounted for.**
 - **Full compliance with CWC demonstrated.**
- ❑ **Effective contribution to strengthening international verification regimes.**

ASNO's principal responsibilities are, to ensure that Australia is in compliance with its international treaty commitments to prevent the proliferation of weapons of mass destruction, and to contribute to the development of strengthened non-proliferation verification regimes. Its primary focus is thus international and national security. ASNO's activities are also central to Government policy regarding the mining and export of uranium.

ASNO is a unique organisation both for DFAT and the Australian Government, working at the interface of policy and technical (science and engineering) knowledge. ASNO makes a major contribution to DFAT policy making, and at the same time pursues policy objectives in its own right in a complex and specialised area of international relations. Additionally, ASNO exercises important regulatory responsibilities under the *Nuclear Non-Proliferation (Safeguards) Act 1987* and the *Chemical Weapons (Prohibition) Act 1994*. Drawing on its sound base of technical expertise, ASNO also makes a significant contribution to Australian Intelligence Community assessments.

As a centre of technical excellence, ASNO has accrued significant professional skills and expertise (which are hard to find and maintain in Australia). It provides DFAT with a critical source of long term, stable, professional staff with its own international network of specialised knowledge.

Despite the disadvantages of a small skills base, and its distance from major international centres of political and industrial activity in relevant fields, ASNO has built a high reputation amongst counterparts worldwide, and is a major contributor to Australia's position as an effective and constructive participant in the non-proliferation regimes.

The IAEA is charged with preventing the proliferation of nuclear weapons, while ensuring that the benefits of nuclear technology are available for peaceful purposes. The IAEA is considered by the international community to be a highly effective organisation. During the year steady progress was made in the development of measures and procedures for strengthening the safeguards system. Other areas of significant progress included the development of verification measures for nuclear material released from the US and Russian weapons programs.

The role of the IAEA, and international efforts to promote nuclear restraint and eventual disarmament, were enhanced by a successful NPT Review Conference in April/May 2000.

Nevertheless, the nuclear non-proliferation regime faces some challenges, and it is noted that the IAEA, in its annual safeguards statement (see page 84), reported unfavourably once again on the safeguards situation in Iraq and the DPRK. Other setbacks for the non-proliferation regime included the continued failure to secure the necessary ratifications for the CTBT to enter into force, and the continuing delay in the commencement of FMCT negotiations.

During the year the heads of all three international non-proliferation agencies—the Directors General of the IAEA and the OPCW and the Executive Director of the CTBTO Preparatory Commission—visited Australia. In addition, the heads of ASNO's counterpart organisations in Indonesia, Japan and the ROK all visited in connection with the regional safeguards training course, mentioned below.

INTERNATIONAL SAFEGUARDS

Key ASNO roles are: to develop and promote effective international nuclear non-proliferation and safeguards arrangements; to evaluate the efficacy of these arrangements; and to evaluate nuclear fuel cycle developments and implications for safeguards implementation as a basis for advising Government. A vital component of ASNO's core business is support for the IAEA through a safeguards R&D program—part of which involves collaboration with other countries, in particular longstanding collaboration with the US.

Throughout the year, ASNO made a substantial contribution to the development of strengthened IAEA safeguards and the integration of strengthened safeguards with the established (classical) safeguards system. ASNO is working closely with the IAEA to develop the procedures and methods required to effectively implement the IAEA's authority and responsibilities as the Additional Protocol enters general application, as well as the specific arrangements which will apply in Australia. In the latter context, ASNO offers the IAEA a safeguards-friendly environment, together with constructive critique, to assist in the development and testing of new techniques. This work is important in ensuring the effective implementation of strengthened safeguards elsewhere. On behalf of the IAEA, ASNO planned and managed a regional training course on national safeguards in Sydney and Canberra (March—April 2000) which was highly regarded by the Agency. Eleven regional States were represented, including participants from the DPRK.

ASNO is participating in an international review of the Convention on the Physical Protection of Nuclear Material (CPPNM), which is considering whether there is a need to strengthen the commitment of States to apply internationally agreed standards of physical protection (security).

BILATERAL SAFEGUARDS

ASNO is responsible for ensuring that all AONM (Australian Obligated Nuclear Material, i.e. exported uranium and nuclear material derived from these exports) is accounted for in accordance with bilateral agreements, and that AONM is used for exclusively peaceful purposes. In this work, ASNO supports DFAT with the negotiation and review of safeguards agreements, and is responsible for the implementation of these agreements. This year ASNO and DFAT made substantial progress on several new bilateral nuclear safeguards agreements. An agreement with the US covering transfer of the Silex laser enrichment technology came into force, and ASNO is now working with US authorities to

develop the detailed administrative arrangements required to give effect to this agreement. Also concluded during the year was an agreement with New Zealand covering transfers of uranium for non-nuclear use (as a colouring agent in glass manufacture).

As in previous years, all AONM under Australia's various bilateral agreements was satisfactorily accounted for.

DOMESTIC SAFEGUARDS

As mentioned above, ASNO has developed and implemented new safeguards arrangements in Australia under the Additional Protocol for strengthened safeguards. The IAEA is continuing to develop its approaches for exercising complementary access, and this year visited the Defence establishment at DSTO Salisbury as well as a range of buildings at Lucas Heights. For the first time, the IAEA provided 'whole of State' assessments in its annual Safeguards Implementation Report (SIR). As the State furthest advanced in the implementation of the Additional Protocol, Australia was one of two States mentioned in this regard (see page 84). The work undertaken by ASNO during and since the IAEA complementary access to the Ranger uranium mine in 1999 has uniquely enabled the IAEA to develop procedures and analysis methodologies for this type of evaluation, and enhanced its strengthened safeguards work.

One major activity for ASNO is monitoring the progress of the Silex project, mentioned above (also on page 24), to ensure that, as soon as appropriate, the technology is declared 'associated technology' and controlled in accordance with relevant legislative and treaty requirements. In anticipation of this, ASNO has already taken steps to effectively protect this technology against unauthorised access. In evaluating the status of the Silex project, ASNO is working closely with US authorities.

ASNO is working closely with ANSTO to ensure that nuclear material accountancy and control at Lucas Heights accords with best international practice, particularly having regard to the requirements of the IAEA under integrated safeguards.

CWC (INCLUDING BWC ISSUES)

ASNO has maintained an excellent professional relationship with the OPCW and counterpart national authorities, particularly in our region. Consequently, we have been able to promote effective and efficient CWC verification arrangements in a number of States Parties. As part of our regional outreach, ASNO has helped Indonesia and Vietnam to establish their CWC implementation arrangements. ASNO has provided expert support to DFAT in the negotiation of a protocol to strengthen the BWC. ASNO has made a strong contribution to the BWC National Consultative Group (NCG) coordinated by DFAT, specifically in the area of how 'declaration triggers' might be strengthened.

This has been a busy year in which new arrangements under the facility inspection regime, extending it to unscheduled discrete organic chemical (DOC) production sites, have come into force. To prepare industry, ASNO has implemented an extensive industry outreach program. Also, ASNO has facilitated four OPCW inspections across the full range of scheduled facilities. The OPCW has given each site visited a clean bill of health and reported favourably on ASNO's highly professional management of the inspections.

Revised import arrangements affecting certain Scheduled chemicals also came into effect during the year. ASNO has been active in implementing these requirements, including

through developing arrangements designed to minimise burdens on industry while ensuring Australia's obligations under the CWC are fully met. This work has entailed an extensive industry outreach program, including the publication of explanatory guidelines, and the issue of approximately 30 import permits to date.

CTBT

Over the past 12 months, ASNO has strengthened its role as the provisional CTBT national authority. ASNO's relationship with the CTBTO Preparatory Commission and its Provisional Technical Secretariat in Vienna has been strengthened and ASNO has made further progress towards establishing the Australian components of the International Monitoring System. In March 2000, during his visit to Australia, Dr Hoffmann, Executive Director of the Preparatory Commission and Mr Downer signed an arrangement to facilitate the establishment and effective operation of IMS stations in Australia. ASNO has identified key issues which must be resolved before the full IMS can be operated here, and has made a good start to resolving these matters, which include: inter-agency issues; long-term management of the IMS in Australia; and establishing green field sites for the IMS (Cape Leeuwin). By drawing on its safeguards and CWC expertise, ASNO has also been able to boost Australia's contribution to the development of verification procedures for the CTBT's On Site Inspection mechanism.



ASNO and OPCW inspectors using a GPS system during an inspection— photograph courtesy of Wesfarmers CSBP Ltd

OUTLOOK: THE YEAR AHEAD

Despite a satisfactory outcome from the 2000 NPT Review Conference, there are still some major challenges to be addressed in making further progress towards the reduction and eventual elimination of weapons of mass destruction. While neither India nor Pakistan has conducted full scale nuclear tests since 1998, neither shows any signs of winding back its nuclear weapons programs or signing the CTBT in the near future. The security of fissile material in Russia continues to be the focus of international programs. Concluding a protocol to strengthen the BWC, and unlocking the work program of the Conference on Disarmament (CD) to enable commencement of negotiations on the FMCT, are other areas requiring major effort.

Generally, States have been slow to conclude Additional Protocols, and the hope that the Protocol would have become the safeguards norm by the 2000 NPT Review Conference was not realised. As at 30 June 2000, there were only 11 Protocols in effect, though a further 44 Protocols had been signed or approved by the IAEA Board of Governors, and ratification of these can be expected during the year as the necessary legislation is put in place. However, this leaves 23 non-nuclear-weapon States Party to the NPT that have nuclear activities but as yet have made no commitment to conclude Additional Protocols. A major priority for 2000-01 will be continuing encouragement for other States to conclude their Protocols as quickly as possible, so that strengthened safeguards measures can be brought into general application without delay.

In the nuclear non-proliferation/safeguards area, ASNO will continue to work closely with the IAEA and our counterpart organisations in the further development of strengthened and integrated safeguards. ASNO expects to commence significant new projects under our safeguards R&D program in support of the IAEA, in collaboration with the US. ASNO will also be closely following developments in nuclear technology, with regard to their possible non-proliferation implications.

Notwithstanding difficulties in the Conference for Disarmament, ASNO will continue to develop technical proposals in support of the FMCT, under which the production of fissile material for nuclear weapons would be prohibited. ASNO has established itself internationally as a leader in this area. The FMCT will be complementary to the CTBT—together they would place a quantitative cap on the nuclear material available for weapons and a qualitative cap on nuclear weapon development.

The initial phase of the international review of the CPPNM is likely to be concluded, and ASNO expects there will be follow-up work to progress this review to a more formal stage, possibly leading to a revision of the Convention.

ASNO is engaged in informal discussions with regional counterparts on possibilities for increasing cooperation on safeguards matters, and hopes to progress this work during the year.

Work on the operation of Australia's bilateral safeguards agreements is ongoing. In the coming year ASNO will participate in nuclear policy discussions with Japan, the ROK and Euratom. Also there will be technical discussions with ASNO's counterparts on holdings of AONM and on international safeguards issues. Of relevance both to ASNO's bilateral and domestic activities, it is expected that arrangements for the transfer of Silex laser enrichment technology to the US will come into operation, and a determination is likely to be made that Silex is 'associated technology' under the Safeguards Act.

ASNO will be working closely with ANSTO on physical protection aspects of the replacement research reactor project, and will be collaborating with DFAT on international matters associated with this project.

As Australia's national authority for the CWC, ASNO will collect national information for, and make declarations to, the OPCW, while facilitating OPCW inspections of relevant facilities in Australia. Similarly, we will strive to strengthen the CWC verification regime by, *inter alia*, helping to resolve outstanding technical implementation issues, particularly those affecting industry. In conjunction with the OPCW and the Royal Australian Chemical Institute, ASNO will co-host, in May 2001, a regional conference designed to enhance knowledge of the CWC among government and non-government organisations and to promote the peaceful application of chemistry.

Pending the conclusion of negotiations for a protocol to strengthen the BWC (with its attendant national responsibilities and obligations) and formal establishment of a BWC national authority, ASNO will provide technical support to DFAT for the negotiations, which could be concluded in 2000-01.

ASNO will work to ensure that Australia's CTBT obligations are met, primarily by coordinating the establishment and operation of Australian stations in the Treaty's International Monitoring System. ASNO will also make a significant contribution to development of procedures for the conduct of an On-site Inspection under the CTBT.

RESOURCES OVERVIEW: CORPORATE MANAGEMENT

ASNO is required, as part of a Commonwealth Department and in accordance with subsection 50(1) of the *Audit Act 1901*, to submit to the Auditor-General an annual Financial Statement. Details relating to that Financial Statement are contained in the Department of Foreign Affairs and Trade (DFAT) Annual Report for 1999-2000 and salaries are managed centrally in the Department.

ASNO continued to review its administrative and accounting procedures during the reporting period. Revised and new instructions or guidelines issued by DFAT, the Department of Finance and Administration and other regulatory bodies were implemented where applicable.

Further details of ASNO activities relating to financial management and performance, occupational health and safety, industrial democracy and advertising are included in the DFAT Annual Report for 1999-2000.

STAFFING

During 1999-2000 ASNO was staffed on a basis similar to a DFAT Division. The Director General holds the statutory office of Director of Safeguards, established under the *Nuclear Non-Proliferation (Safeguards) Act 1987*. All other staff were employed under the *Public Service Act 1999*, on a full-time basis.

Table 1—Details of ASNO Budget and Expenditure 1999-2000.

	1998-99 Actual	1999-00 Actual
Salaries	\$778,268	\$912,887
Administrative Costs	\$587,906	\$487,761
Total	\$1,366,174	\$1,400,648

During 1999-2000 the following staff changes occurred:

The Department approved an increase of one in ASNO's staffing level. This was highly appreciated, enabling ASNO to place in its International Safeguards Section an officer returning from a four-year secondment to the IAEA.

On 23 June 2000 Mr John Hill, Head of the International Safeguards Section and a longstanding member of ASNO, resigned from the APS. Dr Victor Bragin, Safeguards Adviser, was transferred to Mr Hill's position, and recruitment action was set in train to fill the resulting vacancy.

In view of the highly specialised nature of ASNO's work, it has been an ongoing challenge to ensure the recruitment and retention of suitably skilled staff and the maintenance of their expertise. This is particularly the case for nuclear safeguards. Given the limited extent of nuclear activities in Australia, and the international orientation of safeguards, practical experience in international safeguards primarily has to be obtained overseas. Staff who retire or resign cannot be easily replaced. ASNO has particular needs which are relatively unusual in Public Service terms: these include availability of funding sufficient to second

staff overseas for extended periods for professional development, and maintenance of an overall level of staff sufficient to provide the flexibility for such secondments and to guarantee continuity of expertise in the face of staff movements.

In 1999-2000 ASNO's level of professional staff engaged on nuclear issues was seven—ASNO continues to perform well despite this modest number by virtue of the high degree of expertise and efficiency of current staff members. With key staff members at or approaching retirement age, maintaining a core of technical excellence will remain a challenge for the foreseeable future.

Table 2—Categories of Staff at 30 June 2000—approved and actual (in brackets)

	<i>Male</i>	<i>Female</i>	<i>Total</i>
SES B2	1		1
SES B1	1		1
Executive level 2	4		5 (4)
Executive level 1	2		2
APS level 6	1		1
APS level 5		2	2
APS level 2	1		1
Total	10	2	13 (12)

ORGANISATION OF ASNO AT 30 JUNE 2000

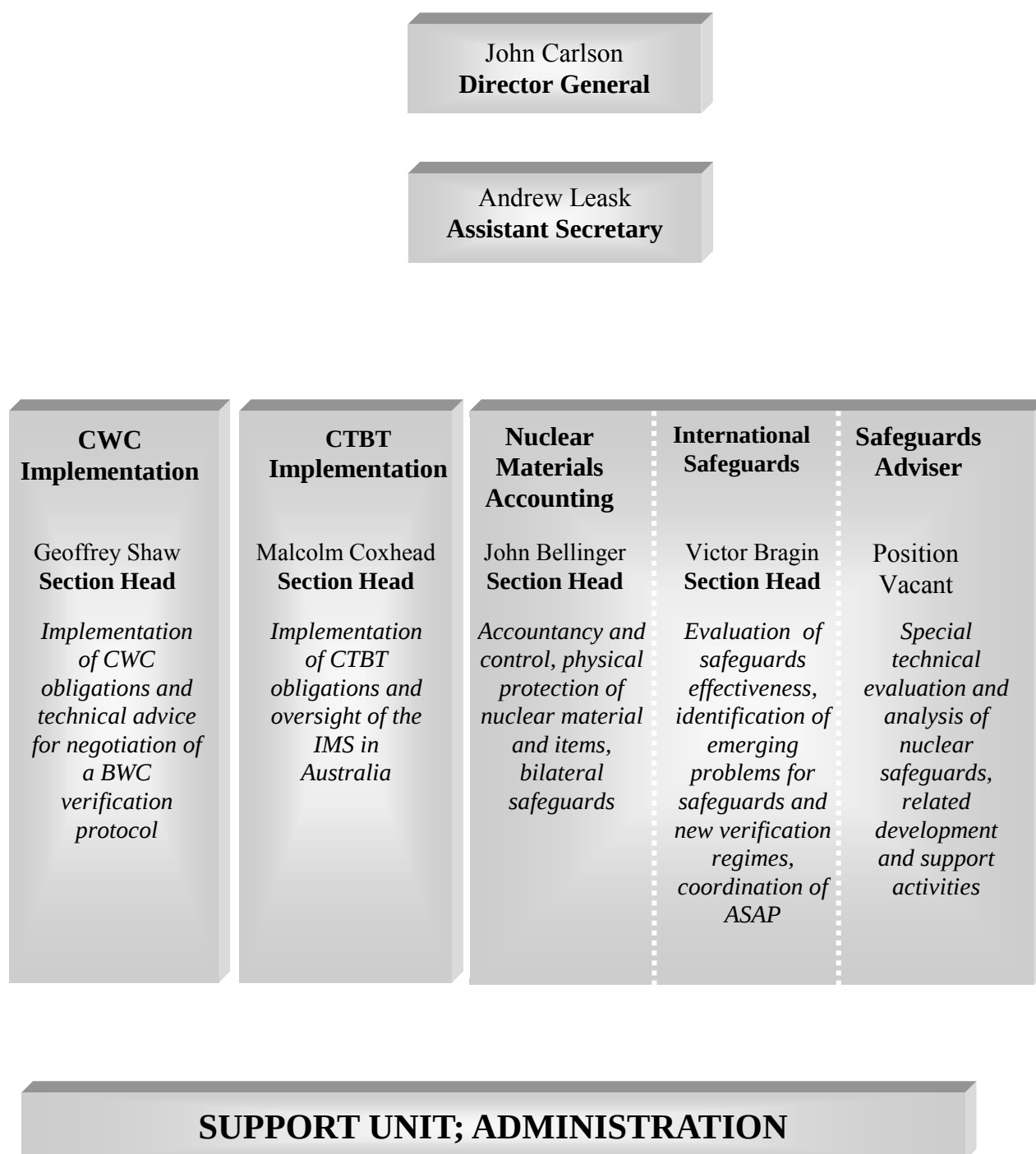


Figure 2—ASNO Organisational Chart

(Note—Following the resignation of John Hill on 23 June 1999 Victor Bragin was appointed Section Head).

(Action for the recruitment of a suitable Safeguards Adviser is at an advanced stage).

PERFORMANCE INDICATORS FOR ASNO

ASNO has tracked its performance against specific indicators relating to key aims and organisational groupings. This information is presented below from two differing perspectives. The first relates to the number of events of each type in which ASNO was involved. The second relates to the number of person-days of effort expended in each type of activity.

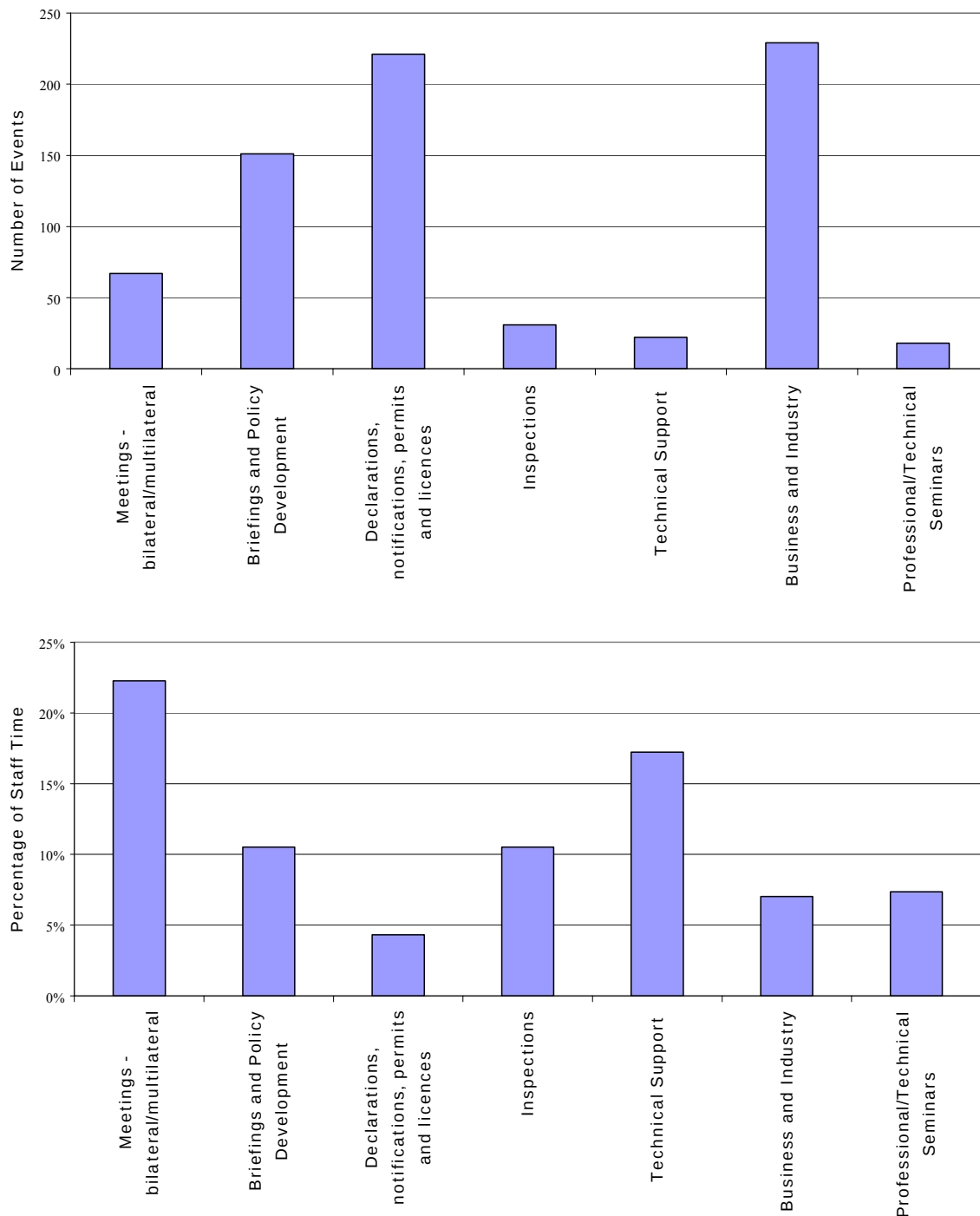


Figure 3—ASNO's performance against specific aims and organisational groupings
Note that figures for percentage of staff time include all preparation, planning, attendance and follow-up action where relevant.

URANIUM PRODUCERS CHARGE

Uranium producers pay an amount that has generally corresponded to 40% of ASNO's annual costs for safeguards activities.

The current arrangements were introduced through the *Nuclear Safeguards (Producers of Uranium Ore Concentrates) Act 1993*, to recover some of the costs of ASNO's activities which the then Government decided were of significant benefit to industry. The Act provides for each producer to pay an annual charge, prescribed by regulation, up to a maximum of \$500,000.

Following a review as part of the Government's overhaul of business regulation, in June 1997 it was recommended that the charge on uranium producers be retained, but in a different form—the charge would be a 'safeguards fee' per kilogram of production—which was seen as a fairer mechanism than the previous flat fee. The fee would include a component for future costs, that is, the ongoing costs in respect of AONM which could remain in the fuel cycle for a considerable period after the originating mine had ceased production.

In November 1999 the fee was set at 8.6456 cents per kilogram of contained uranium produced during 1998–99, which yielded \$468,260 for Consolidated Revenue.



View of Australia's next uranium mine—photograph courtesy Heathgate Resources Pty Ltd

PROGRAM ACTIVITIES

ASNO's activities in 1999-2000 are described and evaluated in the following sections.

Activities are described in relation to particular tasks, and grouped according to the output to which they relate (for summary of outcomes and outputs see page 3).

OUTPUT A—OPERATION OF SSAC

Operation of Australia's national system of accounting for, and control of, nuclear material and items subject to IAEA safeguards, including promotion and regulation, within Australia, of effective measures for the physical protection of nuclear facilities and material.

MILESTONE A1

A1.1 The provisions of the *Nuclear Non-Proliferation (Safeguards) Act 1987* administered effectively.

A1.2 The continued adequacy of the Act's provisions reviewed and evaluated.

A1.3 Under the Act's Permit System, nuclear items in Australia—including those subject to bilateral safeguards agreements—controlled and accounted for effectively.

Activities

Permits and authorities

During the year two new permits or authorities under the Safeguards Act were issued, none expired and none were revoked. The conditions of three permits were varied.

Table 3—Status of Safeguards Permits and Authorities in Australia

Permit or Authority to:	Granted	Varied	Expired	Number at End of Period
Possess nuclear material	1	3	0	31
Possess associated items	0	0	0	21
Transport nuclear material	1	0	0	22
Transport associated items	0	0	0	0
Communicate information contained in associated technology	0	0	0	17
Total	2	3	0	91

Laser enrichment R&D

An Australian company, Silex Systems Limited, is researching an innovative method of separating uranium isotopes using laser techniques. In 1996 the company entered into an agreement with the United States Enrichment Corporation (USEC) to explore the commercial potential of this technology. In the first phase, Silex demonstrated the technology to USEC specialists. If further development work in successive phases is successful, the technology may be commercialised in the United States—this aspect is discussed further under Milestone B2 (on page 29).



Development of Silex enrichment technology — photograph courtesy of Silex Systems Ltd

ASNO is following the progress of this research closely, since the Silex technology will have to be classified as ‘associated technology’ and ‘associated equipment’ under the Safeguards Act if it proves practicable for the enrichment of nuclear material, or if it is considered that details of the technology could be useful for others working in the enrichment field. ASNO’s objective here is to ensure that nuclear technology remains in exclusively peaceful use and does not contribute to any proliferation efforts. Classification as ‘associated technology’ will have the result of restricting access to the technology to authorised persons. ASNO is also concerned to ensure that all IAEA reporting requirements with respect to nuclear-related R&D are met. In anticipation that the Silex process may become ‘associated technology’, ASNO has already put in place appropriate security measures to ensure against unauthorised access.

Data reported pursuant to the Safeguards Act

As required by sub-section 51(2) of the Safeguards Act, details of nuclear material and associated items of Australian origin, and nuclear material and associated items within Australia, regardless of origin, are set out in Annexes to this Report as follows:

- Annex A: Nuclear Material within Australia at 30 June 2000.
- Annex B: Associated Items within Australia at 30 June 2000.
- Annex C: Australian Obligated Nuclear Material Overseas:
 - (i) Locations and Quantities of AONM at 31 December 1999.
 - (ii) Transfers of AONM during 1999.

As in previous years, no associated items of Australian origin are located overseas.

ASNO also provides the Australian National Audit Office with a statement each year of holdings of nuclear items by ANSTO.

Performance Assessment

Administration of the Permit System was carried out in a timely manner, with all changes published in the Commonwealth of Australia Gazette as required by the Safeguards Act. All nuclear material and nuclear items within Australia were satisfactorily accounted for as at 30 June 2000.

MILESTONE A2

IAEA safeguards implemented satisfactorily in Australia.

Activities

Australia's State System of Accounting for and Control of Nuclear Material (SSAC) is operated by ASNO in accordance with Australia's safeguards agreement with the IAEA. ASNO reports to the IAEA on the disposition of nuclear material in Australia and assists inspections carried out by the IAEA at Australian facilities.

Reports on the disposition of nuclear material

Each month an ASNO officer carries out an audit of the inventory of nuclear material at the ANSTO site at Lucas Heights (near Sydney), which is the principal location of safeguardable nuclear material in Australia. Changes during the month in that inventory (as well as any changes elsewhere in Australia) are reported by ASNO to IAEA headquarters in Vienna. Accounting reports are also given to the IAEA by ASNO following the IAEA inspections described below.

Details of Australian Accounting Reports to the IAEA during the year are at Annex D.

IAEA inspections in Australia

As in other countries covered by IAEA safeguards, the Agency carries out routine inspections of Australian nuclear facilities. The aim of these inspections is to verify that nuclear material inventories are as declared by the operator and the SSAC. Each inspection

deals with what is described as a Material Balance Area (MBA), of which Australia has five, as listed in Table 4.

IAEA inspectors visited Australia on 5 occasions during 1999-2000 to carry out routine inspections (see Annex D for details).



ASNO inspector assists IAEA in collection of environmental samples—photograph courtesy of ANSTO

Table 4—Material Balance Areas in Australia

<i>Location</i>	<i>MBA</i>	<i>Facility</i>
ANSTO	AS-A	HIFAR reactor
ANSTO	AS-B	Moata reactor ²
ANSTO	AS-C	Research and Development Laboratories
ANSTO	AS-D	Vault Storage
Elsewhere	AS-E	Other locations in Australia

ASNO, as the national safeguards authority, acts as the intermediary between the IAEA and the facility operator on all safeguards matters. An ASNO officer accompanies IAEA inspectors during inspections in Australia. The officer ensures the inspectors are able to carry out their duties, so that Australia meets its obligations, and mediates on any issues arising between the IAEA and the facility operator. In particular, ASNO assists in the resolution of any inconsistencies discovered during inspections, thus simplifying the IAEA inspectors' task.

A major focus of IAEA inspection activity is the identification and evaluation of 'material unaccounted for' (MUF), that is, the difference between the records maintained by the operator (the 'ending book inventory') and the physical inventory verified by the IAEA. Since MUF is the difference between two measured quantities, it may be equal to zero, or it may be either a positive or negative value. If MUF is positive it does not necessarily indicate that material has been lost, nor does a negative figure mean that material has somehow been created. In the normal course, some measurement differences are expected. There was a small MUF of enriched uranium declared for MBA AS-C (R&D Laboratories) during the year. The Physical Inventory for this MBA was less than the Book Inventory by 4.73 grams of uranium element and 0.10 grams of U-235 isotope.

The IAEA reports all conclusions drawn from its routine safeguards inspections in Australia, including comments on any MUF, in the statements provided pursuant to Article 91(b) of Australia's NPT safeguards agreement. A summary of Statements provided during the year for Material Balance Areas AS-A, B, C and D and an explanatory note on MBA AS-E are at Annex E of this Report.

Declaration of Safeguards Inspectors

Under section 57 of the Safeguards Act, the Minister may declare a person to be an Inspector for the purposes of the Act. In practice, this applies only to officers of ASNO. The role of an Inspector is to ensure compliance with provisions of the Safeguards Act and to assist IAEA inspectors in the conduct of Agency inspections in Australia. No new national inspectors were declared in 1999-2000.

The Minister may declare a person designated by the IAEA as an 'Agency Inspector' for the purpose of the Safeguards Act. In practice, all IAEA staff designated to Australia are declared under the Safeguards Act—there were 21 new designations during 1999-2000. There are currently 181 IAEA staff declared as Agency Inspectors pursuant to the Act.

2. In February 1995 the ANSTO Board decided to cease operation of Moata, and the reactor was defuelled in May 1995.

Since 1990, inspector appointment and declaration powers have been delegated by the Minister to the Director of Safeguards.

Performance Assessment

All routine IAEA inspections were concluded satisfactorily and all apparent discrepancies were resolved.

IAEA statements during 1999-2000 confirm that all of Australia's IAEA safeguards obligations were discharged satisfactorily and, specifically, that Australia's records had been maintained in accordance with prescribed practice. ASNO's reporting fully satisfies IAEA requirements.

The IAEA has never found cause to comment adversely on Australia's accounting for and control of nuclear material—a fact reflected in Article 91(b) statements over the years.

MILESTONE A3

A3.1 Appropriate physical protection measures for nuclear material in Australia reviewed; sites holding nuclear items audited to ensure that prescribed physical protection measures have been implemented effectively.

A3.2 Sites holding nuclear items audited to ensure that prescribed physical protection measures have been implemented effectively.

Activities

Physical Protection within Australia

ASNO is responsible for prescribing the levels of physical protection, or security, to be applied to nuclear items subject to the Safeguards Act. During the year, inspections were carried out of the physical protection measures applied at ANSTO. Inspections were also carried out of the physical protection measures applied at, and in connection with, the uranium mining operations in South Australia and the Northern Territory. In addition, regular inspections were made of the arrangements put in place for the protection of potentially sensitive information relating to the Silex laser enrichment R&D project.

Performance Assessment

Physical protection requirements prescribed by ASNO are consistent with the most recently agreed international standards.

All physical protection inspections undertaken by ASNO had satisfactory outcomes: ANSTO, the uranium mines and associated operations, and Silex were all confirmed to be applying appropriate levels of physical protection.

OUTPUT B—BILATERAL SAFEGUARDS

Development and implementation of bilateral safeguards measures that ensure nuclear material and items exported from Australia remain in exclusively peaceful use.

MILESTONE B1

Internationally agreed standards for physical protection of nuclear material are applied to all AONM.

Activities

ASNO continued its practice of requiring exporters to adopt specific procedures to ensure appropriate levels of physical protection for shipments of uranium ore concentrates (UOC) from Australia to the port of unloading overseas. These procedures included checking on the physical condition of the containers and verifying the container and seal numbers at each port of unloading or transshipment.

ASNO is involved in the development of international standards for physical protection of nuclear material, and uses suitable opportunities to promote their universal adoption. For example, from 15-19 November 1999, at the IAEA in Vienna, Mr John Bellinger, Head, Nuclear Materials Accountancy and Control (NMAC) Section, participated in an Informal Open-Ended Experts Meeting to discuss whether there is a need to revise the Convention on the Physical Protection of Nuclear Material (CPPNM). In order to reach a decision on this, the Experts Meeting established a Working Group which met from 19-26 February and 26-30 June 2000. Mr Bellinger participated in each of these Working Group meetings and Mr Andrew Leask also attended the June meeting. The Experts intend to finalise their deliberations by April 2001 and then reconvene in plenary in May 2001 to make a final decision on the original question of whether there is a need to revise the CPPNM. ASNO will participate in all stages of this important series of meetings.

Performance Assessment

Reporting by conversion facilities, safeguards authorities and shipping agencies confirms that all AONM shipments from Australia safely reached their destinations. The specified physical protection measures effectively contributed to this outcome.

MILESTONE B2

AONM in countries with which Australia has concluded nuclear safeguards agreements is accounted for in accordance with procedures and standards prescribed under relevant agreements.

Activities

Exports of Uranium Ore Concentrates (UOC)

Between 1 July 1999 and 30 June 2000 there were 46 shipments of UOC from Australia. These were made by Energy Resources of Australia Ltd (ERA), Ranger Mine, Northern Territory and WMC (Olympic Dam Corporation) Pty Ltd, South Australia. Exports totalled 8,023 tonnes of U₃O₈ as UOC; export earnings were over \$367 million. Further information on Australia's uranium exports is at page 85.

The UOC were shipped to conversion facilities in the UK, the US, France and Canada. ASNO notified each export to the safeguards authorities in relevant countries. In each case, receipt was confirmed to ASNO by those safeguards authorities. ASNO also notified the IAEA of each export. In the case of exports to Canada, notifications were made pursuant to Article 35(a) of Australia's NPT safeguards agreement with the IAEA. In the case of exports to nuclear-weapon States, notifications were made under the IAEA's Voluntary Reporting Scheme, and also under the Additional Protocol.

The shipper's weight for each consignment was entered on ASNO's record of the relevant country's inventory of AONM. These weights, subject to amendment by measured

Shipper/Receiver Differences, are the basic source data for ASNO's system of accounting for AONM throughout the international nuclear fuel cycle.

Operation of bilateral agreements

Reports from ASNO's counterpart organisations were provided in a timely fashion and in the agreed format which enabled straightforward analysis and reconciliation with ASNO's records.

During May and June 2000, Mr John Bellinger and Nuclear Materials Accountant, Mr Nick Doulgeris, held discussions with ASNO's counterpart organisations in the US, Canada, Japan, the ROK, the UK and Euratom. Accounting figures were reconciled and a range of issues were discussed. Reconciliation of inventories presented few problems. Progress was made in improving the bilateral safeguards system, and there were useful exchanges of experience. As an outcome of bilateral consultations with Euratom in Brussels in November 1999, ASNO and its counterpart the Euratom Safeguards Office (ESO) have established a series of regular meetings which have proved invaluable in understanding ESO's accounting for AONM in the European Community.

Laser enrichment technology

The laser enrichment R&D being undertaken by Silex Systems Limited has produced technology which it is expected will be classified as 'associated technology' under the Safeguards Act in the near future. To enable the technology to be transferred to the US for further development, as envisaged in Silex's agreement with USEC, Australia has concluded a new treaty-level agreement with the US, to ensure the technology is used for exclusively peaceful purposes. This agreement was signed in Washington on 28 October 1999 and entered into force on 24 May 2000.

Performance Assessment

Based on reporting and analysis, ASNO concludes that all AONM is satisfactorily accounted for.

ASNO's counterparts have confirmed receipt of all relevant exports in accordance with the requirements of the bilateral safeguards agreements. In addition, the IAEA provides ASNO with regular acknowledgments of ASNO's notifications of international transfers of nuclear material to and from Australia. The IAEA has confirmed that, as at 14 June 2000 there were no outstanding unconfirmed shipments to Australia (i.e. imports). Similarly, receipt of all of Australia's exports up to 13 January 2000 has been confirmed by the IAEA's transit matching system.

As at 30 June 2000 ASNO had satisfactorily accounted for AONM located overseas through, *inter alia*, the annual reports (made pursuant to bilateral agreements) and other information provided by relevant bilateral treaty partners, namely Canada, Euratom, Finland, France, Japan, ROK, Sweden, Switzerland, the UK and the US. Reports were not provided by Australia's other bilateral partners, the Philippines, Egypt, the Russian Federation, Mexico and New Zealand, as there was no AONM in those countries.

Based on the fact that AONM located overseas is satisfactorily accounted for and under IAEA safeguards, and drawing on the IAEA's Safeguards Statement for 1999 (see page 84), ASNO concludes that no AONM has been used for non-peaceful purposes.

OUTPUT C—INTERNATIONAL SAFEGUARDS

Contribution to the development and effective implementation of international safeguards and Non-proliferation regimes, including participation in international expert groups and conferences, and provision to the IAEA of consultancies, assessments, support in R&D and training; and evaluation of the effectiveness of IAEA safeguards and related regimes.

MILESTONE C1

C1.1 A pro-active and useful contribution made to the development and effective implementation of IAEA safeguards, with national and international safeguards methods evaluated in an expert and thorough manner.

Activities

Australia takes an active part in the development of safeguards, through activities such as:

- ❑ participation in SAGSI (the Standing Advisory Group on Safeguards Implementation) and other international expert bodies (see below);
- ❑ the Australian Safeguards Assistance Program (ASAP), comprising R&D and consultancy work in support of IAEA safeguards (see Milestone C3 on page 35);
- ❑ field testing of new safeguards techniques and approaches in Australia on behalf of the IAEA;
- ❑ participation in relevant DFAT policy development activities, and support for Australia's Mission to the IAEA in Vienna and to Australian Missions in other capitals; and
- ❑ promotion of safeguards and non-proliferation concepts through experts' meetings, publications and conferences.

SAGSI

The Standing Advisory Group on Safeguards Implementation is a group appointed on the basis of their personal expertise by the Director General of the IAEA, in consultation with Governments, to advise him on effectiveness and cost-efficiency in the implementation of IAEA safeguards. SAGSI has provided much of the inspiration for the current program to strengthen IAEA safeguards and continues to review developments. Currently SAGSI has 19 members, including ASNO's Director General, John Carlson, and participation in SAGSI is an important aspect of ASNO's work. Some of SAGSI's work during 1999-2000 is outlined below.

A key topic for SAGSI is the development of integrated safeguards, that is, the optimal combination of 'classical' safeguards and strengthened safeguards measures (integrated safeguards are discussed further on page 51). This is a matter of the highest priority. SAGSI has reviewed the IAEA Secretariat's Work Plan for integrated safeguards and advised the Secretariat on various aspects of it. SAGSI is also examining specific subjects related to integrated safeguards, including development of safeguards concepts and approaches, safeguards parameters, evaluation methodologies, and quality systems. During the year one major subject, in which Australia took the lead, was a thorough review of the role of 'timeliness' (e.g. frequency of inspections) in integrated safeguards. Other subjects include the role of containment and surveillance measures, and the categorisation of nuclear material for safeguards purposes.

Additional topics examined by SAGSI during the year included:

- ❑ safeguards implementation and performance issues, including reporting aspects, and information review and evaluation;
- ❑ further developments in safeguards, including wide area environmental sampling, safeguards approaches for spent fuel repositories, and the application of satellite imagery; and
- ❑ possible new verification roles for the IAEA, including nuclear materials released from weapons programs and the proposed FMCT (further details on FMCT are at page 73).

Evaluation of safeguards

In evaluating IAEA's safeguards performance, ASNO drew on a wide range of activities and sources, including:

- ❑ the IAEA's 'Safeguards Implementation Report' (SIR) and other detailed information made available to Australia as a member of the IAEA Board of Governors;
- ❑ appreciation of practical issues derived from the operation of Australia's Safeguards Assistance Program in support of IAEA safeguards; and
- ❑ exchanges of views and information with IAEA staff, counterpart organisations, and relevant Australian agencies.

ASNO's assessment of IAEA data for 1999 and related information is that the safeguards system has fulfilled its task of verifying the non-diversion of significant quantities of nuclear material subject to IAEA safeguards (see IAEA Safeguards Statement for 1999, on page 84). As in previous years, the IAEA experienced a number of problems with equipment and procedures, but none was sufficiently serious to prevent the Agency from reaching satisfactory conclusions from its safeguards activities.

Other work

At several international conferences³ ASNO has taken the opportunity, to present and promote Australian ideas on safeguards and non-proliferation development (see Milestone C2 on page 34). ASNO has established a reputation for presenting innovative, constructive and thought provoking papers.

Performance Assessment

Australia's participation in international work is making a significant, effective and highly regarded contribution to strengthening the IAEA safeguards system.

ASNO was closely involved with the IAEA through high level participation in SAGSI and other expert meetings⁴. Through the Safeguards Support Program ASNO provided cost free consultancy services to the IAEA for the further development of international safeguards (see Milestone C3 on page 35). The IAEA has expressed appreciation for and satisfaction with these services. This work has contributed to more effective international safeguards with improved use of new technologies and methods.

3. Such as annual meetings of the Institute of Nuclear Materials Management (INMM), the European Safeguards Research and Development Association (ESARDA), and the Japan Atomic Industrial Forum.

4. For example, working groups on integrated safeguards.

ASNO has been an influential advocate for strengthened safeguards through high level participation in international fora such as Institute of Nuclear Materials Management and European Safeguards Research and Development Association.

C1.2 Assessment of developments in nuclear technology

Nuclear fuel cycle developments could have significant implications for the implementation of safeguards measures and the ways in which non-proliferation objectives are pursued. ASNO has followed very closely developments in critical areas including plutonium recycling, new reactor designs, and proliferation resistant fuel cycle concepts. These issues have been explored in detail with the IAEA and at other expert meetings and in bilateral consultations. ASNO's participation and good standing in these expert groups has enabled it to stay abreast of advancements and contribute to a more thorough understanding among experts, policy makers and the public alike. Some of these matters are discussed on pages 62 and 67.

Performance Assessment

Although Australia does not have a nuclear industry and hence is not directly involved in substantial nuclear technology developments, ASNO has maintained a sound understanding of important developments or issues and made a constructive contribution in international fora.

C1.3 Contribution to IAEA technical training courses concerning nuclear material accountancy and control and other safeguard—related topics.

Activities

An important activity for ASNO has been the provision of training in national safeguards for personnel of regional countries. In our region, Australia and Japan have provided such training since 1985 on behalf of and in conjunction with the IAEA. Together they have conducted eight courses (four each in Japan and Australia). The last regional course was held in Australia in April 2000.

This most recent three week course was funded by AusAID and provided training in safeguards and nuclear materials accounting. The IAEA was extremely pleased with the conduct and content of the course. Feedback from students was very positive. Many regional states participated, including Cambodia, China, DPRK, Indonesia, Japan, Malaysia, Philippines, ROK, Thailand and Vietnam. While Australia is expected to conduct a further course in about four years, in view of the evolving nature and importance of integrated safeguards, and increasing regional attention being given to safeguards matters, ASNO is considering the possibility of a follow-up course in about two years. Further details of this year's course are on page 58.

During the year, Mr John Hill was a guest lecturer at a safeguards training course in Japan, (arranged primarily for participants from Eastern Europe and the Newly Independent States), and with ABACC (the Brazilian-Argentine Safeguards Agency) in Brazil.

In October 1999 the Director General, John Carlson, was invited to present a paper to an IAEA seminar for Asia Pacific countries on 'IAEA Safeguards for the 21st Century', at Taejon, ROK, and to participate in a discussion by a panel of international experts.

Performance Assessment

Through its regional training course on nuclear safeguards ASNO has contributed strongly to the IAEA's training programs aimed at a significant contribution to improving the technical performance of safeguards authorities in the region.

An important by-product of this work is strengthened relationships with counterparts in the region.

MILESTONE C2

Highly effective liaison maintained with the IAEA and other safeguards organisations.

Activities

During the reporting period ASNO was active in maintaining and developing its contacts with the IAEA, other safeguards agencies and international safeguards practitioners in several fora, including:

- ❑ the Director General, John Carlson, had extensive discussions with senior IAEA officials (including the Director General, Dr ElBaradei and the Deputy Director General for Safeguards, Dr Goldschmidt) and with counterparts in Euratom and ABACC, as well as with senior officials of several governments and industry representatives;
- ❑ the second and third Technical Coordination Meeting on Integrated Safeguards Development and Implementation Support at the IAEA, Vienna. Here Dr Bragin presented ASNO's report on the application of the State-level safeguards integration concept to Australia's nuclear activities;
- ❑ the International Conference 'Breaking Ground on a Fissile Material Cut-off Treaty', Munich, and at the Second Russian International Conference on Nuclear Material Protection, Control, and Accounting in Obninsk (Dr Bragin). This latter event was an important opportunity to canvas Australian views on current safeguards and non-proliferation issues directly to a wide audience of Russian and other experts, and it provided insight into current views on the future development of nuclear power in Russia;
- ❑ ESARDA Seminar 'The Evolution of Safeguards: Integrating the New and the Old', Dresden, Germany, where Dr Bragin presented an ASNO paper 'Integrated Safeguards: Re-examination of Basic Safeguards Implementation Parameters';
- ❑ the Institute of Nuclear Materials Management (INMM) 1999 Annual Meeting where two papers were presented by John Carlson;
- ❑ an International Symposium on 'Peaceful Uses of Nuclear Energy and Non-Proliferation: A Challenge for the 21st Century', organised by JAIF (Japan Atomic Industrial Forum) where John Carlson presented a paper;
- ❑ bilateral nuclear policy and safeguards meetings, including physical protection issues, with officials and industry in Canada, Euratom, Finland, France, Indonesia, Japan, ROK, Sweden, Switzerland, UK, and US.

In December 1999 Dr Amin Zarkasi, Director of the Safeguards Centre of Indonesia's Nuclear Energy Control Board (BAPETEN), came to ASNO for a familiarisation visit and worked in Canberra for a week. Subsequently, in February 2000, Mr Carlson visited Jakarta for discussions with the Chairman of BAPETEN, Dr Mohammad Ridwan, and the

Chairman of the National Nuclear Energy Agency (BATAN), Mr M. Iyos Subki. As an adjunct to the Safeguards Regional Training Course, in April 2000 Dr Ridwan, Mr B-K Kim, Director of TCNC (Technical Center for Nuclear Control), the ROK's safeguards authority, and Mr Hiroyoshi Kurihara, Senior Executive Director of NMCC (Nuclear Materials Control Centre), Japan's safeguards implementation agency, visited ASNO for consultations.

Performance Assessment

ASNO has achieved highly effective links with the IAEA and a wide range of safeguards organisations and regional counterparts. Because of these links ASNO is: abreast of developments and incipient problems in safeguards; effective in disseminating Australian thinking on a variety of safeguards and related issues; well able to contribute to resolving issues of safeguards concern; and has been able to ensure that its work program is relevant to the international non-proliferation agenda.

ASNO has been able to give the Government sound advice on safeguards, both internationally and in their domestic context.

MILESTONE C3

A technical R&D program, supporting development and enhancement of IAEA safeguards, managed efficiently.

Activities

The resources available to the IAEA have never been sufficient to allow all necessary safeguards R&D programs to be conducted 'in-house'. Safeguards is an evolving discipline and ASAP is intended to assist the IAEA develop the equipment and procedures needed if new challenges are to be met in a cost-effective way.

ASAP, coordinated by Dr Bragin, incorporates consultancy work, analysis, and development of equipment and procedures. The program embraces safeguards projects formally agreed directly with the IAEA, and also participation in other efforts to improve safeguards implementation such as the International Remote Monitoring Project (IRMP), coordinated by the US Department of Energy (DOE).

There are important conceptual changes under way in safeguards, arising from the implementation of strengthened safeguards and the development of integrated safeguards concepts. Support Program tasks in support of those developments generally require considerable experience in safeguards. For that reason, consultancy work carried out directly by ASNO officers forms a significant part of ASAP.

This program is not only an important tangible expression of Australia's support for IAEA safeguards, but plays a major role in maintaining ASNO's technical expertise and appreciation of the practical issues confronting the safeguards system. Fifteen formal Member State Support Programs are currently in operation, with an aggregate annual budget of over US\$20 million. In dollar terms, ASAP is very modest—this year about \$77,000 (not including time spent by ASNO staff and the staff of some other Commonwealth agencies on ASAP projects). Nevertheless, the IAEA and other safeguards agencies judge that work done under ASAP is effective.

Details of the various ASAP projects are summarised at Annex G.

Performance Assessment

The results of several projects progressed and completed under the Australian Safeguards Assistance Program have been incorporated in the practices of the IAEA in 1999-2000. The IAEA has expressed appreciation for the valuable and vital contribution provided by the Australian Safeguards Assistance Program to the Agency's safeguards efforts.

Collaborative projects have strengthened our relationship with counterparts, particularly in the United States.

OUTPUT D—CWC IMPLEMENTATION

Operation of the national authority for implementation of the CWC, including contribution to effective international implementation of the CWC, particularly in Australia's immediate region.

MILESTONE D1

Effective performance as the national focal point for liaison with the OPCW and other States Parties in relation to the fulfilment of Australia's obligations under the CWC.

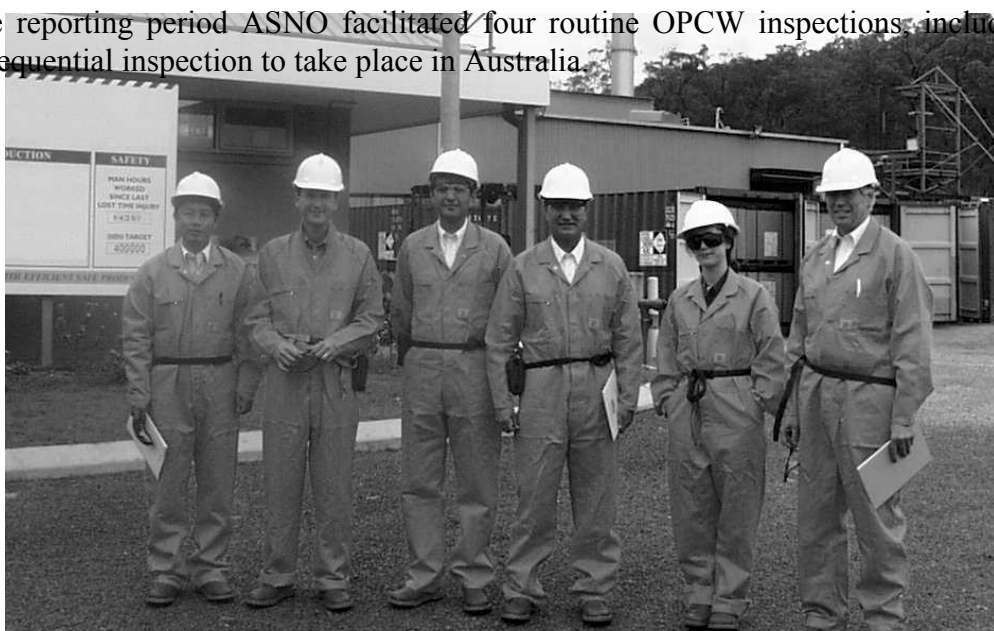
Activities

Interaction with the OPCW

In accordance with Australia's obligations under the CWC, ASNO prepared and submitted routine declarations and notifications to the Technical Secretariat of the OPCW during the year, and facilitated the conduct of four routine on-site inspections in Australia by the OPCW.

In September and October 1999, ASNO submitted routine CWC Article VI declarations on activities anticipated for 2000 for a total of 12 facilities working with Scheduled chemicals. In March 2000, declarations were submitted for 1999 on international transfers of Scheduled chemicals and for work in 60 facilities with CWC-relevant activities. These declarations were compiled using information gathered through the operation of the *Chemical Weapons (Prohibition) Act 1994*, and information on imports and exports of Scheduled chemicals obtained from Customs data, export-licensing records and also through extensive industry surveys.

In the reporting period ASNO facilitated four routine OPCW inspections, including the first sequential inspection to take place in Australia.



ASNO and OPCW inspectors during a Schedule 3 inspection in Australia—photograph courtesy of Ticor

During October/November 1999, the OPCW carried out sequential inspections at two commercial large-scale Schedule 3 production facilities, one located in Western Australia and the other in Queensland. Inspectors checked consistency of activities with declarations and confirmed the absence of any Schedule 1 chemical at both sites. The OPCW agreed with the assessments of both ASNO and the facility operators that ‘facility agreements’ under the CWC were not warranted in either case. Given the geographic location of the two sites, facilitating the smooth transfer of inspectors and their equipment between sites was a major logistical challenge.

The third OPCW inspection took place in February 2000 at a commercial facility producing a Schedule 3 chemical in significant quantities. As with the earlier inspections, the accuracy of the declaration and the absence of Schedule 1 chemistry on-site were checked. Again the OPCW agreed with the assessments of both ASNO and the facility operator that a facility agreement was not warranted.

The second systematic re-inspection of Australia’s single declarable Schedule 1 facility—the Defence Science and Technology Organisation Aeronautical and Maritime Research Laboratories in Maribyrnong, Victoria—took place in April 2000. In accordance with CWC requirements, the objective of the inspection was to verify the information provided in Australia’s declarations with respect to this facility, and that Schedule 1 chemicals were not being diverted or used in undeclared activities.

Other Article VI declarations and notifications to the OPCW during 1999-2000 included: six advance notifications of proposed imports of Schedule 1 chemicals; notifications in relation to approval of inspectors designated to Australia; and as a means of promoting transparency and consistency amongst States Parties, details of the criteria which Australia had used for reporting Schedule 2 and 3 aggregate national data and for making plant site declarations.

In accordance with obligations under Article X, and for the purposes of promoting transparency between States Parties, ASNO submitted to the OPCW an annual declaration of Australia’s national chemical defence program. ASNO worked closely with the Department of Defence in compiling this declaration.

During November 1999, Mr José Bustani, Director-General of the OPCW, visited Australia, including a visit to ASNO where he discussed a range of CWC related issues. In particular, this visit provided a useful opportunity to explain to Mr Bustani our initiatives with regard to both raising public awareness of the CWC in Australia and ASNO’s involvement in regional and international work relating to effective implementation of the Convention.

ASNO (alternately Dr Geoffrey Shaw, Head CWC Implementation and Mr Andrew Leask, AS ASNO) actively participated in a series of industry cluster meetings convened by the OPCW and held in The Hague on an approximately quarterly basis, to resolve outstanding technical issues faced by States Parties in implementing the CWC. Issues included, *inter alia*: low concentration limits for plant site declarations and international transfers of Scheduled chemicals; rounding rules for plant site declarations; access to records during Schedule 2 and 3 inspections; and Schedule 3 plant site selection methodology.

In addition, Dr Shaw was invited by the OPCW Technical Secretariat to present a paper to the second Annual Meeting of National Authorities and Chemical Industry, held in The Hague in May 2000 and attended by delegates from over 100 States Parties. The aim of such international meetings is to promote transparency and cooperation between national

authorities, including regional cooperation, as a means of improving the effectiveness of national implementation of the Convention. Drawing upon practical experiences, Dr Shaw's presentation focused on Australian experiences with import-export control under the CWC and the harmonised export system. Following on from this meeting, Dr Shaw participated in the OPCW Fifth Conference of States Parties.

Dealings with other States Parties

Following an invitation from the Government of Vietnam, ASNO, in conjunction with the OPCW, organised and participated in a CWC workshop in Hanoi during November 1999. The aim of the workshop was to provide practical assistance to Vietnamese officials to help them understand and implement national obligations under the CWC. ASNO has received a request from another State Party to provide similar assistance.

Dr Shaw received an invitation to make a presentation on Australia's implementation experiences at the inaugural Singapore CWC Regional Forum, held in Singapore in May 2000, and attended by delegates from approximately 25 countries. This provided a good opportunity to advance Australia's position on a number of technical implementation issues, while bilateral discussions with other delegates at the meeting provided useful insights into how the CWC is being implemented in a number of ASEAN States.

ASNO continued its extensive liaison with counterparts in Canada throughout the year in providing assistance with respect to enacting implementing CWC legislation and coordinating efforts at industry cluster meetings. Also ASNO continued to liaise with New Zealand counterparts to help them identify potentially declarable CWC activities in that country.

In collaboration with the Royal Australian Chemical Institute (RACI), the Department of Defence and the OPCW, ASNO has commenced preparations to host a regional CWC workshop in Melbourne in May 2001. The focus of the meeting will be twofold: namely to facilitate the exchange of information and experiences; and to promote cooperation amongst participants, especially at the government, industry and academic levels. A national symposium building upon tangible ideas from the workshop will follow immediately. It is intended that this symposium will target domestic industry and academic representatives.

Performance Assessment

By providing accurate and timely declarations and notifications to the OPCW, ASNO has maintained Australia's strong record of performance in meeting its CWC commitments. Recognition of excellence is reflected in invitations from the OPCW and other States Parties to participate in international meetings and to present on Australia's experiences in implementing the Convention.

The four inspections conducted by the OPCW during the year proceeded smoothly. While inspectors were able to fulfil their mandate, ASNO ensured that legitimate commercial and other activities were not unduly affected by these exercises. Inspection reports reflected well upon the performance of ASNO in effectively facilitating these inspections.

A number of recommendations resulting from the series of industry cluster meetings were adopted by the 5th Conference of States Parties in May 2000.

Following the implementation workshop, Vietnam was able to submit its initial CWC declaration. Formal expressions of gratitude for assistance provided either at the workshop

in the case of Vietnam, or throughout the year in the case of Canada, have been received from respective Governments.

MILESTONE D2

Activities and facilities in Australia relevant to CWC declarations are identified and the systems of permits and notifications established by the *Chemical Weapons (Prohibition) Act 1994*, and Regulation 5J of the *Customs (Prohibited Imports) Regulations* are operated effectively and/or amended as necessary.

Activities

Permits and Notifications

During the year ASNO identified one additional facility which required a permit under the Act to process a Schedule 2 chemical.

Table 5—Permits for CWC Scheduled Chemical Facilities held at 30 June 2000

<i>Subsection</i>	<i>19(4)</i>	<i>19(5)</i>	<i>19(6)</i>	<i>18(1)</i>	<i>18(1)</i>
Facility	Schedule 1	Schedule 1	Schedule 1	Schedule 2	Schedule 3
Type	Protective facility	Research facility	Consumption facility	Processing facility	Production facility
Number	1	7	2	11	4

Valid notifications under subsection 29(1) were received from 49 companies in relation to production of discrete organic chemicals during 1999.

ASNO provided reminders to each company or organisation of their obligations to ensure legislative requirements were met.

Industry Consultations

As from May 2000, the OPCW verification regime has been extended to cover facilities producing unscheduled discrete organic chemicals. While the probability of any one site receiving an inspection is low, ASNO has, nonetheless, been active in consulting with industry to advise of this possibility and provided details on how such inspections may work in practice. To this end, ASNO has published and distributed information packages to all potentially affected facilities, in addition to carrying out a series of comprehensive on-site consultations with facility representatives.

Amendments to Customs (Prohibited Imports) Regulations

Minor amendments to Regulation 5J of the *Customs (Prohibited Imports) Regulations*, necessary to implement an OPCW Executive Council decision with respect to international trade in the CWC Schedule 1 chemical saxitoxin, and to regulate the import of CWC Schedule 2 and 3 chemicals from January 2000, received Royal Assent in December 1999.

The amendments mean that import licensing arrangements have been extended to cover Schedule 2 and 3 chemicals. However, as Australia's reporting obligations for Schedule 2 and 3 chemicals are less intensive than for those applying to Schedule 1 chemicals, a simplified licensing arrangement has been introduced which allows for multiple shipments of a particular Schedule 2 or 3 chemical in any given year.

The need to regulate Schedule 2 and 3 chemicals has arisen because, as from April 2000, trade in Schedule 2 chemicals is restricted to CWC States Parties, while similar trade restrictions may also extend to Schedule 3 chemicals from April 2002. The permit system introduced clarifies the legislative basis for Australia collecting the international trade data needed to fulfil Treaty obligations, and also ensures Australia does not inadvertently breach Convention obligations by importing Schedule 2 chemicals from non-States Parties.

ASNO published and distributed approximately 500 information packages to importers detailing the change to the import regulations as pertaining to CWC Scheduled chemicals. In addition, ASNO personally contacted all known importers of CWC Schedules chemicals to explain these amendments.

During the year, ASNO issued 28 import permits covering Schedule 2 and 3 chemicals, and 3 permits covering Schedule 1 chemicals.

While permits to import Schedule 2 and Schedule 3 chemicals have been required since January 2000, in order to collect trade data for 1999 ASNO was required to conduct an extensive survey of chemical importers. Therefore over 220 importers were contacted, although it transpired that very few companies actually imported Schedule 2 and 3 chemicals (less than 25 companies were identified).

Performance Assessment

The system of permits and notifications operated satisfactorily during 1999-2000. As indicated, ASNO was very pro-active in assisting Australian industry to make the various declarations and in notifying industry of changes, such as commencement of the OPCW inspection regime for non-Scheduled chemical producers and changes to import requirements for Scheduled chemicals. Australian industry has expressed strong appreciation for ASNO's efforts in this regard.

Amendments to Regulation 5J of the *Customs (Prohibited Imports) Regulations* were agreed with Customs, proceeded through Executive Council and received Royal Assent in December 1999.



OUTPUT E—CTBT IMPLEMENTATION

Operation of the national authority for implementation of the CTBT, including development of CTBT verification and arrangements in support of Australia's CTBT commitments.

MILESTONE E1

E1.1 Operate effectively as the national point of liaison with the CTBTO and other States in relation to the fulfilment of Australia's obligations under the CTBT.

E1.2 Facilitation and enhancement of Australia's technical contributions to the work of the Preparatory Commission and its working groups.

Activities

ASNO commenced its activities as Australia's CTBT national authority in July 1998. As the Treaty and Australia's implementing legislation are not yet in force, and the Treaty has only provisional application, ASNO does not carry out the full range of anticipated legal functions. Practical work on development of the CTBT's verification system ahead of entry into force is however significant and advancing steadily. ASNO has established and continues to develop contacts with the CTBTO's Provisional Technical Secretariat (PTS) and with Australian governments, agencies and institutions with a stake in CTBT activities, especially the development of the International Monitoring System (IMS). Annex I lists Australian IMS stations.

To facilitate the development of Australian IMS stations, ASNO concluded the negotiation during the year of a Facility Arrangement with the CTBTO Preparatory Commission. This Arrangement sets out requirements and procedures governing the establishment, upgrade and operation of IMS stations in Australia. The estimated value of these activities is \$25 million over the coming five years. The Facility Arrangement was signed by the Minister for Foreign Affairs, Mr Downer, and the Executive Secretary of the CTBTO Preparatory Commission, Dr Wolfgang Hoffmann, during Dr Hoffmann's visit to Australia in March 2000.

Australian IMS stations will be operated on behalf of the Government by organisations with specialist expertise in CTBT verification, such as ARPANSA, the Australian Geological Survey Organisation (AGSO) and the Australian National University (ANU).

The single largest IMS project in Australia will be the establishment of a hydroacoustic monitoring station off Cape Leeuwin in Western Australia (see page 76 of this report for a background article on the station). ASNO worked closely during the year with the PTS, with Western Australian government agencies, and with the consortium installing the station, to facilitate agreement on work proceeding in 2000-2001.

ASNO took part in technical working group sessions at the Preparatory Commission headquarters in Vienna in September 1999 and February and May 2000, and works closely with Australia's technical specialists (from AGSO and ARPANSA) who have contributed over many years to the negotiation and development of the Treaty. ASNO's own long experience in treaty verification is now contributing in particular to work establishing procedures for the conduct of an On Site Inspection (OSI). The role of an OSI is to establish, through activities on the ground, whether an explosive nuclear test has been carried out in violation of the CTBT.

Performance Assessment

ASNO has developed effective liaison with stakeholders in the IMS development process, with useful results during the year advancing preparation for entry into force of the CTBT.

Conclusion by ASNO of Australia's IMS facility arrangement has been widely welcomed among stakeholders, as have developments paving the way for establishment of new IMS stations in Australia.

The signature of Australia's Facility Arrangement, as well as the announcement of contracts for installation of the hydroacoustic station off Cape Leeuwin, offered useful opportunities for Mr Downer to underline Australia's ongoing commitment to the CTBT.

In March 2000, Mr Downer signed an arrangement during the visit by Dr Hoffmann

Australia is widely regarded as making a key contribution to the technical development of the

CTBT and its verification. ASNO has worked successfully to co-ordinate Australia's input in this area during the year and, drawing on its own areas of expertise, to make a substantial contribution.

MILESTONE E2

Timely establishment and maintenance of legal and administrative mechanisms which will give effect to CTBT obligations in Australia.

Activities

Although the *Comprehensive Nuclear Test-Ban Treaty Act 1998* received Royal Assent on 2 July 1998, under section 2 of the Act it will not come into force before the day the CTBT enters into force, which will occur 180 days after the Treaty has been ratified by 44 named States. At 30 June 2000, 155 States had signed the treaty, of which 57 had deposited instruments of ratification. These included 29 of the named 44.

The CTBTO PTS manages the development of the IMS internationally and funds the upgrade or establishment of stations from the contributions of CTBT signatories. To facilitate this work, Australia signed a Facility Arrangement with the CTBTO Preparatory Commission on 11 March 2000 (see also page 76). ASNO managed the preparation of regulations establishing privileges and immunities required by this arrangement. The *Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (Privileges and Immunities) Regulations 2000* were gazetted on 1 June 2000.

Consistent with principles set out in the CTBT, activities associated with the development of its verification are funded primarily from the contributions of signatories. This includes training of people involved with the work of the Treaty. ASNO coordinates the involvement of Australians in this training. During the year three Australians took part in training for future responsibilities as station operators, or as inspectors to be deployed should the Treaty's On-site Inspection provisions be invoked.

Performance Assessment

With the conclusion of Australia's Facility Arrangement and associated regulations, the legal basis for IMS establishment activities in Australia prior to entry into force of the CTBT has been advanced. A further step for 2000-01 will be to put in place arrangements between the Australian Government and technical agencies or institutions that will operate IMS stations on Australia's behalf.

The training and experience, gained both in Australia and overseas, that has accompanied development and maintenance of the CTBT's verification mechanism has provided ASNO with opportunities to nurture a base of expertise in nuclear monitoring and verification issues.

OUTPUT F—NEW NON-PROLIFERATION REGIMES

Contribution to development of new and strengthened WMD Non-proliferation regimes such as the BWC and FMCT.

MILESTONE F1

Provision of effective technical support and advice to Australia's negotiations for a protocol to strengthen the BWC.

Activities

ASNO continued to provide ISD with technical assistance in the development of a protocol to strengthen the BWC, but at a lower level of intensity. This work includes analysis of options for declaration triggers, and identification of Government facilities potentially affected by the protocol in Australia. To this end, ASNO conducted an extensive survey of Government facilities focussing on six key areas, namely: microbiological production; work with micro-organisms and/or toxins; genetic manipulation of organisms; aerosol dissemination; bio-containment facilities; and bio-defence programs. Survey results indicated that the protocol is likely to have a greater impact on Government facilities than the biotechnology industry in Australia. In addition, ASNO also managed a consultancy directed towards developing options for better targeting one specific declaration trigger, namely that for 'Other Production Facilities'.

Performance Assessment

A report on results of the efforts to better define the 'Other Production Facility' declaration trigger was considered by the National Consultative Group and helped inform the Australian delegation to the CD in Geneva. ISD values ASNO's technical input towards the development of an effective BWC verification regime.

MILESTONE F2

Effective contribution to national and international discussions on Fissile Material Cut-off Treaty (FMCT) developments.

Activities

The concept of an FMCT is described on page 73. Effective and cost-efficient verification will be fundamental to the FMCT regime. An important part of preparation for FMCT negotiations, therefore, is the development of verification concepts to help guide the negotiations to a successful outcome.

Development of verification concepts for the FMCT is a task of high priority for ASNO. During the year ASNO further developed, and presented at different international fora, new ideas on basic verification aspects of the FMCT including, *inter alia*, routine and non-routine verification activities, managed access, and challenge inspection mechanisms.

The IAEA has decided to refine its previous analyses undertaken in preparation for providing assistance in the negotiation of this Treaty. At the IAEA's request, ASNO has made available a senior staff member, Dr Bragin, as a part-time cost-free consultant to the IAEA on matters relating to the proposed FMCT. Dr Bragin assisted the IAEA in assessing the implications of possible alternative approaches to verification.

ASNO has provided assistance to ISD in the formulation of advice on FMCT for the Australian Delegation in the CD and Australian posts in key capitals. ASNO officers have participated in bilateral consultations on FMCT with our counterparts in other countries and the IAEA. Activities have also included publications, presentation of conference papers, and participation in international seminars.

Performance Assessment

ASNO's ideas on a focused FMCT verification regime were presented at several international seminars and conferences where they were well received. These ideas appear to be accepted by the majority of the international experts.

ISD values ASNO input towards the development of effective verification arrangements for the FMCT.

OUTPUT G—ADVICE TO GOVERNMENT

Provision of high quality, timely and relevant professional advice to Government.

MILESTONE G1

Ministers and other key stakeholders satisfied with policy advice, analysis and briefings.

Activities

ASNO provided advice to the Minister for Foreign Affairs, and on occasions the Minister for Trade, on a range of issues, as well as contributing extensively to the development of advice provided by other Divisions in DFAT, other Government agencies and departments. The prime agency was DFAT; other agencies included the Department of Industry, Science and Resources, the Department of Defence and the Office of National Assessments.

Significant issues affecting international safeguards, the CWC, the BWC and the CTBT were kept under review, and close liaison was maintained with DFAT on these and other matters of common interest.

ASNO attended as an expert witness several Parliamentary hearings, notably the Joint Standing Committee on Treaties on two occasions.

Performance Assessment

ASNO submitted 39 Ministerial briefs, Parliamentary Question briefs and other briefs, and contributed to all other DFAT items on nuclear, CWC and BWC related issues. ASNO was involved in preparation of seven pieces of Ministerial correspondence. ASNO made a significant contribution to assessments by the Australian intelligence community. Ministers, Departments and Agencies have indicated appreciation of the high quality, timely and relevant advice provided by ASNO.

OUTPUT H—PROVISION OF PUBLIC INFORMATION

Provision of public information on the development, management and regulation of WMD non-proliferation treaties, and Australia's role in these activities.

MILESTONE H1

Management of an effective program to inform and educate the public and government departments and agencies on nuclear safeguards and CWC issues, and promotion of an understanding of the CTBT and its verification arrangements.

Nuclear Safeguards Activities

ASNO's Annual Report contains a considerable amount of background information on nuclear matters in an effort to enhance public understanding of the issues involved.

Messrs Carlson and Leask have provided the media with background briefings.

Basic details of permits issued, revoked and varied under the Safeguards Act are published in the Commonwealth Government Gazette.

CWC Related Activities

ASNO continued to ensure that operators of facilities which might be affected by the Convention were informed of their obligations, including through the publishing and distribution of two new industry brochures, and the updating of the ASNO Internet site, which can be found at <http://www.asno.dfat.gov.au>.

Dr Kylie Brown participated in the second Australian Chemicals Summit, held in Melbourne during July 1999. The chemical industry focus of the meeting provided a useful occasion for ASNO to raise industry awareness of the CWC and concomitant domestic legislative requirements, and to identify possible new facilities requiring permits under the Act.

Dr Geoffrey Shaw was invited to present a lecture at a meeting of the ACT Rotary Club during June 2000. The presentation provided an overview of the chemical warfare, the CWC and the impact of the CWC in Australia.

General Activities

ASNO organised a series of technical seminars covering technologies, threats and non-proliferation of weapons of mass destruction. These seminars were conceived to meet ASNO's own need for greater 'multi-skilling' of its staff and as one way of better managing its corporate knowledge but have been used widely by Commonwealth agencies in Canberra and Sydney. These seminars attracted substantial participation of practitioners of WMD non-proliferation from several agencies.

Performance Assessment

ASNO has used a wide range of material to inform the public and WMD practitioners about current nuclear issues.

ASNO's technical seminar series has been an effective tool for enhancing knowledge of WMD issues among Government agencies.

An assessment of ASNO's dealings with industry shows that the dissemination of information material has fostered an acceptance and broader understanding of the CWC and its verification mechanism. In particular, industry has expressed appreciation for efforts to keep them informed with respect to changes under the CWC and/or domestic legislation.

Rotary expressed appreciation of ASNO's efforts with regard to enhancing national security, and has requested further presentations on ASNO's work.

Requests for briefing on CBW related issues have increased as a result of the ASNO seminar series.

CURRENT TOPICS

IAEA SAFEGUARDS—AN OVERVIEW

Nuclear safeguards are a key element in international action against the spread of nuclear weapons. Safeguards are directed at the verification of peaceful use commitments, given by States through international agreements to use nuclear materials and facilities for exclusively peaceful purposes. Broadly, safeguards may be described as a complex system of declarations by States, verified by inspections and evaluations, undertaken principally by the IAEA.

It should be emphasised that the task of safeguards is not prevention, except in so far as risk of discovery may act as a deterrent to a would-be proliferator. Nor is the IAEA an international policeman. Rather, the political objective of safeguards, in simple terms, is to exercise a positive influence on the behaviour of States by:

- ❑ providing assurance to reinforce non-proliferation commitments; and
- ❑ deterring non-compliance through the risk of timely detection.

Importantly, safeguards serve to assist States who recognise it is in their own interest to demonstrate their compliance to others. Thus safeguards are an important confidence-building measure in their own right, as well as being a major complement to the broader range of international confidence-building measures.

Safeguards are complemented by other important elements in the non-proliferation regime such as: export controls on nuclear items; political incentives and sanctions; and national intelligence activities. Some institutional and technical aspects of non-proliferation are discussed at page 65.

TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS (NPT)

The NPT is the centrepiece of the international nuclear non-proliferation regime. The Treaty was concluded in 1968 and entered into force in 1970. It is now almost universal, with 187 Parties. Only four States remain outside the NPT. Three (Israel, India and Pakistan) have unsafeguarded nuclear activities—the fourth, Cuba, has safeguards on all existing nuclear activities.

The overwhelming majority of States have renounced nuclear weapons, recognising that the possession of these weapons would threaten, rather than enhance, their national security.

The NPT has been essential to establishing the conditions under which the renunciation of nuclear weapons has been possible. It has done this by providing:

- ❑ a legal framework within which States can express their commitment to use nuclear energy for exclusively peaceful purposes; and
- ❑ a credible verification mechanism, IAEA safeguards, to assist States demonstrate that they are honouring their Treaty commitments and to give them confidence that others are doing the same.

The key provisions of the NPT can be outlined as follows:

- ❑ Nuclear-weapon States (NWS)⁵ agree not to assist any non-nuclear-weapon State (NNWS) to acquire nuclear weapons.
- ❑ NNWS agree not to acquire nuclear weapons or other nuclear explosive devices, and to accept IAEA safeguards on all their current and future holdings of nuclear material ('full scope' or 'comprehensive' safeguards).
- ❑ All Parties agree to cooperate in the peaceful uses of nuclear energy—but not to supply nuclear items to a NNWS except under safeguards.
- ❑ All Parties agree to pursue nuclear disarmament, and complete and general disarmament.

IAEA SAFEGUARDS—THE 'CLASSICAL' SYSTEM

The system of safeguards developed to give effect to the full scope safeguards commitment under the NPT is commonly described as the 'classical' system. The classical system is characterised by:

- ❑ an emphasis on the verification of nuclear materials accountancy, using containment and surveillance as complementary measures; and
- ❑ a focus, inherited from pre-NPT safeguards, on the concept of diversion as comprising the removal of nuclear material from declared facilities or locations.

The legal basis for classical safeguards is an agreement concluded by each State with the IAEA. In the case of the full scope (now more commonly called 'comprehensive') safeguards applied to NNWS NPT Parties, these agreements are based on an IAEA document referred to as 'INFCIRC/153' (Information Circular number 153).

The central feature of IAEA safeguards is inspections—the verification of nuclear material in declared facilities by safeguards inspectors. Nuclear facility operators are required to maintain, under the supervision of each country's national safeguards authority, detailed accounting records of all movements and other physical transactions involving nuclear material. IAEA inspectors regularly visit nuclear facilities to verify the completeness and accuracy of this documentation through activities such as checking inventories, sampling and other analytical procedures.

Nuclear material accountancy is complemented by other technical measures such as containment (e.g. the placement of special seals on nuclear items), and surveillance (e.g. the operation of automatic cameras), to maintain continuity of knowledge between inspections. With the increasing complexity of modern nuclear facilities, especially large-scale bulk-handling facilities such as reprocessing plants, use of containment and surveillance is assuming greater importance. Containment and surveillance, in the form of remote monitoring systems, are also becoming increasingly important as a way of improving both the cost-efficiency and the effectiveness of safeguards.

The classical safeguards system has provided the international community with a high level of assurance that all the nuclear material declared to the IAEA by NPT Parties remains in the civil nuclear fuel cycle. However, events in Iraq showed the limitations of the classical system and prompted a program to strengthen safeguards, in order to address the possibility

5. The NPT formally recognises as NWS the States that had nuclear weapons when the Treaty was concluded in 1968, i.e. US, Russia, UK, France and China.

of undeclared nuclear activities.

STRENGTHENED SAFEGUARDS

From the early 1990s, the IAEA, with the assistance of Member States, has been engaged in a major undertaking to strengthen and streamline the safeguards system. The principal directions of the strengthened safeguards system currently under development are to:

- ❑ shift the focus from declared inventories and flows of nuclear material at individual facilities, towards safeguards approaches based on evaluation of the State as a whole;
- ❑ provide credible assurance of the absence of undeclared nuclear material and activities in the State; and
- ❑ diversify the methods of detection, introducing methods based upon quite different principles (such as environmental analysis), resulting in a more robust system.

Early in the strengthening process two broad groups of safeguards strengthening measures were identified: ‘Part 1’ measures which the IAEA could implement under current safeguards agreements, and ‘Part 2’ measures which required additional or complementary legal authority. ‘Part 1’ measures include enhanced information collection and analysis, environmental sampling at nuclear sites, and use of unannounced inspections. To provide the necessary legal authority for ‘Part 2’ measures, it was decided to establish an Additional Protocol, a legal instrument that would complement existing safeguards agreements.

THE ADDITIONAL PROTOCOL

The text of the Additional Protocol (published by the IAEA as INFCIRC/540), to be used as a model for each State to conclude a Protocol with the IAEA, was negotiated in a Special Committee of the IAEA Board of Governors, and was agreed in May 1997. Australia played a major role in the negotiation of the Additional Protocol and, as outlined in the following article in this Report, was the first State to bring an Additional Protocol into effect.

Key elements of the strengthened safeguards regime, of which the Additional Protocol is a central element, are:

- ❑ The IAEA receives considerably more information on nuclear and nuclear-related activities, including through an ‘Expanded Declaration’ by each State and widened reporting requirements. This includes, *inter alia*, information on nuclear-related R&D activities, production of uranium and thorium, production of heavy water and graphite, and nuclear-related imports and exports.
- ❑ IAEA inspectors have substantially increased access rights, termed ‘complementary access’ to:
 - anywhere on a nuclear site;
 - various locations included in the Expanded Declaration; and
 - locations elsewhere in the State to carry out environmental sampling and other verification measures.

At nuclear sites and certain locations listed in the Expanded Declaration the Agency has right of access to confirm that there is no undeclared nuclear material or activities at those places. Access on nuclear sites can be short-notice, two hours or less, if carried

out with a routine or other inspection. Elsewhere access is given to enable the Agency to resolve any ‘question or inconsistency’ arising from its information review. The State may require that access be on a ‘managed’ basis to protect certain categories of information.

- ❑ Environmental sampling is initially to be ‘location-specific’, but the Protocol recognises the possibility of using ‘wide-area’ environmental sampling, looking for nuclear indications over extensive areas, once the efficacy of this technique has been established.
- ❑ Information analysis and the conduct of complementary access are to be used to establish a State Evaluation, that is, the IAEA applies its safeguards approaches and draws its conclusions on the basis of the State as a whole.

PROGRESS WITH STRENGTHENED SAFEGUARDS

As mentioned above, a range of strengthened safeguards measures (‘Part 1’ measures) were introduced under existing safeguards agreements, and have now been in operation for some five years. ‘Part 2’ measures require the conclusion of Additional Protocols—these have proceeded more slowly than Australia would wish, though it is recognised that many States have had to introduce complex legislation and administrative arrangements. At 30 June 2000 only 11 Protocols were in force⁶—a further 44 had been signed or approved by the IAEA Board of Governors. It is of concern however that there were 23 NNWS NPT Parties with nuclear activities that had yet to commit to concluding Protocols.

Substantial work has been undertaken, and is ongoing, developing the approaches and procedures, technologies, quality systems, evaluation methodologies and reporting required to ensure that the strengthened safeguards system will be effective in practice. As outlined elsewhere in this Report, Australia is actively involved in this process.

Information analysis is an essential component of strengthened safeguards. An important aspect of this is acquisition path analysis, that is, assessment of the feasible opportunities available to the particular State to produce or acquire nuclear material to manufacture nuclear weapons—separated plutonium or HEU (high enriched uranium) of suitable quality. A would-be proliferator needs either access to such materials directly or the technologies required to upgrade nuclear materials—i.e. enrichment capability to produce HEU or reprocessing capability to separate plutonium. Diversion of materials requiring further processing, such as natural or low enriched uranium or spent fuel, would be useful only if the diverter has these technologies. Acquisition path analysis is a key part of designing safeguards implementation strategies.

Some of the technical approaches under development include:

- ❑ environmental analysis—this is a very powerful safeguards tool, the value of which was first demonstrated in Iraq. Nuclear activities leave indicators—minute traces—on building surfaces, in plants and soil, in water, and in the air. Detection of such traces can indicate the existence of undeclared nuclear activities;
- ❑ remote surveillance—the use of video cameras and instruments to monitor nuclear facilities, transmitting safeguards data to IAEA headquarters by telephone, satellite, and potentially the internet;

6. In addition the IAEA is implementing Additional Protocol measures in Taiwan, China.

- use of satellite imagery—though too expensive for covering wide areas, this can be valuable for specific applications, such as investigating suspect sites, confirming the operating status of facilities, and possibly assessing production levels of uranium mines.

INTEGRATED SAFEGUARDS

While the implementation of strengthened safeguards is progressing, the focus has already turned to integration, that is, how to merge classical safeguards and strengthened safeguards to give the most effective and cost-efficient outcome.

Integration is prompted by the degree of overlap between the old and the new safeguards measures. Certain acquisition paths have components detectable by both classical and strengthened safeguards (e.g. diversion of spent fuel followed by reprocessing in a clandestine reprocessing plant). There are also acquisition paths that can be detected only by classical safeguards (e.g. diversion of separated plutonium), and others that can be detected only by strengthened safeguards (e.g. totally clandestine fuel cycles). Where there is redundancy there is room for rationalisation, so that the cost-effectiveness of safeguards can be enhanced. Integration therefore is central to efficiency: it is about how to prioritise safeguards resources to achieve the best results.

Integration would involve a reduction in the classical safeguards effort in appropriate areas. The IAEA is developing criteria for integration, which will include achieving and maintaining positive results from the Agency's various safeguards activities. For example, if strengthened safeguards led to confidence of the absence of a reprocessing plant in a particular State, the intensity of classical safeguards on power reactors and spent fuel could be reduced accordingly.

CONCLUSIONS

The greatest single challenge—of critical importance to the credibility of the safeguards system—is to effectively address the issue of undeclared nuclear activities. This is a much less tangible goal than the verification of declared material, and the level of assurance which can be provided will be less certain. Obviously it is essential to avoid the dangers of over-expectation. Nor however should we be pessimistic about what can be achieved over time.

How realistic is it to expect the IAEA to be able to detect undeclared nuclear activities? The difficulties encountered in Iraq in the 1990s, where there was a very intrusive verification regime following the Gulf War, show this is not an easy task. On the other hand, compared with individual States, the IAEA has considerable advantages to build on in pursuing this task. In addition to its expertise, the Agency will have comprehensive information bases, extensive access rights, and increasingly sophisticated verification methods. It is most important for the Agency's work to be complemented through States making available information obtained by intelligence activities and other national means. Other essential elements in the success of this work will be the transparency of States and their willingness to cooperate with the Agency. It can be expected that refusal to cooperate, especially obstructing the exercise of access rights, will be viewed very seriously by the international community.

Therefore, as the strengthened safeguards system develops and experience is gained, it can be expected to make a major contribution to international confidence-building. Australia will continue to be a strong supporter of this process.

IMPLEMENTATION OF INTEGRATED SAFEGUARDS IN AUSTRALIA

INTRODUCTION

The preceding article outlines the program for strengthening safeguards, which commenced in the 1990s and is ongoing. From the outset of this program, ASNO has been closely involved with the IAEA in the development of new concepts, procedures and techniques, including, with the cooperation of ANSTO, the conduct of field trials at Lucas Heights. In 1993 Australia had informally provided the IAEA with extended access through an ‘any where/any time’ offer. As part of the development of the Additional Protocol concept, ASNO prepared a trial Expanded Declaration for the Agency.

Prior to the conclusion of the Additional Protocol, the IAEA had begun carrying out strengthened safeguards measures at Lucas Heights as allowed under the existing safeguards agreement (‘Part 1’ measures), such as environmental sampling, and had exercised wider access at the site pursuant to the offer mentioned above.

CONCLUSION OF AUSTRALIA'S ADDITIONAL PROTOCOL

The text of the Additional Protocol was agreed by the IAEA Board of Governors in May 1997. Australia was the first State to sign an Additional Protocol, on 23 September 1997, and was also the first to ratify the Protocol, which entered into force on 10 December 1997. Australia had given a very high priority to concluding the processes necessary for ratification (including amendments to the Safeguards Act) in order to encourage other States to do so at the earliest opportunity.

Following the ratification of the Additional Protocol, the first practical step in the implementation of strengthened safeguards measures was for ASNO to provide an Expanded Declaration, a full and comprehensive declaration of all safeguards relevant activities that had been ever conducted in Australia. The initial set of formal Protocol Declarations was sent to the IAEA on 26 March 1998, well within the 180-day time limit set in the Protocol.

Preparation of the Expanded Declaration (and the previous drafts) was a major and complex task, even though Australia has only one nuclear operator, ANSTO (before 1987 the AAEC—Australian Atomic Energy Commission). ANSTO's Lucas Heights site has been in use from the 1950s and, as to be expected with a large nuclear research organisation, a variety of programs were conducted there, including reactor materials research, centrifuge uranium enrichment research from the 1960s until the early 1980s, and a large-scale program of radioisotope production. Information was also required on past as well as current uranium mining operations, and on all activities that had involved nuclear material (including for non-nuclear uses). In addition information was provided on the British nuclear weapons tests at Maralinga and the Monte Bello Islands.

IMPLEMENTATION OF STRENGTHENED SAFEGUARDS

An essential part of the strengthened safeguards process is the preparation by the IAEA of a State Evaluation. In accordance with Agency policy, Australia has not been given access to any evaluations or supporting ‘country files’, but understands the Agency’s approach as it compiles the detailed information required. The State Evaluation is the subject of ongoing review—the initial analysis is used to identify areas requiring further clarification,

including through the conduct of safeguards activities such as complementary access and environmental sampling, and the results of these activities are fed back into the evaluation process.

Soon after the entry into force of Australia's Protocol, the IAEA took a further range of environmental samples at Lucas Heights (as already mentioned, this activity had started before the Protocol). These samples enabled the IAEA to confirm the details of Australia's expanded declaration, to raise questions about specific activities revealed by the detailed analysis, and to establish a baseline which is used for comparison in routine environmental sampling campaigns.

To briefly summarise the complementary access provisions of the Additional Protocol, the IAEA is entitled to seek access as of right to any location on a nuclear site (i.e. in Australia's case Lucas Heights), and any location declared to have held nuclear material, and to certain 'nuclear-related' locations, in order to verify that there is no undeclared nuclear material or activities at those locations. Elsewhere the IAEA is entitled to access in order to resolve any 'question or inconsistency' arising from its information analysis. The State may require that access be carried out on a 'managed' basis in order to protect proprietary information, information that may be proliferation-sensitive, etc.

As at 30 June 2000 the IAEA had carried out complementary access in Australia on eight occasions, six times at Lucas Heights and twice elsewhere. One of the complementary accesses at Lucas Heights was carried out on a 'managed access' basis.

An outline of the two complementary accesses conducted away from Lucas Heights is as follows. One was to a location belonging to the Defence Science and Technology Organisation in South Australia. Nuclear material (natural uranium discs) had been used at this site at some stage in the past, for non-nuclear purposes (in sonar research), and the IAEA asked for access to confirm that there was no longer any nuclear material at that location. The buildings where the nuclear material had been used were found to be derelict, so the access was extended to other buildings at the location. Environmental samples were taken to confirm the history of operations at the location.

The other complementary access was to the Ranger uranium mine. The object here was to determine that there was no undeclared uranium production. This access was particularly important as it was the IAEA's first opportunity to trial verification activities at a uranium mine—a difficult task, but one on which ASNO has been working closely with the Agency in the development of concepts and approaches. A report of this access is in ASNO's Annual Report for 1998-99.

Since Australia's Additional Protocol was the first to enter into effect, we are the first to have gone through two complete annual cycles of strengthened safeguards verification and evaluation, i.e. in 1998 and 1999. Thus Australia is the first candidate for the introduction of integrated safeguards, and ASNO has been in detailed discussion with the IAEA on how this might be done.

INTEGRATED SAFEGUARDS

As discussed in the preceding article (on page 51), the concept of integrated safeguards is that classical and strengthened safeguards are self-reinforcing and to some extent redundant, and that in certain circumstances it may be appropriate to recognise this through commensurate reductions in classical safeguards effort. The IAEA has determined that the

introduction of integrated safeguards can be considered if there are positive results from the implementation of both classical and strengthened safeguards activities. Progress to integrated safeguards is thus a two-stage process, the first stage being to meet the requirements of strengthened safeguards.

Under classical safeguards the IAEA's inspection activity for Australia is determined primarily by Australia's holdings of research reactor fuel. Australia has large holdings of irradiated (spent) HEU (high enriched uranium) fuel—though these holdings are being steadily reduced through transfers to the US and France. The Agency's current criteria require this spent fuel to be inspected four times a year.

If Australia were to divert this material for weapons purposes, we would need both to reprocess the fuel to separate the HEU from fission products, and to enrich the recovered HEU to the levels required for a nuclear weapon. The enrichment level of currently used HIFAR fuel is 60% U-235, and the average residual enrichment level of the spent fuel is about the same (this is because some earlier fuel was of higher enrichment—spent fuel from the current 60% enriched fuel will have a residual enrichment of about 40%): this compares with weapons-grade HEU, 93% U-235.

Under classical safeguards, the 'timeliness' requirement of three months was set on the basis that if a State has an undeclared, operational, reprocessing plant it would take at least three months to reprocess spent fuel and to fabricate a weapon from the recovered material. Thus the diversion of safeguarded material could be discovered before there was sufficient time to manufacture a weapon. Under classical safeguards the Agency had limited capabilities for establishing whether there may be an undeclared facility, and therefore it had to be assumed that they might exist. The issue for integrated safeguards can be stated as follows: if the IAEA has been able to establish a satisfactory level of confidence that Australia has no undeclared reprocessing facility—and no undeclared enrichment facility—how should this be reflected in the intensity of routine safeguards? Does the Agency need to continue 3-monthly inspections, or is a lesser level of effort appropriate?

ASNO and the IAEA are currently developing an integrated safeguards approach for Australia on a State-as-a-whole level. It is envisaged that the frequency of inspections at Lucas Heights could be reduced from four per year to one full inventory verification and one unannounced (surprise) inspection.

Other aspects being examined are:

- ❑ use of remote monitoring of the spent fuel storage area and of the loading of spent fuel shipping casks;
- ❑ use of power monitors to verify the power level at which HIFAR is operated. This relates to the possible undeclared irradiation of targets to produce plutonium. HIFAR is too small for this—generally production in a research reactor of a safeguards 'significant quantity' (SQ—8 kg) of plutonium in a year would require a very large reactor, more than 25 megawatts thermal power (MWt), compared with HIFAR's level of 10 MWt. In fact, some years ago, as part of an international study for the IAEA on possible misuse of research reactors and safeguards approaches to detect this, ASNO, in collaboration with ANSTO and the Indonesian National Nuclear Energy Agency BATAN, undertook a study of HIFAR which showed that annual plutonium production capability was much less than one SQ, and that any such attempt would be readily indicated by abnormal (significantly increased) fuel use. Thus misuse of HIFAR is not a plausible scenario, but the IAEA will use HIFAR to test new safeguards technology;

- further development of verification approaches appropriate for uranium mines.

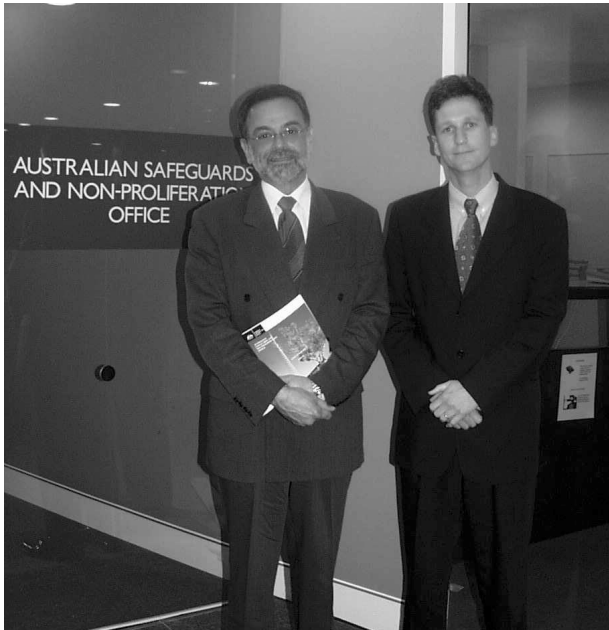
IMPLICATIONS FOR LUCAS HEIGHTS

Strengthened and integrated safeguards will place new requirements on nuclear operators and national safeguards authorities. In particular, for unannounced inspections to work efficiently the operator's accountancy records need to be maintained on a real-time or near-real-time basis (what is referred to as NRTA—'near-real-time accountancy'). This is likely to require integrated site-wide computerised accountancy systems. ASNO is working closely with ANSTO to ensure the necessary standard is achieved.

CONCLUSIONS

Since Australia's Additional Protocol was the first to enter into effect, we have been in a pioneering role in assisting the IAEA to develop the procedures and methods for strengthened safeguards. Australia has hosted the IAEA's first complementary accesses, the first exercise of managed access under the Protocol, and the first complementary access to a uranium mine. We are also working with the Agency in 'generic' areas such as information collection and analysis techniques, criteria for the exercise of complementary access, and evaluation techniques.

STRENGTHENING OUR RELATIONSHIP WITH THE INTERNATIONAL VERIFICATION AGENCIES



Mr Bustani and Dr Shaw at ASNO

During the reporting period, ASNO co-hosted with DFAT visits by the head of each of the three most significant international bodies tasked, together, with preventing the spread of nuclear and chemical weapons worldwide.

The Director-General of the OPCW, Mr José Bustani, visited Australia in November 1999. He was followed by the Director General of the IAEA, Dr Mohammed ElBaradei, who came here in February 2000. Finally, the Executive Secretary of the CTBT Preparatory Commission, Dr Wolfgang Hoffmann, visited in March 2000.

These visits involved discussions in Canberra with some accompanying site-visits to relevant facilities across the country. The meetings enabled ASNO to showcase both its technical excellence in each domain and the synergies obtained from co-locating national authorities across the range of WMD verification regimes.



Dr ElBaradei, Director General of the IAEA—photograph courtesy of IAEA

Mr Bustani met with the Minister for Foreign Affairs Mr Downer, a call he said was particularly valuable. He complimented ASNO on its initiatives regarding a CWC public awareness campaign, and involvement in regional and international work promoting effective implementation of the Convention. While in Australia, Mr Bustani also presented a public lecture on the CWC at the University of Sydney. Dr ElBaradei expressed his deep satisfaction with the contribution made by ASNO to the IAEA and to strengthening nuclear safeguards internationally. Dr ElBaradei was particularly impressed at ASNO's efforts considering the small number of staff. During Dr Hoffmann's visit he and Mr Downer signed a

facility arrangement covering establishment and operation of the international monitoring system (IMS) sites in Australia, when he praised as excellent the cooperation between Australia and his secretariat in Vienna.

Dr Hoffmann took advantage of his time in Australia to call on the Western Australian Minister for the Environment, an important visit since Western Australia will host a number of IMS stations covering the full gamut of technologies (see page 107). Also he gave a public address to the Sydney Institute.

REGIONAL TRAINING COURSE ON NATIONAL SAFEGUARDS SYSTEMS

International safeguards should be understood as a mechanism which allows a State Party to a safeguards agreement to work with the IAEA to assure the State's neighbours, and the international community generally, that it is in compliance with its non-proliferation commitments. This is an important international confidence building measure and so directly benefits the inspected State.

Because of these benefits Australia's overseas development aid program funded a regional training course on national safeguards systems in April 2000. This activity meshed well with Australia's broader non-proliferation objectives. In addition to its international commitments, each State must exercise effective control over nuclear material for domestic reasons. The national infrastructure required for effective and efficient IAEA safeguards is essentially the same as that needed to exercise effective national control of nuclear material and is commonly known as the 'State System of Accounting for and Control of Nuclear Material (SSAC)'.

In 1985 Japan and Australia reached an informal understanding with the IAEA that they would offer regional courses (for participants from the IAEA's Far East and Southeast Asia and Pacific Regions) in alternate years, or as required by the Agency. Since then Japan has hosted regional courses in 1985, 1987, 1991 and 1995 and Australia has hosted courses in 1986, 1989 and 1994, and now most recently in March/April 2000.

Under long-standing arrangements for the conduct of these courses, the host country provides airfares to and from the course location, accommodation and a subsistence allowance for participants from developing countries, for IAEA lecturers, and for Guest Lecturers (senior officers of national and regional safeguards systems within the region and beyond). The host also provides training facilities, including classrooms, a laboratory for nuclear materials measurement practicals, and access to a real nuclear facility (the HIFAR reactor in our case) for other exercises. Lecturers and exercise coordinators from the host country make a substantial contribution.

ASNO obtained funding of about \$250,000 from the Australian Agency for International Development (AusAID). ASNO also entered into an arrangement with ANSTO under which the first half of the course would be conducted at ANSTO's training facilities at Lucas Heights. The course syllabus was designed collaboratively by ASNO and the IAEA Section for Safeguards Training. ASNO included several new elements, mainly covering strengthened safeguards and the Additional Protocol, but also some items that the IAEA had found useful in similar courses in other countries.

The course was conducted from 27 March to 14 April 2000, the first half at Lucas Heights and the second half in Canberra. Participants came from several regional countries: one from Cambodia, two from China, three from Indonesia, one from Japan, two from the Republic of Korea, two from Malaysia, one from the Philippines, one from Thailand and two from Vietnam (participants from industrialised countries were self-funded). There were six students from Australia.



Panel discussion at the regional training course
(left to right—Dr Marzo, ABACC, Mr Kim, TCNC, Dr Ridwan, BAPETEN, Mr Carlson, ASNO,
Mr Kurihara, NMCC and Mr Nackaerts, Euratom Safeguards Office)

In addition, Australia invited two participants from the Democratic People's Republic of Korea (DPRK). Since the DPRK is not a member of the IAEA, their representatives were formally observers, although they received exactly the same training as everybody else. So we had 23 participants from eleven countries. Lecturers came from ABACC (the Brazilian/Argentine Safeguards Agency), Euratom, Indonesia, Japan (2), the Republic of Korea, the IAEA (5), and Australia (11—from ASNO, ANSTO, CSIRO Energy Technology and DFAT's Nuclear Policy Branch).

Both the participants and the IAEA acknowledged the course as very successful. Specifically, Dr Pierre Goldschmidt, the IAEA's Deputy Director General for Safeguards, wrote in a letter thanking ASNO for its efforts, '...the course was organised in a highly professional manner and was truly successful.'

THE NUCLEAR INDUSTRY—SOME CURRENT ISSUES

In view of Australia's position as a major uranium exporter and holder of the world's largest uranium reserves, clearly future developments in the nuclear industry are of considerable interest to Australia. It is essential that nuclear developments, in our region and globally, proceed in a way that enhances non-proliferation objectives. Another area of major importance is the impact of future energy programs on the environment, in particular climate change, and the role of nuclear energy in this context.

INTRODUCTION

It is a common perception that nuclear energy is an industry that has peaked and is facing decline. In recent years there have been no new power reactors built in North America and few in Western Europe, some governments are resolutely against nuclear energy, and one or two governments have adopted a policy of phasing out nuclear energy. The only growth areas appear to be in Asia, but even here some uncertainty has been expressed about the future of the region's largest program, in Japan.

This general impression is misleading. For a start, nuclear energy contributes a very substantial share of world electricity supply—16% globally, an average of 25% in OECD countries. Some 32 countries have nuclear power programs (see Table 8 on page 83). In over half these countries nuclear energy contributes more than 25% of electricity supply, in some as much as 70-80%. A number of other countries import significant amounts of electricity generated by nuclear programs.

In addition to electricity supply, both direct and indirect, there is another way in which nuclear power is important—through the reduction of greenhouse gas emissions. Global CO₂ emissions from electricity generation would increase by 25-30% if existing nuclear power generation were replaced by coal-fired stations.

Increasing electricity demand There is no doubt that global electricity demand will grow very substantially this century, particularly as living standards in developing countries improve. For example, the World Energy Council has estimated⁷ that annual world electricity consumption will at least double or even triple over the next 50 years:

Table 6—Electricity projections (figures in terawatt/hours (TWh))

Scenario	2000	2020	2050
Present:	15,000		
Conservative middle growth scenario:		19,000	32,000
High growth scenario:		23,000	41,000

Electricity consumption could be higher still if opportunities for fuel substitution are maximised, e.g. replacing petroleum through large-scale use of electricity in transportation, both directly and through production of hydrogen fuel. Substitution offers very substantial environmental benefits—but only if supplied by non-fossil sources.

7. WEC/IIASA (International Institute for Applied Systems Analysis), 'Global Energy Perspectives', 1998.

Clearly if a two to three-fold expansion in electrical production were based on fossil fuels the environmental consequences—local and global—would be very serious. Environmental impact has to be a key consideration in making energy choices. Other essential factors will be economics and security of supply. As an illustration, natural gas—the fuel of choice for new power stations in many countries—faces a number of uncertainties in the future: there are predictions that world natural gas production will plateau in 30-35 years, reflected in escalating prices well before then; much of the world's supply comes from, or through, areas of uncertain political stability; and of course use of natural gas releases major greenhouse gases, CO₂ and methane.

Energy choices Governments will choose an energy mix depending on particular national circumstances, e.g. availability of energy resources, including the feasibility of renewables, opportunities for energy conservation and fuel substitution, and so on. Of the various non-fossil sources, only hydropower and nuclear have a demonstrated ability to generate large-scale baseload electricity. Hydro-electrical schemes are not without environmental (including greenhouse) consequences and political difficulties, and in OECD countries few suitable sites remain. The ability of nuclear energy to significantly mitigate the environmental and climate change consequences of using fossil fuels can be expected to become increasingly relevant to decisions about national energy mixes.

Factors affecting the status of nuclear energy In current circumstances there are several factors that work to the disadvantage of nuclear energy:

- ❑ the high capital costs of a new plant;
- ❑ liberalisation of the electricity industry is encouraging short-term profit horizons;
- ❑ comparatively low prices currently for alternative fuels, especially natural gas;
- ❑ whole-of-cycle costs for nuclear are internalised in electricity tariffs, while the indirect costs of other fuels are not;
- ❑ public and political concerns about radioactive waste disposal, safety, and nuclear proliferation.

On the other hand, over the medium to longer term there are important factors which can be expected to lead to a re-evaluation of nuclear energy:

- ❑ increasing public and political concern about the impact of fossil fuels on global climate—likely to be reflected in emission limits and possibly taxation regimes;
- ❑ associated with this, increasing recognition of the ‘internalisation’ issue, i.e. that electricity tariffs should reflect the true costs of different energy sources;
- ❑ while most power generation is sensitive to rises in fuel prices—including taxation—with nuclear capital costs predominate and substantial increases in the price of uranium would have little impact;
- ❑ security of supply considerations.

Issues of waste disposal and safety are beyond the scope of this Report—these are predominantly issues of public confidence, not technical inadequacies, and there is no doubt greater efforts are required towards improving public understanding. As to nuclear proliferation, there is a robust non-proliferation regime, centred on the NPT and IAEA safeguards, which is outlined elsewhere in this Report.

Seeing nuclear energy in context Overall, there is a need to view nuclear energy in context, not in isolation, with any discussion of nuclear's pros and cons being set against

the consequences of other energy sources. The perceived risks of nuclear need to be compared to the certainties—many of them adverse—associated with the use of other fuels.

DEVELOPMENTS IN TECHNOLOGY

ASNO maintains a close interest in developments in nuclear technology from two perspectives: the potential for establishment of, and growth in, nuclear programs; and potential implications for the non-proliferation regime and for the application of safeguards.

In the short to medium term there are two broad trends in power reactor technology—the development of reactors incorporating enhanced safety features, such as advanced pressurised reactors (APWRs) and advanced boiling water reactors (ABWRs), and the development of new reactor types which are more economically competitive than those currently available. These two trends are not mutually exclusive:

- ❑ as far as light water reactors (LWRs) are concerned, while there is some concern that APWRs and ABWRs are more expensive than established models—at a time when the capital costs of nuclear are seen as a disadvantage and there is pressure to reduce costs—it is possible that standardisation on say two or three models that could be manufactured on an assembly-line basis might bring about offsetting savings;
- ❑ on the other hand, cost considerations have led to considerable attention being given to an entirely different reactor concept, the modular high temperature gas-cooled reactor (MHTGCR), which happens to also offer major safety advantages.

Currently there are two MHTGCRs at an advanced stage of development, the ‘pebble-bed’ design of South Africa's ESKOM, and a design from a US/Russian/French/Japanese group led by the US company General Atomics (GA). Both designs are graphite-moderated and cooled by helium which drives a turbine for electrical generation directly (i.e. there is no steam cycle). Both feature emergency passive cooling, i.e. safety does not depend on forced circulation of the coolant. Both are designed to be installed in modules, the ESKOM unit having a capacity of 114 MWe and the GA unit 284 MWe. The small size suits smaller grids, while the modular approach allows capacity at a particular site to be increased progressively by installation of more units. The ESKOM reactor is designed to operate on fuel of around 7-10% enrichment. The GA reactor could operate on a variety of fuels, but is being looked at particularly for the consumption of plutonium released from the Russian weapons program.

Both reactors are designed to operate on a ‘once-through’ cycle, i.e. the fuel would not be reprocessed, and in fact reprocessing would be complicated due to the presence of graphite. If these reactors live up to expectations they will be substantially cheaper to build than LWRs—in the case of the ESKOM design around half current LWR costs. A number of experts are predicting that the MHTGCR will be the next generation of reactor, likely to be chosen for many new nuclear power plants over the period 2010-2030.

On current information the MHTGCR appears to offer advantages from the non-proliferation/safeguards perspective. ASNO will be following the development of this technology with considerable interest.

PLUTONIUM RECYCLE AND FAST REACTORS

The ‘thermal’ fuel cycle—typified by the LWR (the MHTGCR is also a thermal reactor)—is an extremely inefficient use of uranium resources, generating energy primarily from the fissile uranium isotope U-235 which comprises only 1/140th of natural uranium⁸. At current rates of consumption, existing and estimated uranium reserves recoverable at up to \$US80/kg (compared with current spot prices around \$US20/kg) are sufficient for only about 50-60 years—growth in the nuclear industry will reduce this period. Of course, further uranium discoveries can be expected, and very substantial higher cost uranium resources exist (e.g. seawater offers a virtually unlimited supply, albeit at about 10 times current prices). Higher costs, however, will make inefficient resource use even less sustainable.

The most efficient use of uranium resources will come from the use of the fast neutron fuel cycle. The basis of this fuel cycle is the use of fast (unmoderated) neutrons to convert the predominant uranium isotope U-238 to plutonium, and the use of that plutonium as reactor fuel. The development of fast neutron reactors is generally on hold at present, mainly for economic reasons (particularly depressed uranium prices), but also because of engineering complications, and public concerns about safety following incidents at Super-Phénix (France) and Monju (Japan). Nonetheless, the advantages of the fast neutron fuel cycle—in energy terms and also for high level waste management (see the article on partitioning and transmutation on page 70)—are such that it may well come into widespread use in the future.

It should be noted that plutonium plays a significant part even in the current thermal cycle—e.g. towards the end of a fuelling cycle about half the energy in an LWR comes from the fissioning of plutonium produced in the fuel. However, thermal reactors are inefficient users of plutonium: very little of the non-fissile⁹ plutonium isotopes can be fissioned in a thermal reactor, and only a small fraction of the potential energy from plutonium can be realised. Use of MOX fuel in LWRs can be viewed as a fill-in measure pending establishment of the fast neutron fuel cycle.

Conventional fast breeder reactors (FBRs), such as Super-Phénix and Monju, use MOX (uranium/plutonium oxide) fuel with a relatively high proportion (20-30%) of plutonium. The fuel is surrounded by a uranium ‘blanket’ in which neutrons are captured to produce further plutonium. The blanket can be made from depleted uranium, thus providing a use for the millions of tonnes of tails left over from the uranium enrichment process which currently are essentially a waste material. The plutonium produced in the blanket is recovered by reprocessing, and made into fresh fuel. An issue from the non-proliferation perspective however is that plutonium produced in FBR blankets has a very high proportion of the isotope Pu-239, making it highly suited to nuclear weapons.

While on the face of it greater use of plutonium recycle, and the introduction of the fast neutron fuel cycle, will present the non-proliferation regime with new challenges, it is possible for these developments to be pursued in ways which will actually enhance non-proliferation objectives. This is the subject of the following article, on non-proliferation issues.

8. Allowing for U-235 remaining after enrichment in depleted uranium tails, in fact the proportion of uranium unused in the thermal cycle is even greater, around 99.5%.

9. The fissile plutonium isotopes are ‘odd-numbered’, e.g. Pu-239 and Pu-241. Typically they comprise about 70% of the total plutonium in LWR fuel.

CONCLUSIONS

Despite the popular perception of an uncertain future, there are a number of developments that are likely to lead to a re-evaluation of nuclear energy, especially increasing recognition of the global effects of different energy choices, and the changing economics of various energy sources. This century a massive expansion in electricity supply will be essential for rising living standards, and nuclear energy can make a major contribution to mitigating the impact of greatly increased fossil fuel use. Within the nuclear industry there are developments, such as the emergence of new reactor types, aimed at enhancing the competitiveness of nuclear energy. It is essential that an expansion of nuclear programs occurs in a way that enhances non-proliferation objectives. As a major uranium supplier and a key supporter of the non-proliferation regime, Australia is well placed to exercise a constructive influence on these developments, and it is clearly in our national interest to do so. This is an important aspect of ASNO's work.

THE NUCLEAR NON-PROLIFERATION REGIME—INSTITUTIONAL AND TECHNICAL ASPECTS

INTRODUCTION

From the outset of the nuclear era, non-proliferation of nuclear weapons has been an objective of the highest priority. The almost universal adherence to the non-proliferation regime has been possible because of the realisation by the overwhelming majority of States that their security interests would not be furthered by the acquisition of nuclear weapons. Hence most States have joined the NPT as non-nuclear-weapon States, and have accepted comprehensive IAEA safeguards, currently being strengthened by the introduction of the Additional Protocol and related measures. While the political commitment against proliferation has been the decisive factor, curbing nuclear proliferation has also been helped by the relatively limited spread of proliferation-sensitive technologies (enrichment and reprocessing) and the limited availability in civil programs of weapons-grade nuclear materials.

In the early days of the development of nuclear technology, efforts were made to find an inherent technical barrier to proliferation, i.e. some way of ‘spiking’ reactor fuel to render it incapable of being used to produce nuclear weapons material. However, no practicable solution was found, and attention turned to institutional barriers to proliferation. In considering whether technical barriers are now becoming practicable, or desirable, it is worthwhile to review the institutional context in which nuclear energy operates.

INSTITUTIONAL MEASURES IN SUPPORT OF NON-PROLIFERATION

Limiting the spread of sensitive technology The manufacture of nuclear weapons requires either:

- ❑ uranium at very high enrichment levels (while the high enriched uranium (HEU) category starts at 20% U-235, *weapons-grade* uranium comprises 93% or more U-235), produced in enrichment plants designed and operated for this purpose; or
- ❑ plutonium preferably with a very high proportion of Pu-239 (*weapons-grade* plutonium comprises less than 7% Pu-240), produced in reactors designed and operated to produce low burn-up plutonium, and separated from spent fuel or irradiation targets in reprocessing plants or plutonium extraction plants.

These materials are very different to those normally produced in civil programs: low enriched uranium (LEU) typically used in light water reactors (LWRs) is in the range of 3-5% U-235, and *reactor-grade* plutonium from the operation of LWRs is typically around 25% Pu-240. The history of nuclear weapons development shows that those States that have acquired nuclear weapons have established dedicated facilities for this purpose, rather than using civil power programs—indeed, in some of these States nuclear power remains insignificant or non-existent. Nonetheless, because enrichment or reprocessing are indispensable for the production of weapons material, the earliest institutional barrier against proliferation was control over the supply of enrichment and reprocessing technologies, and this remains a key element in the non-proliferation regime. Most States with nuclear power programs have neither enrichment nor reprocessing facilities, instead contracting with others for these services.

Political and legal commitments As more and more States sought to share in the benefits of nuclear science and technology, the focus of non-proliferation efforts turned to establishing legally binding peaceful use commitments, with a verification mechanism in the form of safeguards inspections. Initially this was on a bilateral basis, but in the late 1950s and the 1960s this was multilateralised, culminating in the conclusion of the NPT in 1968, and the introduction of comprehensive (*full scope*) IAEA safeguards soon after.

The non-proliferation regime that has evolved, with the NPT as its centrepiece, is multi-layered, with several elements complementing and reinforcing each other—thus providing defence-in-depth. Of fundamental importance is the political commitment of almost every State against acquiring nuclear weapons. This political commitment is reinforced by treaty commitments, particularly membership of the NPT. The NPT is now almost universal—the only significant non-Parties being Israel, India and Pakistan (Cuba is also a non-Party, but all its existing nuclear activities are under safeguards). Political and legal commitments are further reinforced by confidence-building measures, the most important being IAEA safeguards, which provide assurance through verification. As has been discussed, restraint both in supply and in acquisition of sensitive technology continues to be an essential element in the regime.

Future institutional developments An important area of development is the promotion of transparency in nuclear programs—that the extent of national nuclear programs, and the policies behind them, should be clearly open and comprehensible to others. While the present focus is on transparency through IAEA safeguards, there are other transparency mechanisms, both existing and potential, directly between States, at the bilateral and the regional level.

Another area for further evolution is in relation to access to sensitive technology. Clearly it remains prudent to limit the States operating enrichment and reprocessing facilities. This is not to say that current non-proliferation and safeguards arrangements are inadequate, but rather, to recognise the benefits of mutually reinforcing mechanisms. Containing the spread of sensitive technologies may come under challenge, however, as nuclear power programs grow, and as more States aspire to technological independence and equality. For the limitation of sensitive technology to continue to be effective, it will be necessary to address the commercial terms on which enrichment and reprocessing services are made available, and especially to address the issue of security of supply.

In 1980 the IAEA-coordinated International Nuclear Fuel Cycle Evaluation (INFCE) recommended that sensitive facilities be owned and operated on a multi-nation basis. In some ways the further privatisation of the nuclear industry and the process of globalisation are leading towards the INFCE model: the operation of sensitive facilities by the private sector rather than governments—all the more so where this is by corporations crossing national boundaries—clearly brings benefits in terms of transparency and confidence-building. In the future, the governments concerned may wish to consider establishing enrichment and reprocessing facilities, as well as plutonium storage and fuel fabrication facilities, on a regional basis—servicing the needs of industries in the region, and operated by regional partnership involving governments and the private sector. This approach would limit the overall number of sensitive facilities, would maintain them under multilateral control, and would remove the economic motivation for establishing such facilities on a national basis.

TECHNICAL MEASURES IN SUPPORT OF NON-PROLIFERATION

The institutional elements of the non-proliferation regime have proven very effective. It is timely to consider whether these can be complemented through technical developments. Technical measures could add to the difficulty of diversion of nuclear material useable for weapons, and enhance the international community's capability for timely detection of such diversion. While the choice of future nuclear power systems will depend on factors including economic competitiveness, energy security, safety standards, and waste disposal options, opportunities to address proliferation-related aspects should also be taken into account, preferably at an early stage in the decision-making process.

Developments prompting renewed consideration of these issues include:

- ❑ the fact that reprocessing is well established in a number of countries, and there are substantial quantities of separated plutonium in civil programs;
- ❑ the accumulation of separated plutonium has been exacerbated by the delay of commercialisation of fast breeder reactors (FBRs)—this in turn has led to increasing utilisation of MOX (mixed uranium/plutonium oxide) fuel in thermal reactors;
- ❑ the end of the Cold War has brought about the need to dispose of ex-weapons plutonium and HEU;
- ❑ for the future, the prospect of the introduction of the plutonium breeding cycle.

CURRENT RESEARCH

Currently R&D in this area is proceeding in two broad directions:

- ❑ technical approaches predicated on the 'once-through' cycle, to create a technical barrier to the recovery of plutonium, and minimise plutonium production, and to consume/degrade plutonium released from weapons programs;
- ❑ technical approaches predicated on plutonium recycle, under which recycle could proceed in 'non-proliferation-friendly' ways, e.g. recovery and recycle of plutonium without separation.

Proliferation-resistant Fuels (PRFs) PRFs are an example of the first approach mentioned above. PRFs have been proposed in several countries, including France, Italy, Switzerland, Japan and the US, as a means of disposing of excess military and civil plutonium. PRFs would encapsulate plutonium and burnable poisons in a non-uranium matrix. PRFs are designed to behave like standard, low-enriched uranium fuel, able to be used in standard LWR fuel cycles without reactor modification. Because they do not contain uranium or thorium, PRFs do not produce plutonium or U-233. Consequently, PRFs can consume more plutonium than MOX over identical reactor cycles. The results of extensive theoretical studies are extremely promising. However, deployment of PRFs will require a significant fuel development and qualification program.

Radkowsky Thorium Fuel (RTF) concept This is another approach to a proliferation-resistant fuel. The RTF concept assumes a once-through fuel cycle with no reprocessing. The fuel comprises uranium enriched to a maximum of 20% and a thorium blanket, incorporated in a 'seed-blanket unit' fuel assembly. Compared to an LWR, the partial replacement of uranium by thorium results in a major reduction in plutonium production. U-233 produced through irradiation of the thorium is mostly consumed in the reactor, and the residual U-233 in the spent fuel is denatured by non-fissile uranium isotopes.

Of more significance, given the likelihood of greater plutonium recycle in the future, are approaches which directly address plutonium recycle issues:

Co-processing of FBR material A simple approach to avoiding the separation of the high Pu-239 plutonium produced in FBR blankets is to avoid the separate reprocessing of blanket assemblies, instead reprocessing blanket and core assemblies together, or blending blanket material with LWR fuel in-process, so as to dilute the fissile content of the plutonium before it reaches the separated stage. This approach has been adopted by JNC (Japan Nuclear Cycle Development Institute) for its RETF facility.

DUPIC An interesting example of plutonium recycle without separation is the DUPIC process¹⁰ being developed through collaboration between the ROK, Canada, and the US. By direct re-fabrication of spent PWR fuel into fresh CANDU reactor fuel, the DUPIC fuel cycle can reduce natural uranium requirements and spent fuel arisings. The basis of DUPIC is that the fissile content of spent PWR fuel (residual U-235 and produced plutonium) is well suited for use in heavy-water moderated CANDU reactors. No separation of plutonium is involved: dry thermal-mechanical processes are used to reduce spent PWR fuel to a fine powder, which is subject to high temperature to drive off volatile fission products (around 40% of total fission products), pressed into pellets, and fabricated into CANDU fuel bundles.

Pyro-electro-chemical reprocessing One possibility for simpler reprocessing is adoption of pyro-electro-chemical processes originally developed in the US and Russia. These processes can be applied for many different types of fuel. A key feature is that there is no separation of plutonium from uranium. A number of countries are pursuing research in this area.

Russian BREST Reactor Russian researchers are working on an innovative concept of a ‘transmutational’ fuel cycle based on a fast neutron lead-cooled reactor, ‘BREST’. The proposed reactor has a number of design features that make it proliferation-resistant. The reactor features full plutonium reproduction in the core-uranium blankets are not used to breed plutonium, thus precluding production of weapons-grade plutonium. With a small reactivity margin in the core, it is not feasible to load targets into the reactor for undeclared plutonium production.

The design eliminates the need for plutonium separation from spent fuel. Spent fuel reprocessing will be reduced to removing the bulk of fission products and actinides from the uranium/plutonium mix. To adjust fuel composition, further U-238 is added to compensate for fuel burn-up. A decision on the reprocessing method has yet to be taken, but it will probably be a pyro-electrolytic technique, as discussed above. A small proportion of fission products still remaining in the fuel after incomplete purification will create a radiation barrier facilitating physical protection of the fuel. Spent fuel can be cooled for 3 to 12 months in an in-vessel storage facility-reprocessing and fuel fabrication would take place at the power plant site, eliminating any physical protection issues associated with long-distance shipments of fuel.

The concept also offers major advantages for waste management: fission products and minor actinides would be recycled for transmutation, substantially reducing the period of high radiotoxicity—it is envisaged that the resulting high level waste would decay to levels comparable with natural uranium within about 200 years. Russia hopes to build a 300

10. DUPIC stands for Direct Use of spent PWR fuel in CANDU reactors.

MWe prototype BREST reactor in 2002, for completion in 2007. Provided use of lead coolant proves viable, this concept appears very promising.

Super-PRISM Reactor While the BREST concept appears particularly attractive, there are other fast neutron reactor concepts which avoid plutonium separation. For example, in the US General Electric is developing a modular liquid sodium-cooled fast reactor called Super-PRISM. This concept uses a dry pyro-processing system that does not separate plutonium from minor actinides, thus enhancing the proliferation resistance of the S-PRISM fuel cycle. Due to the compact nature of the dry pyro-processing system, on site processing of the spent metal fuel is a design option. In this case, the fresh and spent fuel storage and receiving facilities would be replaced by a compact co-located Spent Fuel Recycle Facility that integrates spent fuel storage, processing and waste storage and conditioning operations into a single facility.

CONCLUSIONS

Developments in the nuclear industry and in nuclear technology should be considered in the context that the overwhelming majority of countries have given political and legal commitments against the acquisition of nuclear weapons. These commitments are reinforced by the institutional arrangements of the non-proliferation regime, especially by IAEA safeguards, and also by limits on the supply of sensitive technology. Institutional aspects of the non-proliferation regime continue to evolve, e.g. through strengthened safeguards and enhanced transparency. Further developments are likely to include closer regional links.

The non-proliferation regime can be further strengthened through technical barriers, such as proliferation-resistant features at relevant stages of the fuel cycle. This has not been a priority to date, because containing the spread of sensitive technology has been largely effective, and because there is very little weapons-grade material in civil nuclear programs. However, the increasing use of plutonium fuels, and particularly the development of the plutonium breeding cycle, is prompting renewed interest in technical approaches in support of non-proliferation objectives.

Introduction of the plutonium breeding cycle has been delayed by a number of factors, especially economics, brought about by the slowdown in the growth of nuclear energy and by depressed uranium prices. This delay provides an important opportunity for the international community to ensure that non-proliferation aspects are properly addressed at an early stage in the development of new fuel cycle concepts. While plutonium recycle could present a substantial challenge to non-proliferation objectives, some of the approaches outlined above show that, if developed in an appropriate way, plutonium recycle could actually bring major non-proliferation advantages.

This will continue to be a major area of interest to ASNO, ensuring that the Government is kept appraised of developments and that Australia is able to play a constructive role in support of non-proliferation objectives.

NUCLEAR WASTE MANAGEMENT—PARTITIONING AND TRANSMUTATION

INTRODUCTION

Naturally occurring radioactive materials such as uranium and thorium are common elements within the earth's crust. Natural background radiation from these elements and other sources has always been present and is a constant feature of life on earth. Spent fuel from a nuclear reactor is highly radioactive, but over time this radiation decreases and becomes less significant. It would take many thousands of years for the radiation from the spent fuel to fade away completely, but once it reaches the same level as natural background radiation it no longer needs to be kept separate from the biosphere.

If spent fuel is directly disposed of without reprocessing it will remain more radioactive than the corresponding quantity of uranium ore for over 30,000 years. The principal objective of spent fuel reprocessing is recovery of plutonium and uranium for recycling as reactor fuel. There are also substantial waste management advantages—removal of plutonium and uranium reduces the period in which the remaining high level waste will be more radioactive than the corresponding uranium ore to around 2,000 years¹¹.

2,000 years of course is still a significant period. While studies of natural areas of high radioactivity, such as the Oklo natural reactors in Gabon¹², and ore bodies in the Alligator Rivers Region in the Northern Territory, show that radiotoxic elements can be immobilised and isolated from the biosphere for many hundreds of thousands of years, nevertheless it would be advantageous to reduce the period of high radiotoxicity—if for no other reason, to establish public confidence in waste management programs.

Accordingly, a number of countries have been carrying out research into the possibility of partitioning radioactive isotopes from high level waste. Partitioning—in the context of spent fuel management, refers to the processes that provide efficient separation of long-lived radioactive isotopes (fission products and minor actinides) from spent fuel and/or high level waste for further treatment and disposal.

If, for example, reprocessing of spent fuel is modified to remove some of the *minor actinides*, such as neptunium and americium, then the remaining waste will decay to a radioactivity level similar to uranium ore in 1,000 years. If the process is further refined to also remove certain long-lived fission products, the waste will decay to a radioactivity level similar to uranium ore in about 500 years.

11. Time periods taken from 'Radioactive Waste Management—An IAEA Source Book', 1992 (figures 7 and 8).

12. The Oklo natural reactors evolved 1.8 billion years ago, at a time when the content of the fissile isotope uranium-235 in natural uranium was much higher than it is today—around 3%, similar to the level in LEU used in light water reactors. Water saturation of the uranium ore bodies created the conditions for a self-sustained chain reaction—the resulting heat evaporated the water, bringing the chain reaction to a halt. This process repeated itself over many thousands of years, creating natural deposits of fission products and plutonium normally found only in spent reactor fuel. The movement of these radiotoxic materials through the ore bodies has been limited to only a metre or so, providing practical evidence that such materials can be successfully isolated for periods well in excess of that necessary for the protection of the biosphere.

Partitioning of minor actinides and fission products will be more advantageous if there is a further process in place for treating these elements to reduce their half-lives. Hence the concept of transmutation—the return of the materials to reactors for transmutation—through fission or neutron capture—into elements with shorter half-lives. In other words, transmutation refers to the process of gaining a substantial reduction in the period over which waste arising from nuclear energy remains highly radiotoxic, by using the neutron flux within a reactor or other intensive source of neutrons to turn (transmute) long-lived radiotoxic elements into short-lived or stable elements. This transmutation step can substantially decrease the time needed to render the partitioned material harmless.

Efficient transmutation requires fast neutrons (neutrons not slowed down by a moderator). As there is only limited availability of fast neutrons in *thermal* reactors (such as light water reactors), research into partitioning and transmutation arose in the context of expectations of the early deployment of fast breeder or other fast neutron reactors. While the delay in the introduction of fast neutron reactors has led to some diminution of interest in partitioning and transmutation in the short term, nonetheless it is a concept of considerable promise for the future—and for example is the basis of the Russian concept of a ‘transmutational fuel cycle’ (on page 68).

NEPTUNIUM AND AMERICIUM

Two of the materials of interest for partitioning and transmutation are neptunium and americium. Since these are *fissionable* materials (i.e. they can be fissioned by fast neutrons), recycle in a fast neutron reactor would have the advantage that they would contribute to the energy production in the reactor, in other words they would be a useful component of the reactor fuel.

Neptunium and americium are produced in very small quantities in irradiated fuel. Typically (depending on the irradiation history) reactor spent fuel would contain about 1 gram of neptunium for every 20 grams of plutonium. Americium is produced in irradiated fuel at a lower rate, roughly one quarter as much as neptunium, and also arises in separated plutonium or spent fuel through decay of the isotope plutonium-241.

Because neither material is fissionable by *thermal* neutrons, to date there has been limited use for neptunium or americium, and generally they are not separated from fission products: they are either contained within spent fuel or, if reprocessing is undertaken, mostly end up in the waste stream. Both materials have been separated in significant quantities only by the nuclear-weapon States (mainly the US and Russia) for specialised applications. Separated neptunium is used for the production of plutonium-238, which is used in thermo-electrical generating systems for satellites and heart pace-makers. Separated americium is widely used in smoke detectors. Both materials are also used as industrial radioisotopes, e.g. in borehole logging equipment and in instruments for measuring the thickness of processed metals.

Only very small quantities of neptunium and americium have been separated in the non-nuclear-weapon States. Separation in significant quantities would require substantial quantities of spent fuel and a reprocessing program—there are few NNWS in this situation, and there has been no incentive to separate these materials, because the tiny amounts required for research or for the commercial applications mentioned above have been available from NWS. Nonetheless, because these materials are fissionable, and because of ongoing research into their possible separation for transmutation, in recent years interested States and the IAEA have been considering how they should be managed from the

safeguards perspective. ASNO identified this issue early on and has played an active part in the ensuing deliberations.

The matter was considered by the IAEA's Board of Governors in September 1999. In the case of neptunium, the Board decided it is of little proliferation risk in current circumstances, where there are only very small quantities of separated neptunium in the NNWS. The Board decided to establish arrangements to monitor international transfers of neptunium and to verify there is no undeclared separation of neptunium in NNWS. If a significant change in the current situation appears likely the Board will consider the matter further, including whether formal extension of safeguards to neptunium is warranted. The Board considered that the proliferation risk posed by americium is even lower than for neptunium. Not only are there very limited quantities of separated americium in NNWS, but major heat and radiation problems would make any attempted explosive use extremely difficult. Accordingly, the Board asked the IAEA Secretariat to keep the situation under review and report to it if appropriate.

Australia agrees with other Board Members that this is a pragmatic approach in current circumstances, considering the limited quantities of these materials in separated form in NNWS and considering also the uncertainty that significant quantities will be separated in the future. Delays in the development of fast neutron reactors obviously impacts on the interest in separating these materials—and if transmutation programs do proceed, it is possible transmutation could be effected without actually separating the materials, e.g. they could be separated from fission products but remain in stream with plutonium and uranium, covered by the safeguards measures on those materials.

Since all spent fuel contains neptunium and americium, clearly a proportion of these materials in spent fuel is derived from AONM. Accordingly Australia has discussed this matter with relevant bilateral partners, i.e. those that reprocess AONM—UK, France and Japan. Discussions have also been held with the US and with the IAEA. Through these discussions ASNO has established that no neptunium or americium has been separated from AONM. The situation will be kept under review, and Australia will take an active part in any further IAEA Board consideration of this matter. While extension of our bilateral agreements to include these materials is a possibility if they become safeguardable materials, this is not expected to occur for many years, if at all.

THE PROPOSED FISSILE MATERIAL CUT-OFF TREATY (FMCT)

The proposal for an FMCT is one of the most important items on the multilateral disarmament and non-proliferation agenda. FMCT would cap fissile material available for weapons, as it would prohibit production of fissile material for nuclear weapons. Production of fissile material for civil purposes, and for non-explosive military purposes such as naval propulsion, would be permitted, but only under verification to ensure the fissile material is not diverted to weapons.

Australia accords a high priority to the commencement of FMCT negotiations, and it is disappointing that little progress has been made, even though the US, Russia, UK and France have ceased production of fissile material for nuclear weapons, and it is understood that China has also done so. It is essential to extend this freeze to India, Israel and Pakistan. The delay is due to the failure of the Conference on Disarmament (CD) to reach agreement on its program of work—of which FMCT would be a major element. The Final Declaration of the 2000 NPT Review Conference urged the CD to agree to the immediate commencement of negotiations on an FMCT with a view to conclusion within 5 years.

Effective and cost-efficient verification, to provide credible assurance that all participants are honouring their treaty commitments, will be fundamental to the establishment and successful implementation of the FMCT regime. In preparation for the negotiations, ASNO has carried out a considerable amount of work in the development of verification concepts appropriate for the FMCT, an area where we are recognised as being at the forefront of international thinking. Some of the key points of this work are outlined below.

VERIFICATION PRINCIPLES

The negotiating mandate agreed by the CD for the FMCT is for ‘a non-discriminatory, multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons and other nuclear explosive devices’. Thus there is the need to develop an appropriate multilateral verification mechanism.

In considering what form this might take, of course it is not necessary to start with a clean slate. There is already a highly developed verification regime for nuclear material, namely, IAEA safeguards. In the case of non-nuclear-weapon States (NNWS) Party to the NPT, the comprehensive safeguards that apply to them already fully meet FMCT objectives. In principle therefore the FMCT should not involve any additional commitments from States that have in place both an NPT safeguards agreement and the Additional Protocol for strengthened safeguards.

However, in the case of the nuclear-weapon States (NWS) and the non-NPT States (essentially India, Israel and Pakistan), it is apparent that comprehensive NPT safeguards are not an appropriate model for verification under the FMCT:

- ❑ truly comprehensive safeguards covering all nuclear material cannot apply in the NWS while those States have nuclear weapons and therefore will retain, outside verification, nuclear material existing when the FMCT enters into force;
- ❑ the cost of verification on the comprehensive model in the NWS and the other States concerned would be prohibitive;

- another major factor will be the concern of those States to protect national security—and proliferation-sensitive information relating to their past nuclear weapons programs and to their ongoing stockpile stewardship activities.

Taking these and related considerations into account, ASNO has proposed a focused approach, involving the monitoring of enrichment and reprocessing activities, coupled with verification of separated plutonium, U-233 and HEU (high enriched uranium) produced after the FMCT's entry-into-force (EIF). The focussed approach is described in greater detail in ASNO's 1998-99 Annual Report and in our publications listed at page 108.

VERIFICATION OF DECLARED NUCLEAR MATERIAL AND ACTIVITIES

Separation of plutonium, HEU or U-233 from irradiated material, and production of HEU for non-explosive purposes, would not be proscribed by the FMCT. However, monitoring would have to be applied to all enrichment and reprocessing activities to ensure there is no undeclared production of separated fissile material after EIF.

On-site verification is an essential part of IAEA safeguards and also CWC verification, which both involve routine inspections of declared activities. It is clear that the FMCT will require a similar mechanism. FMCT Parties would be required to declare fissile material production facilities, and fissile material produced after EIF, and routine verification would apply to provide assurance that this fissile material is not produced for nuclear weapons use.

MEASURES AGAINST POSSIBLE UNDECLARED ACTIVITIES

Here, there are two broad forms of verification activity: ongoing activities aimed at evaluating the completeness and correctness of States' declarations; and on-site inspections based on suspicion of a breach of treaty commitments.

As discussed elsewhere in this Report, the IAEA is involved in both forms of verification activity. The possibility of 'special inspections' initiated by the IAEA to resolve suspicions about particular locations is a long-standing feature of safeguards agreements. Now the safeguards system is undergoing substantial development, with the objective of establishing credible assurance of the absence of undeclared nuclear material and activities. A whole suite of new measures is being established, including more effective information collection and analysis, and—through the Additional Protocol—wide-ranging 'complementary access' within a State to apply verification measures such as environmental sampling.

By contrast, the routine CWC verification system does not extend beyond declared sites. To deal with suspected undeclared activities, the CWC provides for a challenge inspection mechanism, under which a challenge inspection may be initiated by a State Party, rather than by the verification agency.

The CWC approach reflects practical realities, such as the scale of the world's chemical industries. For the FMCT, ASNO suggests it would be preferable to follow the IAEA model here, and provide for the verification agency to carry out measures aimed at detection of possible undeclared production of fissile material after EIF—along the lines already accepted under the Additional Protocol. Some of these ongoing measures could include:

- ❑ analysis of satellite imagery that could reveal some characteristic structures of a production plant and trigger verification measures such as location-specific environmental sampling;
- ❑ wide-area environmental sampling, e.g. measures aimed at capturing characteristic gaseous effluents and particulates that may be deposited at significant distances from the facility; and
- ❑ acquisition and analysis of open source information, supported by information provided to the verification agency by States.

Just as under the Additional Protocol, the verification agency would have the right to request access to locations, or to the vicinity of locations, to resolve questions and inconsistencies arising from the information available to the agency. ‘Managed access’ provisions would be essential, probably elaborated in greater detail under the FMCT than in the Additional Protocol.

In addition, the FMCT will require a mechanism for right of entry to a specific location if there are serious grounds for suspicion of a breach of treaty commitments. While the special inspection mechanism would be an appropriate model, it is possible that FMCT Parties may wish to have a verification mechanism that they can initiate directly, rather than relying on the verification agency to do so. Thus the FMCT may incorporate a challenge mechanism, perhaps in addition to the special inspection (agency-initiated) mechanism.

CONCLUSION

In sum, there is the need to develop for the FMCT a new verification regime, drawing not only on experience from IAEA safeguards, but also looking at procedures and mechanisms from other verification regimes, particularly the CWC. Specific aspects that may be useful include managed access and possibly challenge inspections. In view of the substantial amount of work done in developing verification concepts, it is to be hoped that when the FMCT negotiations do get under way they can progress very quickly.

CTBT DEVELOPMENTS IN AUSTRALIA

On 23 December 1999 the Minister for Foreign Affairs, Mr Downer, issued a press release welcoming the conclusion of a contract valued in excess of \$10 million to establish a hydroacoustic monitoring station off Cape Leeuwin for the Comprehensive Nuclear-Test-Ban Treaty (CTBT). This station will be one of only eleven CTBT stations around the world listening for signs of an underwater nuclear explosion. Its location off the south-west corner of Australia is critical to effective monitoring of significant parts of both the Indian and Southern Oceans.

The heart of the Cape Leeuwin station will be an undersea triplet of hydrophones designed to detect the sounds generated by explosions, and in particular by any nuclear explosion, that may be carried out at or below the ocean surface. Overall, the station comprises three main elements:

- ❑ a triplet of hydrophones located approximately 114 km south-west of Cape Leeuwin in 1590 metres of water. The hydrophones will be at a depth of about 1100 m and will be suspended from a cable attached to the sea floor;
- ❑ a shore facility which powers the hydrophone array and records and transmits data from it via a satellite link (and possibly by land-line) to analysis centres in Vienna and Canberra; and
- ❑ a seabed cable (2-3 cm diameter) to carry power and data between the hydrophone array and shore facility. The cable would be laid on the sea floor, anchored at various points (and buried where possible). The few kilometres closest to shore would be laid in a split pipe fixed to rock. This should minimise the risk for accidental damage from marine traffic.

Hydrophone arrays such as this are extremely sensitive listening tools. Sound travels very efficiently through water, but this is especially so through part of the ocean called the SOFAR channel:

- ❑ the change in the temperature and pressure of water with depth works to refract sound waves into a particular channel—which in the deep oceans is about 1km down;
- ❑ by placing hydrophones in this channel, it is possible to pick up sounds at very large distances.

The hydroacoustic signal generated by an underwater nuclear explosion has certain characteristics which assists its identification. The appearance of a 'bubble pulse' (from expansion and then contraction of the gas bubble formed by the explosion) is a strong indicator. The frequency mix of sound generated by an explosion is a good indicator also, as is a rapid rise time when the signal first arrives.

Establishment and operation of the CTBT's International Monitoring System (IMS) is being co-ordinated and financed internationally by the Provisional Technical Secretariat of the CTBT Organisation (CTBTO-PTS)—based in Vienna. Co-ordination of the development of Australian IMS facilities is the responsibility of ASNO. In 1998 the CTBTO-PTS commissioned CSIRO to carry out a survey of the site for the Cape Leeuwin station. The contract to establish the station has been concluded with the US firm Science Applications International Corporation (SAIC), with Nautronix Ltd of Perth (WA) as their major sub-contractor. Installation of the station is planned during 2001.

The potential for data from the IMS to contribute to scientific and humanitarian activities is an important element of the CTBT. Data from the Cape Leeuwin station could contribute to monitoring of global warming through a CSIRO project to accurately measure the speed of sound in the Indian Ocean—and thereby ocean temperature.

ASNO TECHNICAL SEMINARS

During the reporting period, ASNO organised a series of technical seminars, coordinated by Dr Bragin, covering basic technologies, threats and non-proliferation of weapons of mass destruction. Originally conceived to meet ASNO's own need for greater multi-skilling of its staff and as a way of better managing its corporate knowledge, these seminars have immediately appealed to practitioners of WMD non-proliferation in several governmental agencies, including Department of Foreign Affairs and Trade, the Department of Health, Customs, Department of the Prime Minister and Cabinet, Department of Industry, Science and Resources and the Australian intelligence community. While these seminars are not open to the public, some of the papers involved are available on request. The main purpose for including this information in this Report is to give an indication of the range of issues dealt with by ASNO.

ASNO staff members made all the presentations, the bulk of which were related to the issues of nuclear non-proliferation and the security of fissile material.

Seminars addressing nuclear issues covered the following:

- ❑ Comparative Analysis of Verification Arrangements under the NPT and the CWC (Mr John Carlson);
- ❑ Verification of the Proposed Fissile Material Cut-off Treaty (Dr Victor Bragin);
- ❑ Evolution of NPT Safeguards (Mr John Hill);
- ❑ The IAEA Verification Process (Mr Russell Leslie);
- ❑ Physical Protection of Nuclear Material and Facilities (Mr John Bellinger);
- ❑ An Overview of Australia's Bilateral Safeguards Arrangements (Mr Nick Doulgeris);
- ❑ Proliferation-resistant Nuclear Fuel Cycles (Dr Victor Bragin).

A further three presentations dealt with chemical and biological weapons:

- ❑ Chemical Weapons (Dr Geoffrey Shaw);
- ❑ Biological Agents as Weapons of Terrorism (Dr Kylie Brown);
- ❑ Analysis of BWC Verification Protocol: Strengths and Weaknesses (Dr Kylie Brown).

Two additional presentations were related to the verification of the CTBT:

- ❑ An Overview of the verification arrangements under the Comprehensive Nuclear Test Ban Treaty (Mr Malcolm Coxhead);
- ❑ CTBT—Verification Challenges (Mr Andrew Leask).

ASNO has planned an extensive program for the second year of the series in which it expects to cover topical issues related to nuclear non-proliferation, CWC and CTBT, including:

- ❑ The History of the DPRK's Nuclear Program;
- ❑ Verification of Nuclear Material: an Overview of Current Technical Approaches;
- ❑ The Use of Credible Data Authentication Techniques in International Safeguards;
- ❑ Terrorism: Potential Threats to Nuclear Fuel Cycle;

- ❑ Verification Elements of Chemical Weapons Convention;
- ❑ CTBT Verification: the On Site Inspection Process;
- ❑ The Use of Radionuclide Technology in CTBT Nuclear-Test Monitoring.

Several lectures will cover issues related to the development of nuclear technology:

- ❑ BREST: a New Concept of a Proliferation-resistant Nuclear Fuel Cycle;
- ❑ Exotic Nuclear Power Generation Concepts;
- ❑ Trends in the Developments of the Nuclear Industry;
- ❑ Natural Uranium—Deposits, Mines and Mills;
- ❑ Russia's Nuclear Fuel Cycle: Evolution from Military to Civil Applications.

BACKGROUND

BRIEF OUTLINE OF THE NUCLEAR FUEL CYCLE

Currently there are more than 430 nuclear power reactors in operation in over 30 countries worldwide. In many cases they supply a substantial proportion of national electricity requirements—see Table 8 on page 83.

REACTOR TYPES

The majority of the world's power reactors are of the light water type (LWRs—light water reactors), where ordinary water acts as both moderator, slowing down neutrons to efficient speeds for nuclear fission to occur, and coolant, transferring heat from the nuclear reaction to steam generators for producing electricity.

Because ordinary water is an inefficient moderator, LWRs must be operated on enriched uranium, that is, uranium in which the proportion of the fissile isotope U-235 has been increased from the level in natural uranium, 0.71%, usually to between 3 and 5%. Some reactor types can be operated on natural uranium, by using more efficient moderators, such as heavy water, which has a proportion of the heavier hydrogen isotope deuterium, and graphite. Typical examples of this type of reactor are the Canadian CANDU, which is moderated and cooled by heavy water, and gas-cooled graphite-moderated reactors such as the UK Magnox.

FUEL CYCLE STAGES

Following mining and milling of uranium and production of uranium ore concentrates (yellowcake), the stages of the light water fuel cycle are as follows (see Figure 4 page 82):

- ❑ Conversion: natural uranium is formed into a gaseous compound, uranium hexafluoride (UF₆), prior to enrichment;
- ❑ Enrichment: a process by which the proportion of the U-235 content is increased. The main technologies in use are gaseous diffusion and centrifuge. The product is described as low enriched uranium (LEU), containing between 3 and 5% U-235;
- ❑ Fabrication: manufacture of LEU into uranium oxide fuel pellets, which are assembled into fuel rods and then fuel elements for use in a reactor;
- ❑ Reactors: a power reactor uses the heat from a controlled nuclear chain reaction to drive a turbine to generate electricity. Typically the turbine(s) is driven by steam. In the case of pressurised water reactors as well as liquid metal-cooled reactors and some gas-cooled reactors, steam for the turbines is produced in a secondary circuit. There are some high-temperature gas-cooled reactors where the generating turbine is gas-driven.

In a typical LWR fuel elements are used over 3-4 operating cycles each of 12-18 months (i.e. the reactor might be unloaded every 12 months, with a third of the core being replaced each time);

- ❑ Reprocessing: spent fuel is dissolved for the separation of highly radioactive fission products, and for the recovery of plutonium and uranium. Uranium can be re-enriched for further reactor use. Plutonium is mixed with uranium to produce MOX (mixed

oxide) fuel and used both in LWRs and potentially in fast breeder or fast neutron reactors.

Partly because depressed uranium prices are impacting on the economics of reprocessing, a number of countries have committed to, or are considering, the once-through cycle, where spent fuel will be disposed of without reprocessing.

MILITARY FUEL CYCLE

There are five acknowledged nuclear-weapon States (US, Russia, UK, France and China) and three ‘threshold’ States, two of which have conducted nuclear explosive tests (India and Pakistan) and one which is suspected of having a nuclear weapon capability (Israel). In all cases the military nuclear programs developed ahead of civil power programs. Military programs involve the production of special grades of nuclear material, substantially different to the material used in civil programs.

Nuclear weapons are based on the following nuclear materials:

Plutonium: Plutonium is formed through the irradiation of uranium in a reactor. The uranium-238 isotope absorbs a neutron, leading to the formation of plutonium-239. Longer irradiation times lead to the formation of higher plutonium isotopes, Pu-240, Pu-241 and Pu-242.

Weapons-grade plutonium predominantly comprises the isotope Pu-239 and contains no more than 7% of the isotope Pu-240. Pu-240 (and the higher isotope Pu-242) are undesirable for weapons purposes because their rate of spontaneous fission causes pre-initiation (a premature chain reaction). By contrast, ‘reactor-grade’ plutonium from the normal operation of a LWR contains high levels of Pu-240, typically around 25%.

Because of the need to minimise the Pu-240 content, weapons-grade plutonium is produced in dedicated plutonium production reactors, usually natural uranium-fuelled, graphite-moderated, where irradiated fuel can be removed after short irradiation times (i.e. at low burn-up levels).

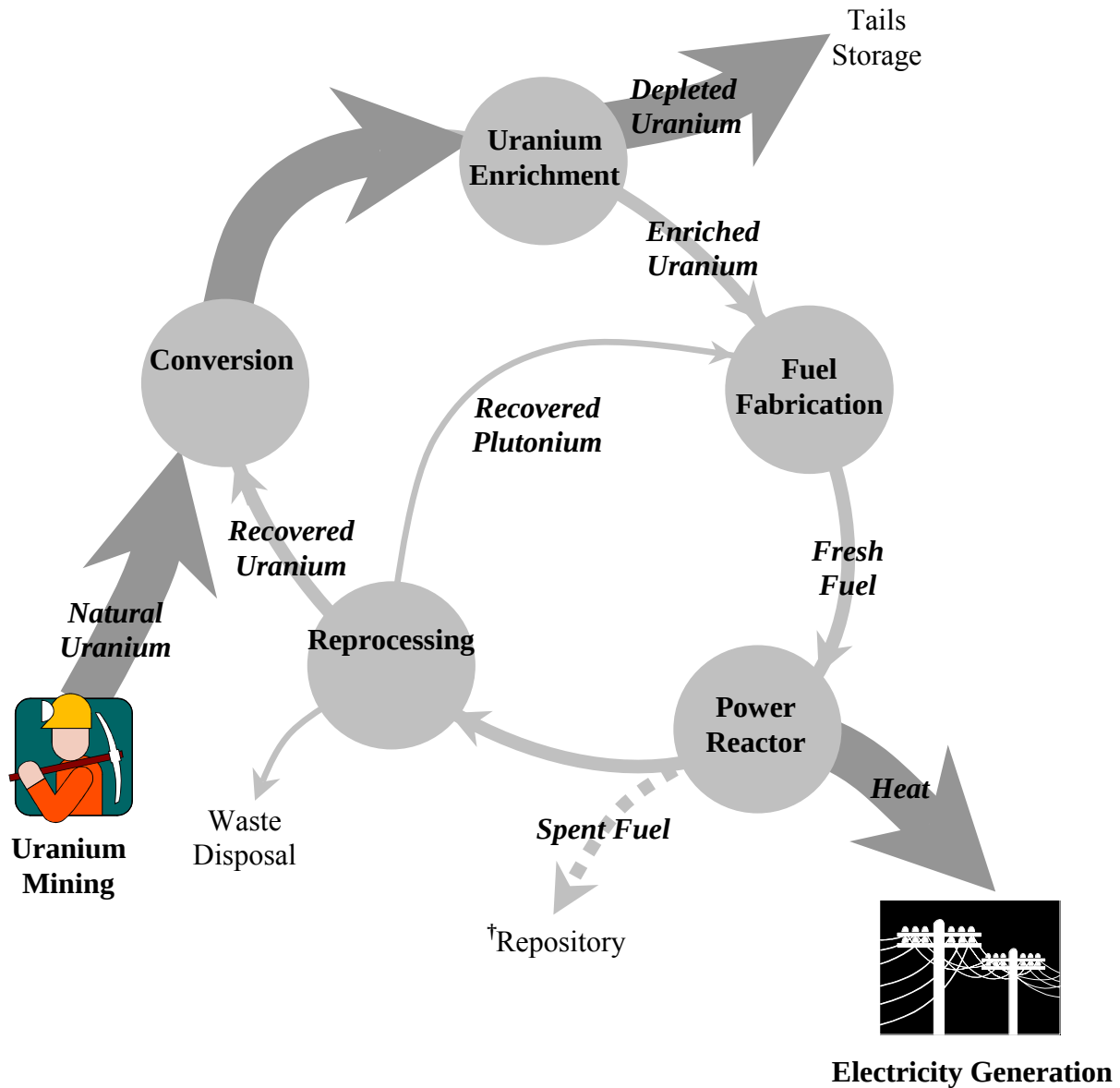
Uranium: Uranium used in nuclear weapons is very highly enriched—‘weapons-grade’ uranium is 93% U-235. This compares with normal civil enrichment levels of around 3-5% U-235. High enrichment levels are produced in enrichment plants specially designed and operated for this purpose.

Table 7—Comparison of Materials in Civil and Military Nuclear Fuel Cycles
(figures are approximate)

Material	<i>Civil</i>	<i>Military</i>
Plutonium	60% Pu-239	93% Pu-239
Uranium	4% U-235	93% U-235

The US, Russia, UK and France have announced that they have ceased production of fissile material for nuclear weapons purposes, and China is believed to have done so. Australia is a strong supporter of a Fissile Material Cut-off Treaty (FMCT) under which this situation will be formalised, and extended to India, Israel and Pakistan. The FMCT will prohibit

production of fissile material for weapons purposes, and will provide for verification on relevant facilities and material.



†Some countries choose to dispose of their spent fuel in repositories instead of recycling it.

Figure 4—Civil Nuclear Fuel Cycle-Outline

Table 8—World Nuclear Electricity Generation at 31 December 1999

<i>Country</i>	<i>Operating Reactors</i>	<i>Capacity (GWe)</i>	<i>% of Total Electricity in 1999</i>	<i>Reactors under construction</i>	
				<i>Number</i>	<i>(GWe)</i>
*USA	104	97.1	19.8		
*France	59	63.1	75.0		
*Japan	53	43.7	35.9	4	4.5
*Germany	19	21.1	31.2		
Russia	29	19.8	14.4	3	2.8
*ROK	16	13.0	42.8		
*UK	35	13.0	28.9		
Ukraine	14	12.2	43.8	4	3.8
*Canada	14	10.0	12.4		
*Sweden	11	9.4	46.8		
*Spain	9	7.5	31.0		
*Belgium	7	5.7	57.7		
Taiwan, China	6	4.9	24.8	2	2.7
Bulgaria	6	3.5	47.1		
*Switzerland	5	3.1	36.0		
*Finland	4	2.7	33.0		
Lithuania	2	2.4	73.1	4	4.5
China	3	2.2	1.2	7	5.4
Slovak Republic	6	2.4	47.0	2	0.8
South Africa	2	1.8	7.1	2	0.8
India	11	1.9	2.7	3	0.6
Hungary	4	1.7	38.3		
Czech Republic	4	1.6	20.8	2	1.8
*Mexico	2	1.3	5.2	4	3.8
Argentina	2	0.9	9.0	1	0.7
Romania	1	0.7	10.7	1	0.7
Slovenia	1	0.6	37.2		
Brazil	1	0.6	1.1	1	1.2
*Netherlands	1	0.4	4.0		
Armenia	1	0.4	36.4		
Pakistan	1	0.1	0.1	1	0.3
World total	433	349.0	(est) 16.0	41	34.4

* Eligible to use Australian uranium. Countries eligible to use Australian uranium operate 339 power reactors, accounting for around 83% of world nuclear generating capacity.

Source: IAEA Press Release 00/9, 6 March 2000

(http://www.iaea.org/worldatom/Press/P_release/2000/99npptable.shtml)

THE IAEA'S SAFEGUARDS STATEMENT FOR 1999

'In fulfilling the safeguards obligations of the Agency in 1999, the Secretariat did not find any indication that nuclear material which had been declared and placed under safeguards had been diverted for any military purpose or for purposes unknown, or that facilities, equipment or non-nuclear material placed under safeguards were being misused. All the information available to the Agency supports the conclusion that the nuclear material and other items placed under safeguards remained in peaceful nuclear activities or were otherwise adequately accounted for.

'In 1999, the Agency was in the early stages of implementing protocols additional to safeguards agreements ('additional protocols'). Having completed the evaluation of all the information available to the Agency in respect of two States, including information obtained through activities pursuant to their comprehensive safeguards agreements and additional protocols, the Agency found no indication either of diversion of declared nuclear material or of the presence of undeclared nuclear material or activities in those States. In the case of other States with comprehensive safeguards agreements and an additional protocols in force, the evaluation of the information available to the Agency was not yet complete.

'The Democratic People's Republic of Korea (DPRK) remains in non-compliance with its safeguards agreement. The Agency is still unable to verify the correctness and completeness of the initial declaration of nuclear material made by the DPRK and is, therefore, unable to conclude that there has been no diversion of nuclear material in the DPRK. Although the safeguards agreement between the DPRK and the Agency remains binding and in force, the Agency is able to implement only some of the required safeguards measures in the DPRK. These measures include monitoring the 'freeze' on the DPRK's graphite moderated reactors and related facilities, as requested by the United Nations Security Council and as foreseen in the 'Agreed Framework' of October 1994 between the United States of America and the DPRK.

'Since 1991, the Agency's safeguards activities in Iraq under the comprehensive safeguards agreement concluded pursuant to the Treaty on the non-Proliferation of Nuclear Weapons (NPT) have been implemented as part of the activities carried out by the Agency in Iraq pursuant to United Nations Security Council resolution 687 and related resolutions. In 1999, the Agency was not in a position to implement its Security Council mandated activities in Iraq and could not, therefore, provide any assurance that Iraq was in compliance with its obligations under these resolutions. In these circumstances, given the requirements of its safeguards system, and pursuant to Iraq's safeguards agreement, the Agency scheduled, for December 1999, a physical inventory verification of the nuclear material subject to safeguards in Iraq with the objective of verifying the presence of the nuclear material in question. The inspection could not be carried out in December 1999 because the Government of Iraq provided the necessary visas for safeguards inspectors only in January 2000.'

Note: The planned physical inventory verification inspection in Iraq took place from 22 to 25 January 2000. The inspectors were able to verify the presence of the nuclear material subject to safeguards.

AUSTRALIAN URANIUM EXPORTS

In 1999-2000 Australia exported 8,023 tonnes of U_3O_8 (uranium ore concentrates). This quantity of uranium is sufficient for the annual fuel requirements of about 40 reactors (of 1000 MWe), producing around 300 billion kilowatt hours (i.e. 300 terawatt hours—TWh) of electricity—one and a half times Australia's own electricity production, which in 1999 totalled about 200 TWh.

Australia holds over a quarter of the world's uranium resources recoverable at less than \$US80/kg. In 1999 the Ranger and Olympic Dam mines were respectively the world's second and third largest uranium producers, and overall Australia was the world's third largest uranium exporter.

While Australia recognises the importance of this substantial uranium holding as a source of energy for other countries not as well endowed with natural resources, strong support for the nuclear non-proliferation regime has always been a paramount consideration.

Australia exports uranium only to countries with which it has a bilateral safeguards agreement—details of these agreements and the conditions under which Australia exports uranium are given in the following pages.

Australia has 15 bilateral agreements covering 25 countries. These agreements are listed in Table 10 on page 88. Those countries which imported Australian uranium in 1999 are listed in Table 9.

Table 9—Countries to which Australian Uranium was supplied in 1999

<i>Country</i>	<i>Tonnes yellowcake (U_3O_8)</i>	<i>% of total (rounded)</i>
US	2302.0	32.1
Japan	2246.6	31.3
ROK	687.6	9.6
UK	599.7	8.4
France	497.2	7.0
Sweden	366.7	5.1
Canada	171.6	2.4
Germany	158.8	2.2
Belgium	88.4	1.2
Finland	53.1	0.7
Total	7171.7	100

These figures are for calendar year 1999 and do not correspond exactly to exports for the 1999-2000 financial year.

As at the end of 1999 there were 433 power reactors in operation in over 30 countries, with a total electrical generating capacity of around 350 GWe, and an electrical output of 2,400 TWh. These reactors produced 16% of the world's electricity (details are on page 83). Of these, 340 reactors were operated by countries eligible to use Australian uranium. The reactors in these countries produced 13% of total world electricity: nuclear energy's contribution to electricity production in countries using Australian uranium ranged from 12.4% in Canada to 75% in France.

In 1999, exports of Australian uranium represented over 11% of the total carbon dioxide emissions avoided world-wide through generating electricity by nuclear energy rather than fossil fuels. Countries using Australian uranium thereby avoided carbon dioxide emissions, relative to coal, equivalent to around two thirds of Australia's total carbon dioxide emissions (from all sources).

SAFEGUARDS ON AUSTRALIAN URANIUM EXPORTS

It is fundamental to the Government's uranium policy that exports are permitted only under stringent safeguards. Uranium exports are made only to selected countries and are covered by a bilateral safeguards agreement. Bilateral safeguards are concluded between the supplier and the recipient of nuclear items and serve as a mechanism for applying conditions additional to IAEA safeguards: for example, restrictions on retransfers, high enrichment, and reprocessing. The safeguards requirements Australia applies to uranium exports are bilateral; they are elaborated in a series of treaty-level agreements with each country involved. These requirements are outlined below.

The key point is that Australia's safeguards requirements are superimposed on IAEA safeguards.

IAEA safeguards provide the basic assurance that nuclear material is not being diverted from peaceful to non-peaceful purposes.

It should be noted that IAEA safeguards are generally not concerned with origin attribution, that is, the 'flag' and conditions attached by suppliers (for the IAEA there are limited exceptions, e.g. under certain non-NPT safeguards agreements). This is the purpose of bilateral safeguards agreements.

Australia's safeguards requirements are intended to ensure that:

- ❑ AONM is properly accounted for as it moves through the nuclear fuel cycle;
- ❑ AONM is used only for peaceful purposes in accordance with the applicable agreements;
- ❑ AONM in no way enhances or contributes to any military process.

AUSTRALIA'S SAFEGUARDS CONDITIONS

The application of Australia's requirements starts with a careful selection of those countries eligible to receive AONM:

- ❑ it is a minimum requirement that, in the case of non-nuclear-weapon States, countries must be subject to NPT full scope safeguards, that is, IAEA safeguards must apply to all existing and future nuclear activities; and
- ❑ in the case of nuclear-weapon States, there must be a treaty level assurance that AONM will only be used for peaceful purposes, and arrangements must be in place under which AONM is covered by IAEA safeguards.

A basic requirement is the conclusion of a safeguards agreement between Australia and the country concerned, setting out the various conditions which apply to AONM. The

principal conditions for the use of AONM set out in Australia's bilateral safeguards agreements are summarised as follows:

- ❑ an undertaking that AONM will be used only for peaceful purposes and will not be diverted to military or explosive purposes, and that IAEA safeguards will apply;
- ❑ none of the following actions can take place without Australia's prior consent:
 - transfers to third parties
 - enrichment to 20% or more in the isotope uranium-235
 - reprocessing¹³;
- ❑ provision for fallback safeguards or contingency arrangements in case NPT or IAEA safeguards cease to apply in the country concerned;
- ❑ an assurance that internationally agreed standards of physical security will be applied to nuclear material in the country concerned;
- ❑ detailed 'administrative arrangements' between ASNO and its counterpart organisation, setting out the procedures to apply in accounting for AONM;
- ❑ regular consultations on the operation of the agreement; and
- ❑ provision for the removal of AONM in the event of a breach of the agreement.

13. Consent has been given in advance to reprocessing on a programmatic basis in the case of five Agreements: Euratom, France, Japan, Sweden and Switzerland.

Table 10—Australia’s Bilateral Safeguards Agreements and their Dates of Entry into Force.

<i>Country</i> ^{14 15 16}	<i>Date of EIF</i>
Republic of Korea (ROK)	2 May 1979
UK	24 July 1979
Finland	9 February 1980
USA	16 January 1981
Canada	9 March 1981
Sweden	22 May 1981
France	12 September 1981
Euratom ¹⁷	15 January 1982
Philippines ¹⁸	11 May 1982
Japan	17 August 1982
Switzerland	27 July 1988
Egypt ¹⁸	2 June 1989
Russian Federation ¹⁹	24 December 1990
Mexico	17 July 1992
New Zealand ²⁰	1 May 2000

AUSTRALIAN OBLIGATED NUCLEAR MATERIAL

A characteristic of the civil nuclear fuel cycle is the international interdependence of facility operators and power utilities. Apart from the nuclear-weapon States, it is unusual for a country to be entirely self-contained in the processing of uranium for civil use—and even in the case of the nuclear-weapon States, power utilities will seek the most favourable financial terms, often going to processors in other countries. Thus it is not unusual, for example, for a Japanese utility buying Australian uranium to have the uranium converted to uranium hexafluoride in Canada, enriched in France, fabricated into fuel in Japan, and reprocessed in the United Kingdom. The international flow of nuclear material enhances safeguards accountability, through ‘transit matching’ of transfers at the different stages of the fuel cycle.

The international nature of nuclear material flows means that uranium from many sources is routinely mixed during processes such as conversion and enrichment. Uranium is termed a ‘fungible’ commodity, that is, at these processing stages uranium from any source is identical to uranium from any other—it is not possible physically to differentiate the origin of the uranium. This is not unique to uranium, but is also the case with a number of other commodities. The fungibility of uranium has led to the establishment of conventions used universally in the industry and in the application of safeguards, namely equivalence and proportionality. These are discussed below.

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14. The above list does not include Australia’s NPT safeguards agreement with the IAEA, concluded on 10 July 1974.
 15. In addition to the above Agreements, Australia also has an Exchange of Notes constituting an Agreement with Singapore Concerning Cooperation on the Physical Protection of Nuclear Materials, which entered into force on 15 December 1989.
 16. The texts of these Agreements are published in the Australian Treaty Series. The Australia/IAEA Agreement is also reproduced as Schedule 3 to the *Nuclear Non-Proliferation (Safeguards) Act 1987*.
 17. Euratom is the atomic energy agency of the European Union. For further details see Glossary.
 18. In the case of the Philippines and Egypt, Administrative Arrangements pursuant to the Agreements have not been concluded, so in practice the Agreements have not entered into operation.
 19. The Australia/Russia Agreement covers the processing (conversion, enrichment or fuel fabrication) of AONM in Russia on behalf of other partner countries, but does not permit the use of AONM by Russia.
 20. The Australia/New Zealand agreement covers the supply of uranium for non-nuclear use.

Because of the impossibility of physically identifying ‘Australian atoms’, and also because Australian obligations apply not just to uranium as it moves through the different stages of the nuclear fuel cycle, but also to material generated through the use of that uranium, e.g. plutonium produced through the irradiation of uranium fuel in a reactor, the obligations under Australia’s various bilateral safeguards agreements are applied to Australian Obligated Nuclear Material (AONM). ‘AONM’ is a shorthand way of describing the nuclear material which is subject to the provisions of the particular bilateral agreement.

This approach is also used by those other countries applying bilateral safeguards comparable to Australia’s, principally the US and Canada. These countries attach a safeguards ‘obligation’ to nuclear material which they upgrade, hence giving rise to the situation of ‘multi-labelling’, for example, AONM enriched in the US will also become US obligated nuclear material (USONM), and its subsequent use will have to meet the requirements of both Australian and US agreements. This is a common situation, that is, a significant proportion of AONM is also characterised as USONM and is accounted for both to ASNO and its US counterpart (the DOE).

The equivalence principle provides that where AONM loses its separate identity because of process characteristics (e.g. mixing), an equivalent quantity is designated AONM, based on the fact that atoms or molecules of the same substance are indistinguishable, any one atom or molecule being identical to any other of the same substance. In such circumstances, equivalent quantities of the products of such nuclear material may be derived by calculation or from operating plant parameters. It should be noted that the principle of equivalence does not permit substitution by a lower quality material, e.g. enriched uranium cannot be replaced by natural or depleted uranium.

The proportionality principle provides that where AONM is mixed with other nuclear material, and is processed or irradiated, a proportion of the resulting material will be regarded as AONM corresponding to the same proportion as was AONM initially.

Some people are concerned that the operation of the equivalence principle means there cannot be assurance that ‘Australian atoms’ do not enter military programs. This overlooks the realities of the situation, that uranium atoms are indistinguishable from one another and there is no practical way of attaching ‘flags’ to atoms. The objective of Australia’s bilateral agreements is to ensure that AONM in no way materially contributes to or enhances any military purpose. Even if AONM were to be in a processing stream with nuclear material subsequently withdrawn for military use, the presence of the AONM would add nothing to the quantity or quality of the military material (NB as noted elsewhere in this Report, those nuclear-weapon States eligible for the supply of Australian uranium have ceased production of fissile material for nuclear weapons).

ACCOUNTING FOR AONM

Australia’s bilateral partners holding AONM are required to maintain detailed records of transactions involving AONM, and ASNO’s counterpart organisations are required to submit regular reports, consent requests, transfer and receipt documentation to ASNO. ASNO accounts for AONM on the basis of information and knowledge including:

- ❑ reports from each bilateral partner;
- ❑ shipping and transfer documentation;
- ❑ calculations of process losses and nuclear consumption, and nuclear production;

- ❑ knowledge of the fuel cycle in each country;
- ❑ regular liaison with counterpart organisations and with industry;
- ❑ reconciliation of any discrepancies with counterparts.

REPORTING REQUIREMENTS

Table 11—Checklist of Reporting Requirements

<i>Reporting Requirements</i>	<i>Page</i>
Letter of Transmittal	iii
Contact Officer for additional information	iv
Corporate Overview	2 , 19
Staffing overview	19—21
Aggregate financial, staffing and resources data	19—23
Program Performance Reporting	24—46
Freedom of Information	92
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Information not included in this Report

Financial statements in respect of ASNO appear in the Annual Report of the Department of Foreign Affairs and Trade. The Auditor General does not audit ASO/CWCO/ACTBO finances separately (some financial information is given at page 19 of this Report).

Information on the operations of ASNO also appears in the 1999-2000 Annual Report of the Department Foreign Affairs and Trade. In particular, any involvement in:

- ❑ industrial democracy;
- ❑ occupational health and safety;
- ❑ advertising and market research;

appears in that Report.

FREEDOM OF INFORMATION ACT 1982

SECTION 8 STATEMENT

This statement is published in order to meet the requirements of section 8 of the *Freedom of Information Act 1982* which commenced operation on 1 December 1982.

Section 8 requires Departments and prescribed agencies to publish statements about their organisation, functions, decision-making powers, consultative arrangements, categories of documents maintained and facilities and procedures to enable members of the public to obtain access to documents under the Act. Departments and agencies must publish updated statements annually.

Information about the organisation and functions, decision-making powers and consultative arrangements of ASNO is found in earlier parts of this Annual Report. This statement provides additional details (where appropriate) of consultative arrangements and categories and availability of documents maintained by ASNO. The Report describes the Office as it existed in 1999-2000 within the Foreign Affairs and Trade portfolio.

Documents are listed under three main headings: agreements; legislation and related documents; and other. All agreements/treaties are available from the Australian Treaty Series from Australian Government Bookshops. Treaty documents are also available from the ASNO website <http://www.asno.dfat.gov.au>. All Acts and Regulations are available from the Australian Government Bookshops and some legislation is available from the Internet sites:

http://www.austlii.edu.au/au/legis/cth/consol_act; or

<http://scaleplus.law.gov.au>.

Except where indicated, none of the documents under 'other' is available for a fee or for purchase by the public nor are they customarily made available free of charge.

Applications for release of documents under the *Freedom of Information Act 1982* should be addressed to the Director General, Australian Safeguards and non-Proliferation Office.

ARRANGEMENTS FOR OUTSIDE PARTICIPATION

ASNO liaises with Federal, State and Territory government departments and authorities, authorities in countries with which Australia has bilateral nuclear safeguards agreements, the IAEA, the OPCW, the Provisional Technical Secretariat of the CTBTO, and the private sector.

Participation in policy formation and administration of enactments and regulations can be undertaken by making representations in writing, including suggestions, complaints and comments, to the Director General, Australian Safeguards and Non-Proliferation Office or to the Minister for Foreign Affairs.

General and media enquiries relating to ASNO activities and responsibilities should be directed to the Director General, Australian Safeguards and Non-Proliferation Office—telephone number: (02) 6261 1920.

CATEGORIES OF DOCUMENTS HELD BY ASNO

Agreements

- ❑ Treaty on the Non-Proliferation of Nuclear Weapons. (This Treaty is reproduced as Schedule 2 to the *Nuclear Non-Proliferation (Safeguards) Act 1987*).
- ❑ Convention on the Physical Protection of Nuclear Material. (This Convention is reproduced as Schedule 4 to the *Nuclear Non-Proliferation (Safeguards) Act 1987*).
- ❑ Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction. (The Convention is reproduced as the Schedule to the *Chemical Weapons (Prohibition) Act 1994*.)
- ❑ Comprehensive Nuclear-Test-Ban Treaty. (The Treaty is reproduced as a Schedule to the *Comprehensive Nuclear Test-Ban Treaty Act 1998*.)
- ❑ Agreement between Australia and the IAEA for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, covering nuclear material within Australia under NPT safeguards. (This Agreement is reproduced as Schedule 3 to the *Nuclear Non-Proliferation (Safeguards) Act 1987*.)
- ❑ Protocol additional to the Agreement between Australia and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons.
- ❑ Agreement between the Government of Australia and the Government of Canada concerning the Peaceful Uses of Nuclear Energy, covering transfers between Australia and Canada of nuclear material, material, equipment and technology.
- ❑ Agreement between the Government of Australia and the European Atomic Energy Community concerning transfers of nuclear material from Australia to the European Atomic Energy Community, covering transfers of nuclear material from Australia to Member States of the Community.
- ❑ Agreement between the Government of Australia and the Government of the Arab Republic of Egypt concerning cooperation in the Peaceful Uses of Nuclear Energy and the Transfer of Nuclear Material between Australia and Egypt.
- ❑ Agreement between the Government of Australia and the Government of the Republic of Finland concerning the Transfer of Nuclear Material between Australia and Finland, covering transfers of nuclear material between Australia and Finland.
- ❑ Agreement between the Government of Australia and the Government of the French Republic concerning Nuclear Transfer between Australia and France, covering transfers of nuclear material, material, equipment and technology between Australia and France.
- ❑ Agreement between the Government of Australia and the Government of Japan for Co-operation in the Peaceful Uses of Nuclear Energy, covering transfers of nuclear material, material, equipment and sensitive technology between Australia and Japan.
- ❑ Agreement between the Government of Australia and the Government of Republic of Korea concerning Co-operation in Peaceful Uses of Nuclear Energy and the Transfer of Nuclear Material, covering transfers of nuclear material between Australia and Republic of Korea.
- ❑ Agreement between the Government of Australia and the Government of New Zealand concerning transfer of Uranium.

- ❑ Agreement between the Government of Australia and the Government of the Republic of the Philippines concerning Co-operation in Peaceful Uses of Nuclear Energy and the Transfer of Nuclear Material, covering transfers of nuclear material between Australian and the Philippines.
- ❑ Exchange of Notes constituting an Agreement between Australia and the Republic of Singapore concerning Cooperation on the Physical Protection of Nuclear Materials.
- ❑ Agreement between the Government of Australia and the Government of Sweden on Conditions and Controls of Nuclear Transfers for Peaceful Purposes between Australia and Sweden, covering transfers of nuclear material, material, equipment and technology.
- ❑ Agreement between the Government of Australia and the Government of the Swiss Confederation concerning the Peaceful Uses of Nuclear Energy, covering transfers of nuclear material, material, equipment and technology between Australia and Switzerland.
- ❑ Agreement between the Government of Australia and Government of the United Kingdom of Great Britain and Northern Ireland concerning Nuclear Transfers between Australia and United Kingdom, covering transfers of nuclear material, material, equipment and technology between Australia and the United Kingdom.
- ❑ Agreement between the Government of Australia and the Government of the United Mexican States concerning Cooperation in Peaceful Uses of Nuclear Energy and the transfer of nuclear material.
- ❑ Agreement between Australia and the United States of America concerning Peaceful Uses of Nuclear Energy, covering transfers of nuclear material, moderator material, equipment and components and information.
- ❑ Agreement for Cooperation between Australia and the United States of America concerning Technology for the Separation of Isotopes of Uranium by Laser Excitation, Agreed Minute, and Exchange of Notes.
- ❑ Agreement between Australia and the Union of Soviet Socialist Republics concerning the Peaceful Uses of Nuclear Energy (this Agreement is now with the Russian Federation).

Legislation and Related Documents

- ❑ *Chemical Weapons (Prohibition) Act 1994.*
- ❑ *Chemical Weapons (Prohibition) Regulations, Statutory Rules 1997 No. 84.*
- ❑ *Chemical Weapons (Prohibition) Amendment Act 1998.*
- ❑ *Chemical Weapons (Prohibition) Amendment Regulations 1998.*
- ❑ *Comprehensive Nuclear Test-Ban Treaty Act 1998.*
- ❑ *Nuclear Non-Proliferation (Safeguards) Act 1987.*
- ❑ *Nuclear Non-Proliferation (Safeguards) (Consequential Amendments) Act 1988.*
- ❑ Declaration under the *Nuclear Non-Proliferation (Safeguards) Act 1987* regarding ‘associated equipment’ and ‘associated material’, dated 31 March 1987 (available from ASNO).
- ❑ *Nuclear Non-Proliferation (Safeguards) Regulations, Statutory Rules 1987 No. 75.*

- ❑ *Nuclear Non-Proliferation (Safeguards) Regulations (Amendment)*, Statutory Rules 1987 No. 258.
- ❑ *Nuclear Non-Proliferation (Safeguards) Regulations (Amendment)*, Statutory Rules 1987 No. 260.
- ❑ *Nuclear Non-Proliferation (Safeguards) Regulations (Amendment)*, Statutory Rules 1990 No. 298.
- ❑ *Nuclear Non-Proliferation (Safeguards) Regulations (Amendment)*, Statutory Rules 1993 No. 178.
- ❑ *Nuclear Non-Proliferation (Safeguards) Regulations (Amendment)*, Statutory Rules 1997 No. 351.
- ❑ *Nuclear Non-Proliferation (Safeguards) Regulations (Amendment)*, Statutory Rules 1998 No. 173.
- ❑ *Nuclear Non-Proliferation (Safeguards) Regulations (Amendment)*, Statutory Rules 1998 No. 318.
- ❑ *Nuclear Non-Proliferation (Safeguards) Amendment Regulations 2000 (No.1)*, Statutory Rules 2000 No.22
- ❑ *Nuclear Non-Proliferation (Safeguards) Amendment Regulations 2000 (No.2)*, Statutory Rules 2000 No.69
- ❑ *Nuclear Safeguards (Producers of Uranium Ore Concentrates) Charge Act 1993*.
- ❑ *South Pacific Nuclear Free Zone Treaty Act 1986*.

Other

- ❑ The Annual Report of the Director of Safeguards, Director, CWCO and Director, ACTBO are included in the ASNO Annual Report (available from ASNO).
- ❑ Papers prepared in whole or in part by ASNO officers for presentation at conferences and meetings. Papers which are in the public domain are listed in Annex J to this Report.
- ❑ Technical and other reports, extracts from published literature and publications (including newspaper, newsletter and journal clippings), representations and other general correspondence, discussion papers, position papers, briefings to the Minister and senior officers, extracts from Parliamentary debates, questions and answers associated with nuclear safeguards issues. Working papers and files related to ASNO's safeguards, CWC and CTBT responsibilities.
- ❑ Minutes and working documents of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO).
- ❑ Industry information booklets and leaflets on the CWC (available from ASNO).
- ❑ Survey forms completed and returned by Australian companies and organisations relating to the applicability of the Chemical Weapons (Prohibition) Act 1994. Information in forms has been provided on a 'Commercial-in-Confidence' basis.
- ❑ A copy of Executive Council papers related to proclamation of Division 1 of Part 7; and sections 95, 96, 97, 99, 102, 103, and 104 of the *Chemical Weapons (Prohibition) Act 1994*.

- ❑ Documents related to the designation of the office of Director of Safeguards as the office whose occupant is the Director of the Chemical Weapons Convention Office, and to the designation of the Controller of Permits and Notifications under the Act.
- ❑ Minutes and working documents of the Organisation for the Prohibition of Chemical Weapons and of its Preparatory Commission.
- ❑ A register of the permits and notifications issued pursuant to the Chemical Weapons (Prohibition) Act 1994.
- ❑ Copies of forms approved by the Director for use pursuant to provisions of the *Chemical Weapons (Prohibition) Act 1994* (available from ASNO).
- ❑ Administrative Arrangements pursuant to the above Agreements. The Administrative Arrangements are not available for public viewing as they have been agreed as being confidential between the Parties to the Agreements.
- ❑ Arrangement between the Australian Safeguards and Non-Proliferation Office and the US Department of Energy Concerning Research and Development in Nuclear Material Control, Accountancy, Verification, Physical Protection, and Advanced Containment and Surveillance technologies for International Safeguards.
- ❑ Arrangement between the Government of Australia and the Preparatory Commission of the Comprehensive Nuclear-Test-Ban Treaty Organization on the conduct of activities including post-certification activities, relating to international monitoring facilities for the Comprehensive Nuclear-Test-Ban-Treaty.
- ❑ A register of permits and authorities which are issued by the Minister for Foreign Affairs or the Minister's delegate pursuant to sections 13, 16 or 18 of the *Nuclear Non-Proliferation (Safeguards) Act 1987*.
- ❑ A Nuclear Materials Accountancy and Control Procedures Manual.
- ❑ A User's Manual for the 'Numbat 3' Nuclear Materials Accountancy and Control Software.
- ❑ Delegations to the Director of Safeguards to exercise powers under the *Nuclear Non-Proliferation (Safeguards) Act 1987*.
- ❑ Documents relating to the declaration under section 57 of the *Nuclear Non-Proliferation (Safeguards) Act 1987* of persons as inspectors for the purposes of that Act. List of persons so declared.
- ❑ Agendas, minutes and working documents of the IAEA, mostly concerned with the activities of its Department of Safeguards.

ANNEXES

ANNEX A—NUCLEAR MATERIAL WITHIN AUSTRALIA.

Table 12—Nuclear Material within Australia at 30 June 2000.

<i>Category</i>	<i>Quantity</i> ²¹	<i>Intended End-use</i>
Source Material		
Uranium ore concentrates (UOC)	1,248 tonnes U ₃ O ₈	Exports for energy use pursuant to bilateral agreements
Natural Uranium (other than UOC)	11,136 kg	Research and shielding
Depleted Uranium	10,246 kg	Research and shielding
Thorium	61,035 kg	Research, industry
Special Fissionable Material		
Uranium-235	223,706 g ²²	Research, industry, radioisotope production
Uranium-233	4 g	Research
Plutonium (except Pu-238) ²³	2,044 g ²⁴	Research, neutron sources

ANNEX B—ASSOCIATED ITEMS WITHIN AUSTRALIA

Table 13—Associated Items within Australia at 30 June 2000

<i>Category</i>	<i>Quantity</i>	<i>Intended End-use</i>
Associated Material		
Deuterium and Heavy Water	17.5 tonnes	Research, including reactor operation
Nuclear grade graphite	115 tonnes	Research, including reactor operation and manufacture of carbon and graphite components
Associated Equipment		
HIFAR research reactor		
Moata research reactor ²⁵		
Fuel charging and discharging machines	2	
HIFAR coarse control arms	7	
HIFAR safety rods	4	
Gas centrifuge components		
In-core fission chambers	2	

-
21. These figures are based on reports received pursuant to Permit requirements and were correct at the time of preparing this Annual Report.
22. Most of the uranium-235 in Australia is contained in irradiated fuel elements which have been used in ANSTO's HIFAR reactor. The figure given here is based on the weight of U-235 in each fuel element before irradiation, in accordance with the accounting convention used in the application of IAEA safeguards to HIFAR and Moata fuel prior to shipment from ANSTO.
23. Plutonium with an isotopic concentration of plutonium-238 exceeding 80% is exempt from safeguards.
24. Because of the IAEA accounting convention mentioned above, this figure does not include any plutonium in irradiated reactor fuel. However this quantity is very small and in the event of reprocessing of the fuel, the contained plutonium is considered practicably irrecoverable.
25. The fuel has been discharged from this reactor pending a decision on final decommissioning.

ANNEX C—AONM OVERSEAS

Australian Obligated Nuclear Material Overseas

Table 14—Locations and Quantities of AONM as at 31 December 1999

<i>Category</i>	<i>Location</i>	<i>Quantity (tonnes)</i>
Natural Uranium	Canada, Euratom, Japan, ROK, USA	16,590
Uranium in Enrichment Plants	Euratom, Japan, USA	24,518
Depleted Uranium	Euratom, Japan, USA	38,384
Low Enriched Uranium	Canada, Euratom, Japan, ROK, Switzerland, USA	6,672
Irradiated Plutonium	Canada, Euratom, Japan, ROK, Switzerland, USA	47.3
Separated Plutonium	Euratom, Japan	1.6
Thorium	USA	86
Total (tonnes) ²⁶		86,299

26. The end-use for all AONM is for the production of electric power in civil nuclear reactors and for related R&D. AONM cannot be used for any military purpose.

In accordance with the relevant agreements, Australia's bilateral safeguards agreement partners report on a calendar year basis.

The actual quantities of AONM held in each country, and accounted for by that country pursuant to the relevant agreement with Australia, are considered by ASNO's counterparts to be confidential information. Totals above have been consolidated from annual reports to ASNO from its counterparts.

All quantities are given as tonnes weight of the element uranium, plutonium or thorium. In the case of uranium, the isotope weight of uranium-235 is, for natural uranium 0.711% of the element weight, for depleted uranium 0.20%, and for low enriched uranium in the range 1-5%.

Irradiated plutonium comprises plutonium contained in irradiated power reactor fuel, or plutonium reloaded in a power reactor following reprocessing, but does not include separated plutonium. Plutonium recovered from reprocessing is categorised as separated plutonium until it has been fabricated with uranium as MOX (mixed oxide) fuel and returned to a reactor for further power generation.

There may be minor discrepancies in the above figures due to rounding.

Table 15—Transfers of AONM during 1999

<i>Process²⁷</i>	<i>Quantity Uranium(tonnes)</i>	<i>Transfer Destination</i>
Conversion	1,286	Canada
	2,578	Euratom
	2,248	USA
Total transfers between jurisdictions to conversion plants	6,112	
Enrichment	830	USA
	4	Japan
Total transfers between jurisdictions to enrichment plants	834	
Fuel fabrication	6	Euratom
	116	Japan
	22	USA
	23	ROK
Total transfers between jurisdictions to fuel fabrication plants	167	
Reactor Irradiation	1	Euratom
	20	Japan
Total transfers between jurisdictions to reactors ²⁸	21	

27. The above figures are for transfers made during 1999 and do not include transfers made in earlier years. The figures do not include transfers of AONM made within the fuel cycle of a State (or of Euratom), only between jurisdictions.

28. There were no transfers of AONM between jurisdictions to reprocessing plants in 1999.

ANNEX D—ACCOUNTING REPORTS TO THE IAEA

Australian Accounting Reports generated for the IAEA for the period 1999/2000 under Australia's NPT Safeguards Agreement with the IAEA.

Table 16—Numbers of Accounting Reports generated for the IAEA

<i>Number of Reports Sent</i>	<i>MBA</i>	<i>ICR</i>	<i>PIL</i>	<i>MBR</i>	<i>Total</i>
HIFAR, ANSTO	AS-A	4	1	1	6
Moata, ANSTO	AS-B	1	1	1	3
R&D Laboratories, ANSTO	AS-C	13	2	1	16
Vault Storage, ANSTO	AS-D	1	1	1	3
Miscellaneous Locations	AS-E	2	0	0	2
Total		21	5	4	30

Table 17—Numbers of Entries covered by Accounting Reports generated for the IAEA

<i>Number of Entries Covered by These Reports</i>	<i>MBA</i>	<i>ICR</i>	<i>PIL</i>	<i>MBR</i>	<i>Total</i>
HIFAR, ANSTO	AS-A	43	27	9	79
Moata, ANSTO	AS-B	1	7	7	15
R&D Laboratories, ANSTO	AS-C	50	111	32	193
Vault Storage, ANSTO	AS-D	1	11	7	19
Miscellaneous Locations	AS-E	3	0	0	3
Total		98	156	55	309

Table 18—Routine Safeguards Inspections Performed by the IAEA during 1999-2000

<i>1999</i>	<i>Type</i>	<i>2000</i>	<i>Type</i>
15 July	MBA AS-A	28 to 30 March	MBAs AS-A, AS-D
22 and 23 September	MBA AS-A	20 to 26 June	MBAs AS-A, AS-B, AS-C, and two complementary accesses
2 to 8 December	MBA AS-A, AS-C environmental sampling Complementary access to DSTO		

MBA Material Balance Area

ICR Inventory Change Report

PIL Physical Inventory Listing

MBR Material Balance Report

ANNEX E—IAEA STATEMENTS OF CONCLUSIONS

IAEA Statements of Conclusions of Inspections in Australia.

During 1999-00 the IAEA carried out inspections in four of Australia's five Material Balance Areas (MBAs): AS-A; AS-B; AS-C; and AS-D. The IAEA provides statements of conclusions about these inspections under Article 91(b) of Australia's NPT Safeguards Agreement.

Article 91(b) statements for inspections conducted during 1998-99 stated the following conclusions (Activity 3 applies only to MBAs AS-A and AS-D).

Table 19—IAEA Conclusions of Inspections in Australia

	<i>Verification Activity</i>	<i>Conclusion</i>
(1)	Examination of records	'The records satisfied the Agency requirements.'
(2)	Examination of Reports to the Agency	'The reports satisfied the Agency requirements.'
(3)	Application of Containment and Surveillance Measures	'The application of containment and surveillance measures adequately complemented the nuclear material accountancy measures.'
(4)	Verification of Physical Inventory	'The physical inventory declared by the operator was verified and the results satisfied the Agency requirements.'

The only material unaccounted for (MUF) declared for the year was a small quantity of enriched uranium in AS-C.

Explanatory note on MBA AS-E

This MBA covers all locations in Australia, except ANSTO at Lucas Heights, where safeguardable nuclear material is present.

No IAEA statement under Article 91(b) of Australia's NPT Safeguards Agreement is provided for this MBA since the IAEA has not inspected the nuclear material located there. This is because the quantities are too small to be of proliferation significance and in most cases have been exempted from active safeguards or have had safeguards terminated in accordance with the Agreement (Articles 36, 37, 38 and 39 of the Agreement refer).

However, this year a complementary access pursuant to the Additional Protocol to INFCIRC/217 took place at the Defence Science and Technology Organisation's establishment at Salisbury in South Australia. The Agency's conclusions drawn from this access have been received, together with those concerning the similar access at the Ranger Mine in June 1999. The Agency noted that access to both locations pursuant to Article 4.a.(i) of the Additional Protocol 'did not indicate the presence of any undeclared nuclear material or activities.'

ANNEX F—IAEA SAFEGUARDS STATISTICS²⁹

Table 20—IAEA Safeguards Expenditure (US\$ million).

	1997	1998	1999
Regular budget expenditure	81.845	80.342	78.985
Extra budgetary funds expenditure	12.217	16.581	13.826

Table 21—IAEA Verification Activities.

	1997	1998	1999
Number of inspectors	218	226	224
Inspections performed	2,499	2,507	2,495
Person-days of inspection	10,240	10,071	10,190
Number of metal seals applied to nuclear material or safeguards equipment, detached and subsequently verified	24,943	26,824	28,044
Video tapes and digital storage media items reviewed	4,010	4,884	5,033

Table 22—Approximate Quantities of Material Subject to IAEA Safeguards on 31 December 1997, 1998 and 1999

<i>Tonnes</i>	1997	1998	1999
Plutonium contained in irradiated fuel including recycled plutonium in fuel elements in reactor cores	571	600	636
Separated plutonium outside reactor cores	57.6	62.4	73.1
Highly enriched uranium	20.5	21.4	21.2
Low enriched uranium	49,282	49,482	51,191
Source material (natural or depleted uranium or thorium)	108,648	90,622	92,150

Table 23—Number of Installations under IAEA Safeguards or Containing Safeguarded Material on 31 December 1997, 1998 and 1999

	<i>Number of Installations and Facilities</i>		
<i>Facility Type</i>	1997	1998	1999
Power reactors	234	236	236
Research reactors and critical assemblies	171	169	168
Conversion plants	13	13	13
Fuel fabrication plants	44	46	43
Reprocessing plants	6	6	6
Enrichment plants	13	14	14
Separate storage facilities	72	70	69
Other facilities	79	82	86
Subtotals	632	636	635
Other locations and non-nuclear installations	477	449	317 ³⁰
Totals	1,109	1,085	952

29. Source of information: IAEA Safeguards Implementation Reports for 1996-1999. All figures given are for calendar years.

30. The decrease in the number of other installations is attributable to a change in the way these installations are defined by the Agency.

ANNEX G—ASAP

Australian Safeguards Assistance Program

Analytical Services for Environmental Sampling Environmental sampling is an important safeguards strengthening measure that will enhance the IAEA's capability to detect undeclared nuclear activities. ANSTO has demonstrated that mass spectrometry using a tandem accelerator can be used to analyse environmental samples with very high sensitivity. It has participated in an international exercise for the measurement of I-129 (a long-lived fission product) in test samples prepared in the US, with good results. ASNO has supplemented the funding of this work to allow ANSTO to construct a new beam-line facility for uranium and plutonium and complete the R&D needed to perfect its analytical techniques.

Application of the State-level Integration Concept on Fuel Cycles Under Safeguards This program of work has assisted the IAEA to determine exactly how the current safeguards system can be strengthened and made more cost-effective by integrating safeguards measures (INFCIRC/153) with those implemented under the Additional Protocol (INFCIRC/540). Under this task, six IAEA non-nuclear-weapon States, including Australia, each developed integrated safeguards approaches for their own particular fuel cycles. The intention is to derive generic guidance on how integrated safeguards schemes should be designed from a study of specific real cases.

Re-Examination of Basic Safeguards Implementation Parameters The IAEA has acknowledged the need, in parallel with the development of strengthened and integrated safeguards concepts, to re-examine certain basic parameters used in safeguards, such as timeliness goals, 'significant quantities', and the classification of nuclear material for safeguards purposes. ASNO has prepared papers on timeliness goals and the categorisation of nuclear material, which have been used by the IAEA and formed an important input to SAGSI's deliberations on these subjects. Additional papers relating to other verification parameters have been drafted and will be submitted to the IAEA in the next reporting period. The results of these studies are used by the IAEA to directly support efforts to develop and implement integrated safeguards.

Expansion of the 'Physical Model' The document known as the 'Physical Model' was developed for the IAEA by a panel of international experts (including ASNO staff) in support of the Agency's improved analysis of information in the context of strengthened safeguards. It was an attempt to identify, describe and characterise every known technology and process for carrying out each step necessary for the acquisition of weapons-useable fissile material. As developed, the Physical Model is a living document subject to periodic review and update. ASNO has agreed to contribute to the project by providing support in the area of hot cells and R&D activities. The task results will be incorporated into the Physical Model as integral parts of the document and be used by safeguards analysts and inspectors as technical tools in the enhanced information analysis in the context of strengthened and integrated safeguards.

Support for Information Review and Evaluation Since 1997, ASNO has undertaken for the IAEA a number of consultancy subtasks in support of the implementation of strengthened safeguards. Activity for the reporting period is set out below.

- ❑ *To evaluate information on mining and milling of uranium for safeguards purposes.* This task seeks to: determine the circumstances under which the IAEA might undertake complementary access to a uranium mining/milling site; what verification activities

would be applicable; and how declared information about mining/milling activities would contribute to an assessment on undeclared activities.

- ❑ *To develop logic trees designed to evaluate proliferation pathways.* This task requires the application of techniques used in safety and reliability analysis to the acquisition of nuclear material for weapons purposes. The technique generates a complete set of proliferation strategies, including those that require diversion of safeguarded nuclear material and those that make use only of activities outside safeguards. It allows the analyst to see easily where classical safeguards measures and safeguards-strengthening measures are complementary and where they are redundant. This task is a completed sub-task of a larger task.
- ❑ *To evaluate the ways in which technology transfers (both within and outside the internationally established export control regimes) contribute to clandestine weapon programs.* Under this subtask, the routes for transfer of technology needed to establish an undeclared capability for nuclear weapon production are being studied.
- ❑ *Provide assistance in the use of the scientific literature.* The IAEA has established a small international group of experts (including an ASNO officer) to provide assistance and guidance in the effective use of scientific literature for safeguards purposes.
- ❑ *Provide assistance in the collection and handling of open source information.* Under this subtask, ASNO assisted the IAEA in the establishment of logical mechanisms (search trees) for searching the Agency's databases of open-source literature for potentially proliferation-relevant items. This task is complete. IAEA analysts are using the search trees routinely.

Installation and Demonstration of Reactor Power Monitors at the HIFAR Reactor

This task requires the installation and demonstration of two categories of power monitor at ANSTO's HIFAR research reactor, the purpose of which is to detect operation of the reactor at a power higher than declared and to detect undeclared shutdowns. Both these activities could be linked to the production of plutonium for potential use in a nuclear weapons program or associated R&D. This work has been progressed in collaboration with the IAEA, but will not be completed until 2001.

Criteria for Evaluating Information Technology Security for Safeguards Equipment Systems

Unattended safeguards equipment in the field requires data authentication to provide a high level of assurance that the generated safeguards data are secure from unauthorised access and tampering. Under various support programs, the IAEA has organised assessments of the vulnerability of new authentication systems, normally in countries other than those where the authentication system was developed or is intended to be used. The Defence Signals Directorate (DSD), as Australia's expert in this area, is contributing to the development of the new standardised criteria for the IAEA.

Tasks Completed During 1999-2000

Consultant—to coordinate the implementation of digital image surveillance

The IAEA is deploying about 400 digital surveillance camera systems to replace the relatively unreliable analog systems currently in use. The consultant coordinated activities such as acceptance testing, site surveys, commissioning systems in the field, and maintenance. An Australian expert in digital surveillance systems was seconded to the Agency in Vienna for this purpose.

Collaboration with other countries

ASNO has an active and growing safeguards R&D collaboration program with US research laboratories, under an ASNO/DOE agreement first concluded in 1992 and renewed in September 1998. Several projects have been proposed during the year and work on formalising these projects is continuing.

In collaboration with the DOE, SNL and the IAEA, ASNO is designing a remote monitoring system for the materials balance area of the HIFAR research reactor. The purpose of this is to save IAEA inspection resources by reducing the number of routine inspections at HIFAR each year from four to one, with an additional unannounced inspection once per year. The equipment will be provided by SNL and it is planned that the system will go into routine safeguards use in 2001/2002. This remote monitoring system will also be an important feature of the new integrated safeguards approach proposed for Australia.

MEDIA RELEASE

DEPARTMENT OF FOREIGN AFFAIRS AND TRADE—AUSTRALIA



D68

31 August 1998

New Australian Safeguards And Non-Proliferation Office

The Department of Foreign Affairs and Trade has today announced the establishment of the Australian Safeguards and Non-Proliferation Office (ASNO) to play a central role in Australia's efforts to promote a more secure world environment.

Australia has had a strong commitment to non-proliferation and disarmament with respect to nuclear, chemical and biological weapons, the weapons of mass destruction. Recent actions by Australia internationally include the initiation of a series of diplomatic measures to strengthen the Biological Weapons Convention, ratification of the Comprehensive Nuclear Test-Ban Treaty (CTBT), and active support for commencement in the Conference on Disarmament of negotiations on a 'Cut-off' treaty to ban the production of fissile material for nuclear weapons.

ASNO's principal objective is to enhance Australian and international security through activities which contribute to effective regimes against the proliferation of weapons of mass destruction. ASNO will combine the functions of the Australian Safeguards Office (ASO), the Chemical Weapons Convention Office (CWCO), and the Australian Comprehensive Test Ban Office (ACTBO) established following ratification of the CTBT. ASNO will also assume responsibility for implementation aspects of the Biological Weapons Convention protocol currently being negotiated in Geneva.

The focus of ASNO will be verification of treaty commitments. ASNO will contribute to the development and operation of effective international verification mechanisms designed to promote transparency and provide assurance that non-proliferation obligations are being observed.

Within ASNO, ASO will continue its work with nuclear safeguards to verify that peaceful use commitments for nuclear material and items are being honoured. An important part of ASO's work is ensuring that Australia's uranium exports remain in exclusively peaceful use, in accordance with Australia's bilateral safeguards agreements.

CWCO will continue to work with verification arrangements on the production and use of specified toxic chemicals and their precursors, while ACTBO is set to implement the CTBT in Australia including the establishment of significant elements of the international system to detect any nuclear testing. The close parallels between the nuclear non-proliferation regimes and the chemical weapons prohibition regime will enable the most effective use to be made of available technical expertise and administrative resources, and promote cross-fertilisation of ideas between individual regimes, thereby further enhancing Australian interests.

ASNO will be headed by a Director-General, Mr John Carlson, who has held the statutory position of Director of Safeguards since 1989, and also the position of Director CWCO since 1995.

ANNEX I—STATUS OF AUSTRALIAN IMS STATIONS

Table 24—Australian IMS Stations—Status as at 30 June 2000

	Type	Status ¹	Operator ²
Primary Seismic Stations			
Warramunga, NT	array ³¹	XUT	ANU
Alice Springs, NT	array	X	AGSO/ US
Stephens Creek, NSW	3-C ³²	XU	AGSO
Mawson, Antarctica	3-C	X	AGSO
Auxiliary Seismic Stations			
Charters Towers, QLD	3-C	X	AGSO
Fitzroy Crossing, WA	3-C	X	AGSO
Narrogin, WA	3-C	X	AGSO
Infrasound Stations			
Warramunga, NT		XSUT	ANU
Hobart, TAS		S	AGSO
Shannon, WA		S	AGSO
Cocos Islands		P	AGSO
Davis Base, Antarctica		P	AGSO
Radionuclide Stations Particulates (all)			
Melbourne, VIC	Noble gas	XSUT	ARPANSA
Perth, WA	Noble gas	XSUT	ARPANSA
Townsville, QLD		XS	ARPANSA
Darwin, NT		XS	ARPANSA
Cocos Islands		S	ARPANSA
Macquarie Island, TAS		P	ARPANSA
Mawson, Antarctica		P	ARPANSA
Radionuclide Laboratory			
Melbourne, VIC		X	ARPANSA
Hydroacoustic Stations			
Cape Leeuwin, WA	Hydrophone array	SU	AGSO
1. Status codes		2. Operators	
P	planned new station	AGSO	Australian Geological Survey Organisation
X	existing station (upgrade required—except radionuclide lab)	ANU	Australian National University
S	site survey work underway or completed	ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
U	establishment/upgrade work underway or completed		
T	testing and evaluation underway for certification against CTBT standards		<i>(Anticipated operators shown with italics.)</i>

31. Seismic array

32. Single 3-component seismometer

ANNEX J—ASNO PUBLICATIONS AND PRESENTATIONS

The publications listed below are available on request, and will be available on the ASNO website in 2000 at <http://www.asno.dfat.gov.au>.

V Bragin, J Carlson and J Hill, *Re-Examination of the Timeliness Verification Goals*, Proceedings of the International Seminar on Strengthening of Safeguards: Integrating the New and the Old, Dresden, Germany, 9-11 May, 2000.

V Bragin, J Carlson and J Hill, *FMCT—Purpose and Scope of Verification Activities*, Proceedings of the 40th Annual INMM Meeting, Phoenix, Arizona, July 26-29, 1999.

V Bragin, *An Introduction to Focused Approach to Verification under FMCT*, International Conference 'Breaking Ground on a Fissile Material Cut-off Treaty,' Munich, Germany, July 23-25, 1999.

V Bragin and J Carlson, *The Timeliness Goal in the Context of Integrated Safeguards*, Proceedings of the Second Russian International Conference on Nuclear Material Protection, Control, & Accounting, Obninsk, Russia, 22-26 May, 2000.

V Bragin and J Carlson, *On the Verification of a Fissile Material Cut-off Treaty*, Proceedings of the Second Russian International Conference on Nuclear Material Protection, Control, & Accounting, Obninsk, Russia, 22-26 May, 2000.

V Bragin and J Carlson, *FMCT: Some Significant Divisions in the Scope Debate*, Disarmament Forum, UNIDIR, 2, 1999, pp. 29-34.

V Bragin and J Carlson, *An Introduction to Focused Approach to Verification under FMCT*, JNMM, Winter 2000, pp 39-45.

K Brown and G Shaw, *The Chemical Weapons Convention Import Controls*, Chemistry in Australia, June 2000, pp 28.

K Brown and G Shaw, *The Chemical Weapons Convention—An Overview of the Inspection Process : Guidelines for Producers of Chemicals*, published and distributed May 2000.

K Brown and G Shaw, *Protocol to the Biological Weapons Convention: Government Survey*, presented at National Consultative Group Meeting September 1999.

K Brown and G Shaw, *Australian Controls on the Import of Chemicals under the Chemical Weapons Convention : Guidelines for Importers*, published and distributed December 1999.

J Carlson, V Bragin and J Hill, *Safeguards Reform—A Decade On*, Proceedings of the 40th Annual INMM Meeting, Phoenix, Arizona, July 26-29, 1999.

J Carlson, *Nuclear Safeguards—A System in Transition*, Australian Nuclear Association Conference, 27 October 1999.

J Carlson, *Nuclear Energy and Non-Proliferation—Issues and Challenges: An Australian Perspective*, JAIF Symposium on Peaceful Uses of Nuclear Energy and Non-Proliferation, Tokyo, 9-10 March 2000.

J Carlson, *How Regional Non-Proliferation Arrangements Complement International Verification*, IAEA seminar on 'IAEA Safeguards for the 21st Century', Taejeon, ROK, 18-20 October 1999.

G Shaw, *The Chemical Weapons Convention*, presented at an ACT Rotary Club meeting, Canberra, June 2000.

G Shaw, *Australian Experiences with import-export control of chemicals under the CWC and the harmonised system*, presented at the 2nd OPCW Meeting of National Authorities, The Hague, May 2000.

G Shaw, *Australian experiences in implementing the Chemical Weapons Convention*, presented at the Singapore Regional CWC Forum, Singapore, May 2000.

Papers prepared prior to July 1999 are listed in the 1998-99 Annual Report.

Papers prepared prior to July 1997 are listed in the 1997-98 Annual Report.

Papers prepared prior to July 1996 are listed in the 1996-97 Annual Report.

Papers prepared prior to July 1991 are listed in the 1994-95 Annual Report.

GLOSSARY OF ABBREVIATIONS, ACRONYMS AND DEFINITIONS

AA	Administrative Arrangement. An arrangement made under each of Australia's bilateral safeguards agreements setting out detailed procedures for the implementation of the agreement.
AAEC	Australian Atomic Energy Commission—predecessor of ANSTO.
ABACC	Brazilian-Argentine Safeguards Agency.
Additional Protocol	Published as IAEA document INFCIRC/540, the Additional Protocol is designed to complement a State's Safeguards Agreement with the IAEA, in order to strengthen the effectiveness and improve the efficiency of the safeguards system.
AGSO	Australian Geological Survey Organisation.
ANSTO	Australian Nuclear Science and Technology Organisation
AONM	Australian Obligated Nuclear Material: nuclear material which is subject to obligations pursuant to one of Australia's bilateral safeguards agreements. In practice it relates to Australian uranium and nuclear material derived from it (e.g. uranium hexafluoride, low enriched uranium, depleted uranium, plutonium).
AOPu	Australian Obligated Plutonium (i.e. plutonium which is AONM).
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency.
ASAP	Australian Safeguards Assistance Program.
Australia Group	A group of States that adhere to common guidelines for controls on exports with the aim of preventing the proliferation of chemical and biological weapons.
BAPETEN	Nuclear Energy Control Board (Indonesia).
BATAN	National Nuclear Energy Agency (Indonesia).
Biocontainment	A room or suite of rooms designed to handle biological agents according to their risk groups defined in the WHO biosafety manual. Work undertaken in a laboratory at a specific level should follow procedures prescribed for that level of containment.
BWC	Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction.
BWR	Boiling Water Reactor: an LWR in which the moderator/coolant is used directly to produce steam for electricity generation.
C/S	Containment and Surveillance. Containment refers to structural features of a facility or equipment which enable access to nuclear material to be monitored and detected—e.g. by applying seals to a door. Surveillance refers to monitoring of nuclear material, e.g. by cameras.
CD	Conference on Disarmament.
Challenge inspection	Under the CWC, an inspection that can be initiated by a State Party to resolve suspicions about a particular site.

Classical safeguards	The system of safeguards based on INFCIRC/153.
Complementary Access	The right of the IAEA pursuant the Additional Protocol to access a location to carry out verification activities.
Comprehensive safeguards agreement	Agreement between a State and the IAEA for the application of safeguards to all of the State's current and future nuclear activities (equivalent to 'full scope' safeguards)—based on INFCIRC/153.
Conversion	Processing of natural uranium into a gaseous compound, uranium hexafluoride, for use as the feedstock for uranium enrichment.
CPPNM	Convention on the Physical Protection of Nuclear Material.
CTBT	Comprehensive Nuclear-Test-Ban Treaty.
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organisation—Vienna based international organisation established to give effect to the CTBT.
CWC	Chemical Weapons Convention.
Depleted uranium	Uranium having a U-235 content less than that found in nature (i.e. as a result of uranium enrichment).
DFAT	Department of Foreign Affairs and Trade.
Direct—Use Material	Nuclear material defined for safeguards purposes as being useable for nuclear explosives without transmutation or further enrichment, e.g. plutonium, high-enriched uranium (HEU) and U-233.
Discrete organic chemical (DOC)	Any chemical belonging to the class of chemical compounds consisting of all compounds of carbon, except for its oxides, sulphides and metal carbonates, identifiable by chemical name, by structural formula, if known, and by Chemical Abstracts Service (CAS) registry number, if assigned. Long chain polymers are not included in this definition.
DOE	United States Department of Energy.
DPRK	Democratic People's Republic of Korea.
Enrichment	A physical or chemical process for increasing the proportion of a particular isotope. Uranium enrichment involves increasing the proportion of U-235 from its level in natural uranium, 0.711%: for LEU fuel the proportion of U-235 (the enrichment level) is typically increased to between 3% and 5%.
ESARDA	European Safeguards Research and Development Association.
Euratom	The Atomic Energy Agency of the European Union. Its Safeguards Office is responsible for the application of safeguards to all nuclear material in civil nuclear facilities in Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UK.
Facility	(for CWC purposes) A plant, plant site or production/processing unit. [NB. for legal purposes, the term 'Facility', as it appears in provisions of the Chemical Weapons (Prohibition) Act, has the same meaning as 'plant site'].
Facility	(for safeguards purposes) A document agreed between the IAEA

Attachment	and the relevant Member State which specifies the nuclear materials accountancy system for a specific facility, and defines the format and scope of inspection activities.
Fast neutron	A neutron in the ‘fast’ energy range (>0.1 MeV).
Fast neutron reactor	A reactor that operates mainly with neutrons in the fast energy range. Because a moderator is not used, a fuel with a high energy density is required, usually plutonium (more specifically, MOX with a high proportion, e.g. 20-30%, of plutonium) or HEU. Through transmutation of U-238, a fast breeder reactor is designed to produce more plutonium than it consumes. However fast neutron reactors can also be operated as net plutonium consumers.
Fissile	Referring to a nuclide capable of undergoing fission by ‘thermal’ neutrons (e.g. U-233, U-235, Pu-239).
Fission	The splitting of an atomic nucleus into roughly equal parts, often by a neutron. In a fission reaction, a neutron collides with fissile nuclide (e.g. U-235) and splits, releasing energy and new neutrons. Many of these neutrons may go on to collide with other fissile nuclei, setting up a nuclear chain reaction.
Fissionable	Referring to a nuclide capable of undergoing fission by ‘fast’ neutrons (e.g. Pu-240, Pu-242).
FMCT	Proposed Fissile Material Cut-off Treaty.
Fuel Assembly (fuel element or fuel bundle)	A grouping of fuel rods, pins, plates, etc., held together by spacer grids and other structural components, which is maintained intact during fuel transfer and irradiation operations in a reactor.
Full Scope Safeguards	The application of IAEA safeguards to all of a State’s present and future nuclear activities.
Graphite	A form of carbon, used as a moderator in certain types of nuclear reactor. Graphite is a very efficient moderator, enabling uranium to be used in a fission reactor without enrichment.
GW	Gigawatt (Giga = billion, 10^9).
GWe / GWt	Gigawatts of electrical / thermal power.
Heavy water (D ₂ O)	Water containing the ‘heavy’ hydrogen isotope deuterium (hydrogen 2) which consists of a proton and a neutron. D ₂ O occurs naturally as about one part in 6000 of ordinary water. D ₂ O is a very efficient moderator, enabling uranium to be used in a fission reactor without enrichment.
HEU	High enriched uranium. Uranium enriched to 20% or more in U-235. ‘Weapons grade’ HEU has been enriched to over 90% U-235.
HIFAR	High Flux Australian Reactor: the 10 MWt research reactor located at ANSTO’s Lucas Heights Research Laboratories.
Hot Cell	A shielded work area, with thick lead glass windows and remote manipulation devices, in which radioactive materials can be safely handled and inspected.
HTGCR	High temperature gas-cooled reactor.
Hydroacoustic	Term referring to underwater propagation of pressure waves

	(sounds).
IAEA	International Atomic Energy Agency.
ICR	Inventory Change Report. A term used in nuclear materials accountancy.
IDC	International Data Centre. Data gathered by monitoring stations of the CTBT IMS network are compiled, analysed and archived by the Vienna based IDC. IDC products giving the results of analyses are made available to CTBT signatories.
IMS	International Monitoring System—A network of 337 monitoring stations and analytical laboratories established pursuant to the CTBT which, together with the IDC, gather and analyse data with the aim of detecting any explosive nuclear testing.
Indirect—Use Material	Nuclear material that cannot be used for a nuclear explosive without transmutation or further enrichment, e.g. depleted uranium, natural uranium, low-enriched uranium (LEU), and thorium.
INFCIRC	Information Circular. A series of documents published by the IAEA setting out safeguards, physical protection and export control arrangements.
INFCIRC/66 Rev.2	The model safeguards agreement used by the IAEA since 1965. Essentially this agreement is facility—specific. In the case of non-nuclear-weapon States party to the NPT, it has been replaced by INFCIRC/153.
INFCIRC/153 (Corrected)	The model agreement used by the IAEA as a basis for negotiating safeguards agreements with non-nuclear-weapon States party to the NPT.
INFCIRC/225 Rev.4.(Corr)	IAEA document entitled ‘The Physical Protection of Nuclear Material and Nuclear Facilities’. Its recommendations reflect a consensus of views among IAEA Member States on desirable requirements for physical protection measures on nuclear material, that is, measures taken for its physical security.
Infrasound	Sound in the frequency range of 0.02 to 4 Hertz. One category of CTBT IMS stations will monitor sound at these frequencies with the aim of detecting explosive events such as a nuclear test explosion at a range up to 5000 km.
INMM	Institute of Nuclear Materials Management.
Integrated safeguards	The combination of ‘classical’ and strengthened safeguards measures to give optimal effectiveness and cost-efficiency.
ISD	International Security Division, Department of Foreign Affairs and Trade.
Isotopes	Nuclides with the same number of protons, but different numbers of neutrons, e.g. U-235 (92 protons and 143 neutrons) and U-238 (92 protons and 146 neutrons). The number of neutrons in an atomic nucleus, while not significantly altering its chemistry, does alter its properties in nuclear reactions.
LEU	Low Enriched Uranium; uranium enriched to less than 20% in U-235. Commonly LEU for use as LWR fuel is enriched to between

	3% and 5% U-235.
LHRL	Lucas Heights Research Laboratories.
Listed Agents	A specific list of microorganisms and toxins proposed in the current draft of the verification protocol to the BWC.
LWR	Light Water Reactor. The most common type of power reactor, using ordinary (light) water as the moderator and coolant. Because light water is not an efficient moderator the uranium fuel must be slightly enriched (LEU).
MBA	Material Balance Area. A term used in nuclear materials accountancy.
MBR	Material Balance Report. A term used in nuclear materials accountancy.
Microbiological production	Production of food, medicine and other chemicals by cultivation of microorganisms or tissue cultures.
Microorganism	Dead or alive bacteria, viruses, fungi and single—cell organisms.
Moata	ANSTO's 'university training reactor' (Moata means 'firestick' in an Aboriginal language). Now defuelled and awaiting decommissioning.
Moderator	A material used to slow 'fast' neutrons to 'thermal' speeds where they can readily be absorbed by U-235 or plutonium nuclei and initiate a fission reaction. The most commonly used moderator materials are light water, heavy water or graphite.
MOX	Mixed oxide reactor fuel, consisting of a mixture of uranium and plutonium oxides—for fresh LWR fuel the plutonium content is typically around 5%.
MHTGCR	Modular high temperature gas-cooled reactor.
MUF	Material Unaccounted For. A term used in nuclear materials accountancy.
MW	Megawatt (Mega = million, 10^6).
MWe / MWt	Megawatts of electrical / thermal power.
Natural uranium	In nature uranium consists predominantly of the isotope U-238 (approx. 99.3%), with the fissile isotope U-235 comprising only 0.711%.
NCG	National Consultative Group, established by the Minister for Foreign Affairs in 1998 to provide advice in the context of negotiations on strengthening BWC Verification Protocol.
NDA	Non-destructive analysis or assay.
NDC	National Data Centre, pursuant to the CTBT.
NMAC	Nuclear Materials Accountancy and Control.
NMCC	Nuclear Material Control Centre (Japan).
NNWS	Non-nuclear-weapon State(s).
NPT	Treaty on the Non-Proliferation of Nuclear Weapons.
NRC	US Nuclear Regulatory Commission.
NSG	Nuclear Suppliers Group: a group comprised of nuclear supplier States that adhere to guidelines set out in the IAEA document INFCIRC/254 for controls on exports of nuclear materials,

	equipment and technology.
Nuclide	Nuclear species characterised by the number of protons (atomic number) and the number of neutrons. The total number of protons and neutrons is called the mass number of the nuclide.
NWS	Nuclear-weapon State(s): those States recognised by the NPT as having nuclear weapons when the Treaty was concluded, that is, US, UK, Russia, France and China.
OCPF	Other Chemical Production Facility: a facility that produces discrete organic chemicals in quantities exceeding thresholds defined in the CWC.
OPCW	Organization for the Prohibition of Chemical Weapons.
OSI	On-site Inspection—a short notice ‘challenge type inspection’ provided for in the CTBT as a means for investigation concerns about serious non-compliance the testing prohibition.
Pebble bed reactor	HTGCR using fuel in the form of uranium/graphite spheres.
PIL	Physical Inventory Listing. A term used in nuclear materials accountancy.
Plant	For CWC purposes, is defined as a relatively self—contained area, structure or building containing one or more units for the production, processing or consumption of a chemical, along with associated infrastructure.
Plant site	For CWC purposes, is defined as the local integration of one or more plants, with any intermediate administrative levels, which are under one operational control, and includes common infrastructure.
Production	For CWC purposes, is defined as the formation of a chemical through chemical reaction. Production of chemicals specified by the CWC is declarable, even if produced as intermediates and irrespective of whether or not they are isolated.
Programmatic	Refers to an agreed delineated fuel—cycle program (facilities and activities).
PWR	Pressurised water reactor: an LWR in which the moderator/coolant heats a secondary cooling circuit that produces steam for electricity generation.
R&D	Research and Development.
Reprocessing	Processing of spent fuel to separate uranium and plutonium from highly radioactive fission products.
ROK	Republic of Korea.
S/RD	Shipper/Receiver Difference. A term used in nuclear materials accountancy.
SAGSI	Standing Advisory Group on Safeguards Implementation: an advisory group to the Director General of the IAEA.
SNL	Sandia National Laboratories, USA.
SPNFZ	South Pacific Nuclear Free Zone Treaty.
SSAC	State System of Accounting for and Control of Nuclear Material: the national safeguards system required of each State under its

	safeguards agreement with the IAEA.
Thermal neutron	A neutron in the ‘thermal’ energy range (<0.1 MeV). The thermal energy range is optimal for causing fission reactions through neutron capture.
Thermal reactor	A reactor in which neutrons are slowed to ‘thermal’ speeds by use of a moderator.
TCNC	Technical Center for Nuclear Control (ROK).
Toxin	Compound originating from microorganisms animals or plants irrespective of the method of production whether natural or modified that can death, disease or ill health to humans, animals or plants.
TW	Terawatt (tera = trillion, 10^{12}).
TWh	Terawatt hours.
U-233	Isotope 233 of uranium, produced through neutron irradiation of thorium-232.
U-235	Isotope 235 of uranium (occurs as 0.711% of natural uranium), comprising 92 protons and 143 neutrons.
U-238	Isotope 238 of uranium (occurs as about 99.3% of natural uranium), comprising 92 protons and 146 neutrons.
UF ₆	Uranium hexafluoride, a gaseous compound of uranium and fluorine used as the feedstock for most enrichment processes.
UOC	Uranium Ore Concentrates (i.e. yellowcake).
WMD	Weapons of mass destruction (nuclear, chemical, biological).

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