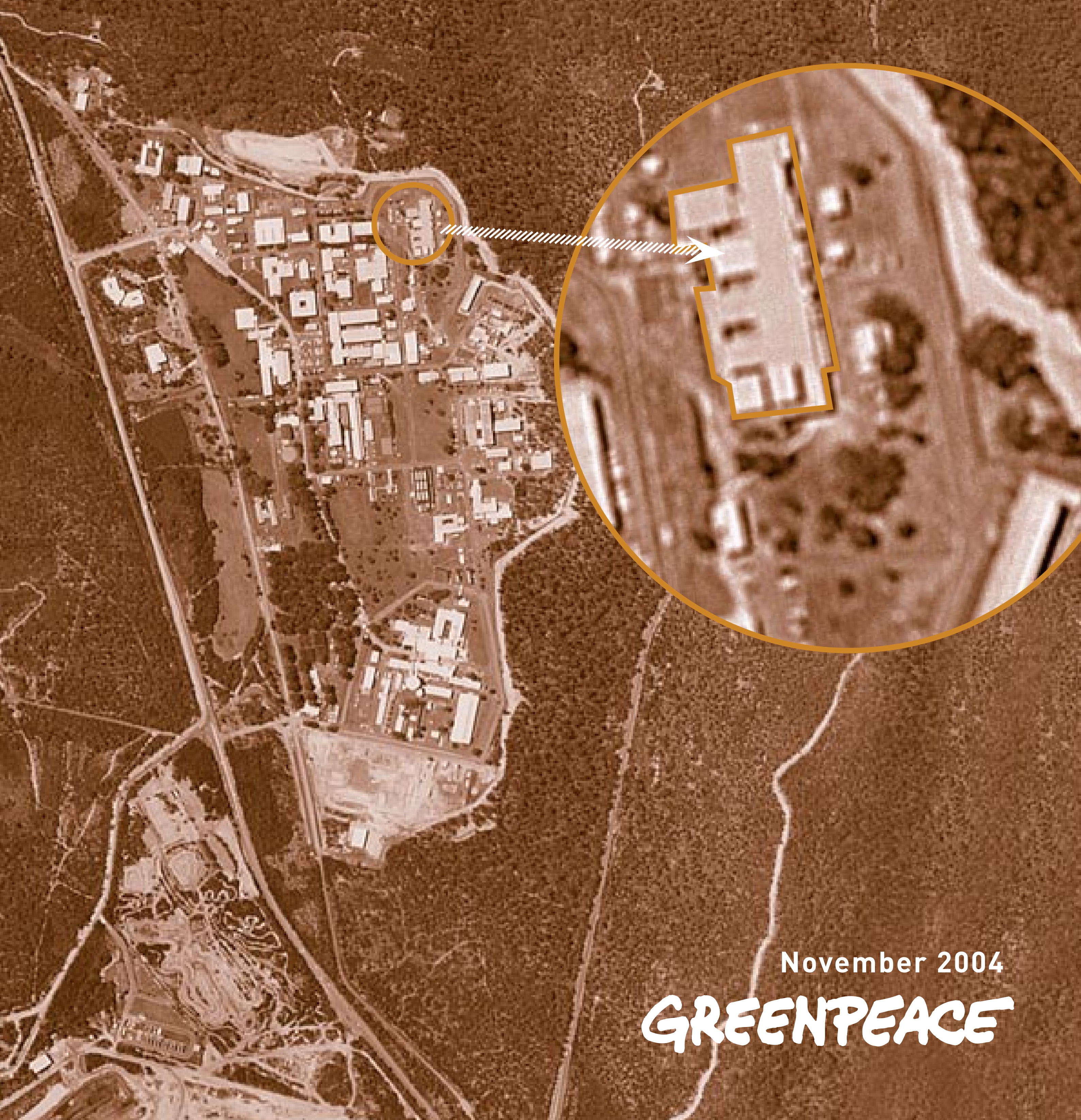
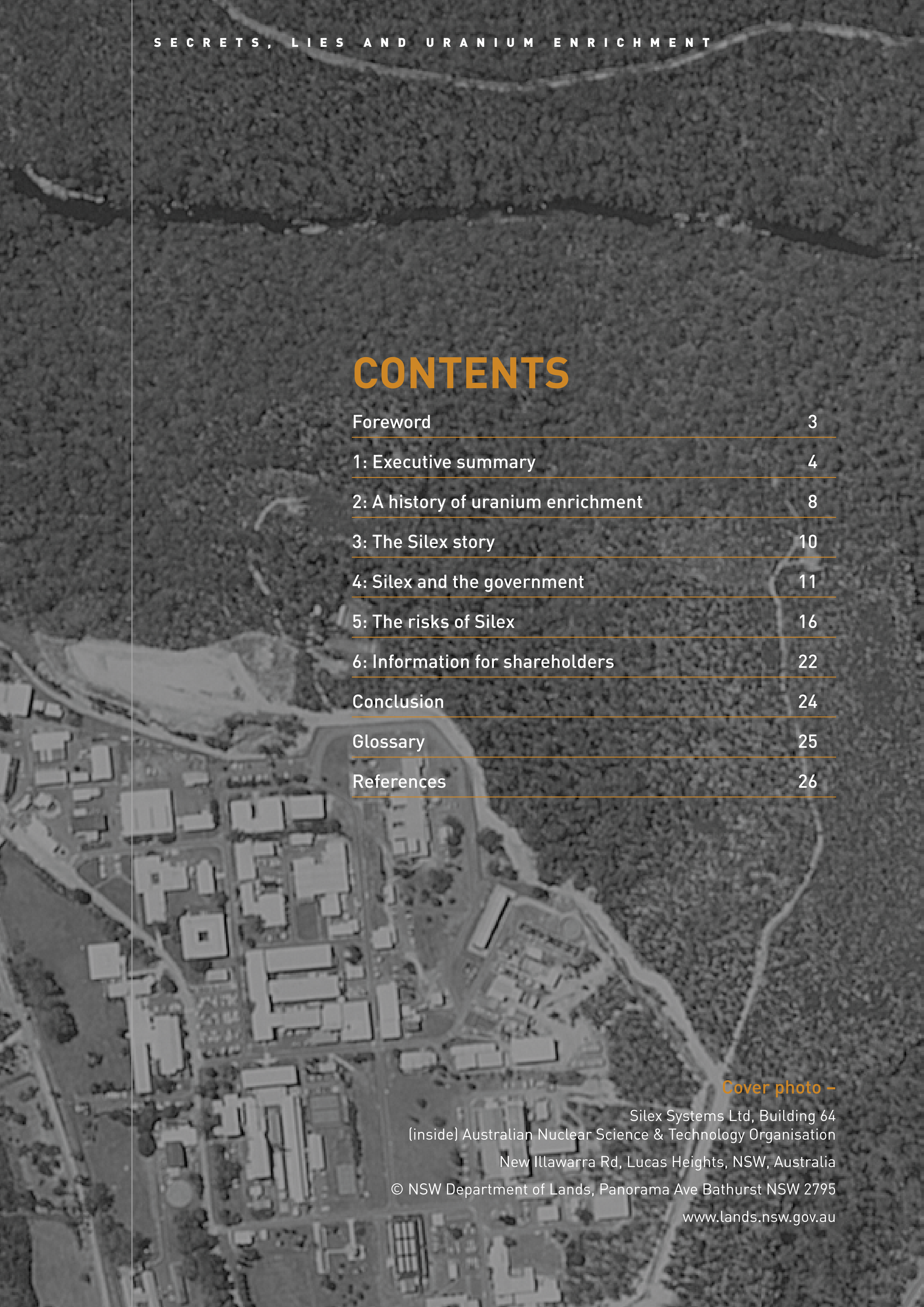
SECRETS, LIES AND URANIUM ENRICHMENT

The classified Silex project at Lucas Heights



November 2004

GREENPEACE



CONTENTS

Cover photo –
Silex Systems Ltd, Building 64
(inside) Australian Nuclear Science & Technology Organisation
New Illawarra Rd, Lucas Heights, NSW, Australia

FOREWORD

The SILEX technology, has a number of applications, including: uranium enrichment; silicon enrichment, for advanced semiconductor materials; and carbon enrichment, for advanced semiconductor and medical diagnostic materials. For uranium enrichment, Silex has the advantages, compared with other enrichment methods, of low power consumption and capital costs. These are significant advantages – hence the considerable interest in Silex.

Highly enriched uranium can be used as the fissile material to fabricate nuclear weapons. Methods to enrich uranium like Silex are, therefore, of major concern and progress in them should be carefully monitored.

This comprehensive report is factual and an important addition to the literature about enrichment techniques, particularly laser enrichment techniques. It explains current research into laser enrichment and its links to nuclear weapons programs.

Australia has been considered a nuclear weapons capable state for many years, and that perfection of laser technologies is fundamental to a modern weapons programme. There are many more applications for laser technology to weapons research and development.

All attempts to prevent the spread of nuclear technologies have failed. If Silex is fully developed it is, to say the least, highly likely that eventually the technology could be used for the production of fissile materials for use in nuclear weapons. Countries interested in setting up clandestine programs to produce highly enriched uranium for use in nuclear weapons will find Silex an attractive technology.

The Australian government's support of this technology undermines its stated commitment to nuclear non-proliferation. Furthermore, conducting this research in a nuclear facility that the public is told is mainly engaged in medical research is hypocritical.

This report should be widely read, particularly by politicians and diplomats. It is essential reading for those interested in nuclear disarmament issues, international politics, international relations and strategic studies.

Dr Frank Barnaby

Nuclear Physicist and author of 'The Invisible Bomb' (Tauris, 1989), 'The Automated Battlefield' (Sidgwick & Jackson, 1987), 'Star Wars' (Fourth Estate, 1987), 'Future Warfare' (Michael Joseph, 1986) and 'The Role and Control of Military Force in the 1990s'.

1 EXECUTIVE SUMMARY

The nuclear industry has for many years sought to perfect methods for enriching uranium, using lasers. The world's nuclear powers have tried to perfect laser enrichment technology – including the US, the French, the Japanese – and have abandoned the quest. In Australia the search goes on.

There is a partnership between the Australian government and the private sector that continues to pursue the development of this technology. If perfected, it will create new risks for the spread of nuclear weapons technology and raises serious questions about Australia's commitment to nuclear non-proliferation.

SILEX AND THE TRUTH ABOUT NUCLEAR RESEARCH AT LUCAS HEIGHTS

The Australian government has supported research into laser enrichment of uranium at Lucas Heights for decades. This research has been shielded from scrutiny by interdepartmental slight of hand and government legislation.

ANSTO at Lucas Heights
Laser enrichment of uranium has been researched at Lucas Heights since 1978. Silex has been involved in this research since 1988 and has a lab within the nuclear facility (Building 64).

In fact, the Australian Atomic Energy Commission (AAEC) [later to become the Australian Nuclear Science and Technology Organisation (ANSTO)] has worked on laser enrichment of uranium at Lucas Heights in Sydney since 1978. Further, a private company known as Silex Systems Ltd, has been involved in this research at the same location since 1990.

The relationship between ANSTO – the government funded nuclear research facility and Silex Systems – the private company is unclear. Silex Systems claims it has developed its enrichment technology independently of ANSTO and that its technology is unique. However, Greenpeace has uncovered a set of complex, interwoven relationships between the government and Silex Systems. These raise a range of questions:

Who owns the emerging technology?
The government began the laser enrichment program, and ANSTO claims to have sold the technology to Silex Systems Ltd in 1994. However, no details of this sale are disclosed in publicly available documents.

Who pays for what?
ANSTO has provided Silex Systems with numerous resources to conduct their 'private' enrichment project – including contract staff, equipment and radioactive materials. Silex leases more than 2000 square metres of space at Lucas Heights and has unspecified access to ANSTO technology and information.

Who owns the uranium used in the research?
ANSTO and the Australian Safeguards and Non-proliferation Office (ASNO) have assisted Silex Systems with the importation and storage of uranium hexafluoride (UF_6) – a radioactive gas used in the uranium enrichment process.

Who is responsible for the nuclear waste?

Silex Systems has not revealed how much nuclear waste its operations have generated or what the company plans to do with it. ANSTO cannot legally dispose of another organisation's waste.

During Senate Estimates questioning, Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) CEO Dr Loy, stated that for reasons of commercial-in-confidence, he could not disclose details relating to nuclear waste generated by Silex Systems.

Where are the regulators of the nuclear industry?

Silex Systems is the only private company in Australia to come under the regulation of ARPANSA. However, no mention of Silex Systems or laser enrichment has ever appeared in a publicly available ARPANSA report. The activities of Silex Systems are not accurately reported by the international nuclear watchdog, the International Atomic Energy Agency (IAEA).[i]

Despite the requirements to detail all nuclear activities conducted at Lucas Heights, the Environmental Impact Statement for the replacement reactor at Lucas Heights submitted to the government by ANSTO contained no reference to uranium enrichment, the use of UF_6 or of Silex Systems.

Silex Systems has regularly imported radioactive materials into Australia by air. These transportations have apparently occurred without any supervision by the nuclear watchdog ARPANSA.

Three shipments of radioactive material, arrived in Australia in January 2001 and August 2002 – possibly through Sydney's Kingsford Smith Airport. When questioned in a Senate Estimates hearing whether ARPANSA or the NSW Emergency Services were consulted in relation to the transports, ARPANSA CEO Dr John Loy said, "this information is unknown to ARPANSA".[ii]

ANSTO/SILEX AND THE THREAT OF PROLIFERATION

The Silex uranium enrichment technology is 'dual use' technology, meaning it can also be used to produce materials for use in nuclear weapons.

Uranium enrichment through gaseous diffusion is expensive, technically difficult and reliant on components engineered to exceedingly high standards. The process consumes vast amounts of energy. These factors have limited the acquisition of enrichment plants and have therefore slowed the proliferation of nuclear weapons. It is traditionally assumed that only the most economically and technologically advanced countries could ever develop enrichment capabilities.

"There can be no doubt that continued progress in laser isotope separation will greatly complicate efforts to control nuclear weapon proliferation".

Stockholm International Peace and Research Institute[iii]

---

[i] *IAEA annual reports contain lists of facilities conducting safeguarded activities. Reference to the research being conducted by Silex Systems was not made until 2003, and the location not revealed as Lucas Heights.*

[ii] *Health and Ageing Portfolio, Senate Community Affairs Legislation Committee, Answers to Estimates Questions on Notice, Additional Estimates 2003-2004, Question: E04-141, February 18 2004.*

[iii] *Allan S. Krass, Peter Boskma, Boelie Elzen, Wim A. Smit, Uranium Enrichment and Nuclear Weapon Proliferation, Taylor and Francis Ltd, London, 1983, p173.*

It is of great concern that the very benefits Silex Systems cites for its laser enrichment process are the same characteristics that would make it easier for a country to secretly build a uranium enrichment plant.

1. an extremely low energy process;
2. based on relatively simple and practical separation modules;
3. a modular technology providing versatility in deployment;
4. expected to have significantly lower overall power consumption and capital costs.[v]

Laser enrichment is believed to pose a serious proliferation threat, due to the simplicity and size of the technology. When compared with centrifuge and diffusion plants, a molecular laser facility capable of producing several bombs per year, can be the size of a small warehouse.

Laser enrichment plants can be used to produce highly enriched uranium in just a few stages, as opposed to the thousands of stages required using centrifuges. A 1977 report by the US Office of Technology Assessment (OTA) highlighted this as one of the major proliferation problems posed by laser enrichment.[iv] The report also expressed the concern that the sale of laser enrichment technology by commercial entities, could hasten the proliferation of the technology.

PROTECTING THE SILEX TECHNOLOGY

The sensitive nature of the Silex technology was formally recognised in 1996, after Silex Systems signed an agreement with the United States Enrichment Corporation (USEC).[vi] The US Department of Energy (DOE) then classified the Silex process as “Restricted Data”, RD – a classification that usually relates to the design of nuclear weapons, or the use or acquisition of nuclear material suitable for their construction.

This was the first time in history that privately held technology was given this classification.

The deal with USEC required the drafting of a new bilateral agreement between Australia and the US, because existing agreements specifically banned the transfer of weapons related technology.

Known as the Silex Agreement, the ‘Agreement for Cooperation with the United States of America concerning Technology for the Separation of isotopes of Uranium by Laser Excitation’ provided for the transfer of Restricted Data, sensitive nuclear technology, sensitive nuclear facilities, and major critical components of such facilities.[vii]

A result of the RD classification is that Silex Systems was required to conduct its activities in secrecy, effectively avoiding public scrutiny. Although it uses radioactive materials, has built a uranium enrichment facility and generates radioactive waste all in the heart of Sydney, there is no public analysis or reportage of the threats posed by these actionsby Australia’s regulatory agencies.

[iv] *Emilio Q. Daddario, Nuclear Proliferation and Safeguards, Office of Technology Assessment, US Congress, Washington, June 1977, Woodrow Wilson School of Public and International Affairs website,http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/disk3/1977/7705/7705.PDF*

[v] *Silex Systems Limited, Annual Report, 2000, p 6.*

[vi] *US Department of Energy, Federal Register 66, June 26, 2001, p 33954.*

[vii] *Department of Foreign Affairs and Trade, Agreement for Cooperation with the United States of America concerning Technology for the Separation of Isotopes of Uranium by Laser Excitation, Canberra, May 2000, Article 3 (1) a,b,c.*

SILEX AND ITS COMMERCIAL VIABILITY

In countries such as the US, Japan and France, research into the laser enrichment of uranium was abandoned as too costly. It provided too little return on investment and is now considered commercially unviable.

In January 2004, the French Atomic Energy Commission ended a 20-year laser enrichment project, after investing around AU$1.84 billion (1.1billion euros). In October 2001, Japan abandoned its 20-year laser enrichment research project, after spending more than AU$784 million (50 billion yen).

In the US, the development of the uranium AVLIS laser enrichment process was abandoned by USEC, after spending approximately AU$3.3 billion (US$ 2 billion) in research and development. USEC then invested in Australia's Silex technology. After financially supporting the project for six years, at an approximate cost of AU$29 million, USEC withdrew from the project. A USEC press release dated April 30th 2003, states "it is unlikely that the Silex technology can be utilized to meet USEC's needs and it would not be a prudent investment for its shareholders". USEC has since proceeded with the construction of a new enrichment plant using established centrifuge technologies.

According to the World Nuclear Association Symposium (2002), there is no demand for new enrichment technologies.[viii] The world enrichment market is considered "harmonious and stable" with four main suppliers that possess "the capacity necessary to meet the demand of the reactor operators".

SILEX AND CORPORATE ACOUNTABILITY

The lack of clarity around Silex Systems contractual relationships with ANSTO, is such that public shareholders of Silex Systems have not been provided with key information such as:

- Who owns the technology?
- What business risks are involved with moving the technology to the pilot phase?
- What additional costs are involved, should expansion plans be slowed by regulatory processes?
- What is the basis for continued expenditure on uranium enrichment, given the withdrawal of USEC and the abandonment of laser enrichment research by all other countries that have pursued it?
- What constraints are imposed on the export and commercialisation of the technology?
- What liabilities were created by the enrichment research – such as the cost of long-term waste management?
- What other costs were not paid by Silex Systems in the past? Costs such as for the provision of security to cover uranium hexafluoride (UF_6) imports, waste storage, insurance liability, risk assessment or emergency planning preparedness should future imports be scrutinised?

[viii] *Jean-Jacques Gautrot, "The Harmonious Market for Uranium Enrichment Services", The World Nuclear Association website, http://www.world-nuclear.org/sym/2002/gautrot.htm*

2 A HISTORY OF URANIUM ENRICHMENT

It is estimated that currently, some 40 countries have the technical capability to produce nuclear weapons.

URANIUM ENRICHMENT GLOBALLY

Currently, there are seven countries with declared nuclear weapons - the US, the UK, Russia, France, China, Pakistan and India. It is generally accepted that Israel has nuclear weapons and it is speculated that North Korea possesses them. It is estimated that some 40 countries have the technical capability to produce nuclear weapons.[1] The basic technology required for a nuclear weapons program is uranium enrichment.

The large-scale enrichment of uranium was first undertaken in the US by the Manhattan Project, which manufactured the bombs that destroyed Hiroshima and Nagasaki in Japan, in 1945. After World War II, the UK, USSR, France and China all constructed gaseous diffusion plants to provide enriched uranium for their nuclear weapons programs.

By 1977, the IAEA documented nine countries that had developed laser uranium enrichment to the laboratory stage[2] – six countries were publicly known to be researching laser enrichment: the USA, Germany, UK, USSR, Japan and Israel. According to an international conference on Uranium Isotope Separation in 1975, security considerations prevented the world's largest investors in laser research from revealing the details of their work.[3]

THE HISTORY OF URANIUM ENRICHMENT IN AUSTRALIA 1965-1988

The sixties were perceived as a period of great instability for the Asia Pacific region. China had tested its first nuclear weapon in 1964, the Vietnam War was underway and security issues were a significant concern for the Australian federal government.

In October 1965, the Menzies government requested that the Australian Atomic Energy Commission (AAEC) and the Department of Supply investigate Australia's policy towards nuclear weapons and the cost of developing the capacity for building them.[4]

Soon afterwards the AAEC began research into the enrichment of uranium using lasers at Lucas Heights, though this was not revealed until the 1975/1976 annual report, which announced the ongoing project was "concentrating on techniques using gas centrifuge technology and lasers."[5]

The annual report further discloses that AAEC staff had conducted an "extensive theoretical assessment" of laser enrichment technology in 1970/1971 and that the results where contained in a 1972 confidential report.

A 1972 confidential report on laser uranium enrichment by Dr Horst Struve, of the Australian Atomic Energy Commission, heralded the expansion of the laser enrichment research program in Australia. Struve was to later become chief scientist for Silex Systems Ltd. He remains the largest private shareholder in the company.

This confidential report was arguably responsible for the expansion of the laser enrichment research program in Australia. It was declared 'classified information' and written by a Dr Horst Struve.[6] Struve was to later become chief scientist for Silex Systems Ltd. He remains the largest private shareholder in the company.[7]

In his book, *Enriching Experiences* – Uranium Enrichment in Australia 1963-1996, Dr Clarence Hardy states that some 20 staff were involved in the Lucas Heights uranium enrichment project by 1974. Hardy writes that in 1975, Dr Struve filed a provisional Australian patent for a "multiphoton process to enrich uranium using a carbon dioxide laser and selected volatile uranium complexes."[8]

In 1978, the AAEC established a Laser Isotope Separation Project Review Committee. In November of that year, the committee reported that the objective of the laser program was to develop "an economically attractive process of uranium enrichment which was in Australia's national interest"[9] and to "enable staff to provide expert advice to government in a field which was important to non-proliferation concerns."[10] In March 1983, the Hawke Government was elected and funding for enrichment research was severely cut.[11]

There is little available information relating to research conducted between 1984 and 1987, when the AAEC was replaced by ANSTO. Subsequent to this change, the laser program received renewed government support and funding and a new period of research began.

"The growth of this industry and the expertise and the facilities which it will create will provide a basis from which an Australian government, at any future date, feeling that nuclear weapons were essential to provide this nation's security, could move with a minimum of delay to provide such means of defence."[12]

Sir Philip Baxter, Chairman of the Australian Atomic Energy Commission 1957-1972.

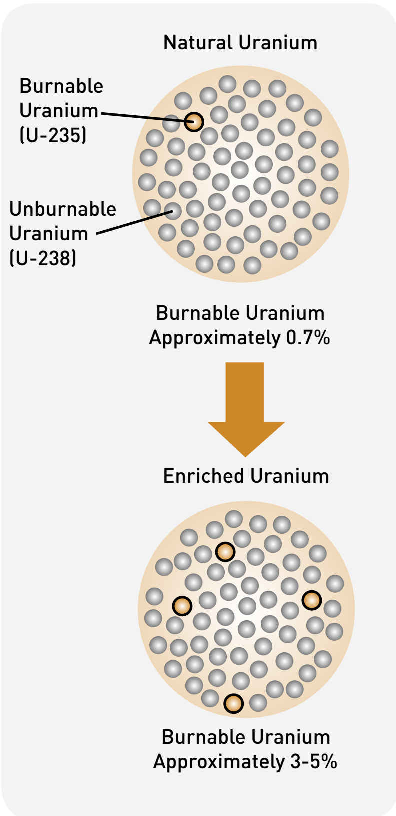
WHAT IS URANIUM ENRICHMENT?

Enriched uranium is the central ingredient of nuclear power reactors and nuclear weapons. In producing weapons or fuel for reactors, specific radioisotopes are separated and concentrated, in a process known as 'enrichment'.

The radioisotopes most often used for producing nuclear weapons or to fuel power reactors, are uranium 235 (U-235) and plutonium 239 (Pu-239). U-235 occurs naturally at around 0.7% enrichment. To fuel power reactors however, this uranium is increased to a minimum of 3% to 5%. Under Australian legislation, once U-235 reaches an enrichment level of 20%, it is considered to have the potential for use in nuclear weapons[13] – although the optimum enrichment for a weapon is 80%.[14]

The most common enrichment method is known as the 'centrifuge' process. Centrifuges are rapidly spinning cylinders, into which UF6 is injected. The gravitational force within the cylinder means molecules of the lighter U-235 isotope concentrate toward the centre. This U-235 is passed through a 'cascade' of such drums, and the process is repeated until the desired enrichment level is achieved.

The precise methods by which lasers are used to enrich radioisotopes remain secret. It is, however, known that the process uses high-powered lasers tuned to the vibrational frequency of the radioisotope to be enriched.[15] This causes the atoms of the targeted isotope to vibrate (referred to as 'excitation'). The excited isotope is then separated and the process repeated, resulting in an enriched product.



3 THE SILEX STORY

The name 'Silex' is derived from a description of the laser separation process – Separation of Isotopes by Laser Excitation.

Sonic Healthcare in Ryde
Silex Systems Ltd began as a subsidiary of Sonic Healthcare (pictured), whose Ryde headquarters show ownership of pathology company Douglass Hanly Moir.

The Silex Systems story begins in 1986 when the Australian company Gunnerson Nosworthy, changed its name to Sonic Technology, with a focus on the development of "technologies that could be acquired at low cost."[16]

By 1989, Sonic Technology was involved in advanced negotiations for its subsidiary Australian Nuclear Enterprises (ANE) to "participate in a joint venture to develop an innovative uranium enrichment process in Australia."[17] In 1990, as part of its business plan to "develop and exploit the Laser Isotope Separation technology known as Silas,"[18] ANE struck an agreement with ANSTO, to use its, "state of the art laser laboratory to further research this process and demonstrate the technical viability of the Silas process."[19] This laboratory was at the Lucas Heights reactor complex, in suburban southern Sydney.

By 1993, the name Silas had been replaced with Silex and the success of the project was said to have led to the application for a provisional patent of the technology.[20] In 1994, parent company Sonic Technologies expressed "confidence for the economic application of the process to uranium enrichment."[21]

In 1995, ANE changed its name to Silex Systems Limited. The 1995 annual report states that the Silex research project had taken "significant strides forward."[22]

By the end of 1995, Sonic Technology had changed it's name again to Sonic Healthcare, after acquiring Australia's largest pathology companies, Clinipath, Hanly Moir and Barratt Smith Pathology. Silex Systems Ltd was divested and eventually listed on the Australian Stock Exchange in 1998.

In 1996, Silex Systems signed an agreement with the world's largest enrichment company, USEC.[23] In return for exclusive rights to the use of the Silex technology for uranium enrichment, USEC agreed to fully fund the uranium development program and provide both technical assistance and equipment.

This landmark agreement between Silex and USEC faced one significant obstacle –the transfer of information relating to sensitive technologies such as uranium enrichment, was expressly forbidden under the *Agreement between Australia and the United States of America concerning Peaceful Uses of Nuclear Energy.*[24]

4 SILEX AND THE GOVERNMENT

CHANGING THE RULES

The bilateral agreement for peaceful uses of nuclear energy came into force on January 16th 1981. Under the agreement, the transfer of information relating to the production of nuclear weapons, or nuclear materials used in the production of nuclear weapons was strictly excluded, unless specifically agreed to by an amendment or a separate agreement.

In order to allow the transfer of technology between USEC and Silex Systems, a special separate agreement was thus framed. The *Agreement for Cooperation with the United States of America concerning Technology for the Separation of isotopes of Uranium by Laser Excitation* or the 'Silex Agreement', provided for the transfer of restricted data, sensitive nuclear technology, sensitive nuclear facilities, and major critical components of such facilities.

The Silex Agreement was announced on May 26th 2000, by Australia's Minister for Foreign Affairs, Alexander Downer and included, but was not limited to:

a) research on and development, design, construction, operation, maintenance and use of sensitive nuclear facilities for Silex technology;

b) safeguards and physical protection of materials and sensitive nuclear facilities and major critical components related to the foregoing; and

c) health, safety and environmental considerations related to the foregoing.[25]

The Agreement also contained the following significant articles:

- High enriched uranium produced through the use of sensitive nuclear facilities and major critical components subject to this Agreement, and plutonium, uranium 233 and high enriched uranium recovered from source or special nuclear material used in or produced through the use of sensitive nuclear facilities and major critical components subject to this Agreement, shall only be stored in a facility which the Parties mutually accept[26]
- Uranium used in or produced through the use of any sensitive nuclear facilities or major critical components subject to this Agreement shall not be enriched to 20 percent or greater in the isotope uranium 235[27]
- Sensitive nuclear facilities and major critical components subject to this Agreement and any material used in them or produced through their use, and Restricted Data and sensitive nuclear technology transferred pursuant to this Agreement, shall not be used for any nuclear explosive device, for research on or development of any nuclear explosive device, or for any military purpose.[28]

These clauses specifically refer to the technology's applications to the production of nuclear weapons, including the enrichment of plutonium.

In 1996, the transfer of information relating to sensitive technologies, such as uranium enrichment, was expressly forbidden under a US-Australian bilateral agreement concerning 'Peaceful Uses of Nuclear Energy'.

Foreign Affairs Minister Alexander Downer signed off on an agreement with the United States to allow further development of the Silex technology, in 2000. The US then classified the technology as "Restricted Data."

AFP PHOTO/CHOO YOUN-KONG

The US Secretary of Energy classified the Silex process as RD – Restricted Data – a category usually relating to the design, use or acquisition of nuclear weapons or nuclear material. This was the first time in history that privately held technology was given this classification.

CLASSIFYING SILEX

On June 26th 2001, following an investigation of the Silex technology by the US Department of Energy (DOE), the US Secretary of Energy determined that the Silex process would be classified RD – Restricted Data.[29]

This was the first time in history that privately held technology was given this classification.[30]

According to *Security Classification of Information - Introduction, History, and Adverse Impacts*[31] the classification 'RD' that the Silex technology received, usually relates to the design of nuclear weapons, or the use or acquisition of nuclear weapons or nuclear material.

This classification clearly indicates that the Silex technology could be applied to the production of nuclear weapons, and was a perceived proliferation threat. The DOE classifies all information relating to methods of isotope separation that have a "reasonable potential for the separation of 'practical' quantities of special nuclear material or other isotopes of military interest". A technique is considered 'practical' if it is able to "produce one or more critical masses in approximately one year"[32] – that is, the radioactive core of a nuclear weapon.

Further to the RD classification, the Silex technology is also listed on the US DOE's "sensitive subjects list" – a list which details "technologies deemed significant to the national security of the United States."[33]

WHAT IS RD CLASSIFICATION?

Silex technology was the first ever privately-held technology classified as RD by the US Government. The US Federal Register of 1997[34] states that RD classifications are applied to:

(1) Nuclear weapon design and utilization (includes selected information revealing theory, design principles and details, yields, inventories, mode of operation, methods for command and control, destruction, and vulnerabilities to sabotage or countermeasures)

(2) Nuclear material and nuclear weapon production (includes selected information revealing special techniques for manufacture)

(3) Inertial confinement fusion (includes selected target design and operational information judged to be particularly revealing of nuclear weapons technology)

(4) Military nuclear reactors (includes selected design, development, test, and operational information concerning reactor power systems for military purposes, especially for naval nuclear propulsion, and selected information concerning capabilities and vulnerabilities)

(5) Isotope separation (includes key process and design information for practical techniques for enrichment of uranium and certain other elements of military significance).

Aerial view of Lucas Heights.
Silex building 64 – bottom right.

AVOIDING DOMESTIC REGULATIONS

The RD classification meant that Silex Systems did not have to publicly disclose details of its activities - which include using radioactive materials, constructing a uranium enrichment facility and generating radioactive waste in suburban Sydney.

In a session of Senate Estimates on the 18th of February 2004,[35] Dr John Loy, CEO of the federal regulator ARPANSA, made some startling revelations about the regulation of Silex Systems. After explaining that ARPANSA regulates Commonwealth entities, Loy stated that private contractors to the Commonwealth can also fall within his jurisdiction. “If a Commonwealth agency directly contracts with a company to perform work that falls under my Act, then I would license the government agency and the contractor”, he said.[36]

When asked specifically about Silex Systems, Loy went on to reveal that Silex Systems is the only private company in Australia to come under ARPANSA regulation. Despite this, no mention of Silex Systems or laser enrichment has ever appeared in a publicly available ARPANSA report.

“Because that company operated on the ANSTO site and was closely linked with the ANSTO site, I decided that I should licence it” Loy said, “rather than it be in a little bit of a legal limbo.”[37]

“And the way I could do that” he went on, “was by declaring the site a Commonwealth place, or words to that effect - I cannot quite remember how the act describes it. I then captured this one company to licence its operations.”[38]

During this questioning, Loy displayed an alarmingly vague understanding of the status of Silex Systems activities. He claimed he was not sure if ARPANSA was consulted about the importation and storage of UF_6 gas by Silex Systems, and that he could not recall whether there were discussions between ASNO and ARPANSA about Silex Systems. Loy also said no communication was received by his office from Silex Systems, of their intentions to expand their operations to the pilot plant stage.[39] This is a particularly concerning point, as the pilot plant proposal has been published in Silex’s annual reports since the year 2000.

It is internationally recognised that all nuclear activities pose risks that require specialised regulation. In Australia the Australian Radiation Protection And Nuclear Safety Act, 1998 (as amended) and the Nuclear Non-Proliferation Safeguards Act, 1987 (as amended) should fulfil this regulatory role. The ARPANS Act was developed to “protect the health and safety of people, and to protect the environment, from the harmful effects of radiation.”[40] If, as Loy says, Silex Systems is now considered a contractor to the Commonwealth, then it should be subject to the regulations of the ARPANS Act Section 11 – ‘Application of Act to Commonwealth contractors’.

Instead, Loy’s statements reveal that Silex Systems appears to operate free from the intense level of scrutiny that the company should be subjected to, by the regulator ARPANSA.

Silex Systems is the only private company in Australia to come under ARPANSA regulation. However, no mention of Silex or laser enrichment has ever appeared in an ARPANSA report.

THE ANSTO MYSTERY

The relationship between ANSTO, the government funded nuclear research facility and Silex Systems, the private company has always been unclear. However, there is evidence that ANSTO has provided contract staff, equipment and radioactive materials to the Silex laboratory at Lucas Heights.

One of the great mysteries of the Silex story, is that it is not clear at what point ANSTO's research into uranium enrichment, became the activities of the private company, Silex Systems.

In 1988, ANSTO was given permission to resume limited laser enrichment research with the intention of providing technical advice to the government and "to reinforce Australia's international and national strategic interests in nuclear technology and to ensure that Australia has the technical credibility to further its non-proliferation, nuclear safeguards and wider nuclear technology policies and interests.[41].

This research program was reported to have a budget of $590, 492,[42] The biomedicine and health division - for the development of nuclear medicine - received a budget of just $382,000 for the same period.[43]

There are many varying reports on the nature of the relationship between ANSTO and Silex Systems. *In Enriching Experiences*, Dr Clarence Hardy writes that ANE conducted research at Lucas Heights using laboratories and staff provided under contract by ANSTO from the 1990's. Hardy clearly states that the result of this collaboration was the process known as Silex.[44]

Silex Systems itself states that the company began researching the technology in 1990, co-invented by Drs Michael Goldsworthy and Horst Struve.[45]

In February 1999, John Carlson, head of nuclear safeguards for ASNO, referred to the research as the "Silex Project" – which he stated had become a "private sector project around 1989". Contrary to the Program Reports of the time, Carlson further insisted the project was "not actually enriching uranium" and was just a "very small" laboratory scale project that "would not be regulated under the Safeguards Act until it had been proven that the technology is effective - which has not happened yet."[46]

Another example of the inter-relationship between ANSTO and Silex Systems, is the radioactive materials used by Silex Systems that were stored by ANSTO for many years. Silex Systems has apparently now taken over full management of its radioactive materials and has a specially designated "material balance area" monitored by ASNO.[47] As the Silex Systems premises are located at Lucas Heights, it seems likely, that this monitoring is of an administrative kind. It is unclear whether ANSTO still stores and manages the materials for Silex Systems.

In August 2004, a statement appeared on the ANSTO website stating that, "this project [Silex] finished at ANSTO in 1994, when the technology was sold to Silex Systems Limited, a privately owned company."[48] However, no report of this transaction could be found in ANSTO annual reports or Silex Systems correspondence with the Australian Stock Exchange.

PROTECTING WITH LEGISLATION

In October 2003, the Australian government attempted to speed through a set of amendments to the *Nuclear Non-proliferation Safeguards Act* of 1987. The amendments were described by the government, as necessary to align the Act with international non-proliferation regimes.[49]

Action by opposition parties ensured that a Committee of Inquiry took place before the amendments were passed and this process revealed an additional intent of the new laws – to keep secret the activities of companies such as Silex Systems and to introduce significant penalties for revealing information about the company.[50]

The amendments to the Act were consequently passed, resulting in the introduction of laws empowering arrest without warrant and mandatory two-year penalties, for any person found guilty of communicating information that might prejudice the physical security of nuclear or associated material. Most disturbing of all perhaps, these new provisions of the Safeguards Act restricted the ability of the independent regulator, ARPANSA, to publicly reveal information relating to Silex Systems.

Amendments to the *Nuclear Non-proliferation Safeguards Act* introduced laws to prevent distribution of information relating to nuclear facilities and associated materials. Under these laws, even ARPANSA is restricted from publicly revealing issues related to the Silex technology.

5 THE RISKS OF SILEX

Ghauri missile test just prior to Pakistan's first underground nuclear test. India and Pakistan have indicated they would cap long range missiles with nuclear war-heads. (AP Photo/Pakistan Television)

Pakistan gained the enrichment technology to develop it's first nuclear bomb through scientists who had worked for a European enrichment company.

GLOBAL RISKS OF SILEX

Proliferation potential

It could be argued that article IV of the international Nuclear Non-proliferation Treaty (NPT)[51] - which ensures that all signatories have the right to develop nuclear energy for peaceful purposes - has led to the proliferation problems facing the world today. It has allowed countries such as North Korea and Iran, for example, to develop nuclear weapons capability under the guise of nuclear power programs.

International experience has already shown that it is virtually impossible to contain the spread of enrichment technology. Pakistan's acquisition of centrifuge technology occurred via scientists that joined their weapons program, after working for a European enrichment company (URENCO). The subsequent transfer of the technology to other countries via the Khan network, is testament to the failure of international safeguards.[52]

Australia's own lack of confidence in non-proliferation safeguards, was highlighted by the Australian Ambassador and permanent representative to the United Nations, Mr John Dauth, in April 2004.

In giving Australia's opening address to the third preparatory committee meeting for the 2005 Nuclear Non-proliferation Review conference, Mr Dauth detailed the failure of non-proliferation mechanisms, stating, "our fears that existing methods were insufficient to stop determined proliferators have been confirmed."[53]

"Australia considers a moratorium on new enrichment and reprocessing plants should be applied while an appropriate framework is developed to ensure such projects do not pose a risk to non-proliferation objectives," Dauth continued.[54]

This statement seems to acknowledge that the world market for enriched uranium is adequately supplied. It also reflects the sentiment that countries must thus be denied the opportunity to claim that new enrichment capacity is for the production of fuel for power reactors.

Dauth called for harsher punishment of proliferators and referred to the risk of countries misusing the treaties peaceful uses of nuclear technology provisions to acquire the "technical basis for a rapid breakout to nuclear weapons."[55]

The Australian government's call for a moratorium on new enrichment plants must be a blow to Silex System's objective of using their technology in a full scale enrichment plant.

The Australian government's call for a moratorium on new enrichment plants must be a blow to Silex's objective of using their technology in a full scale enrichment plant.

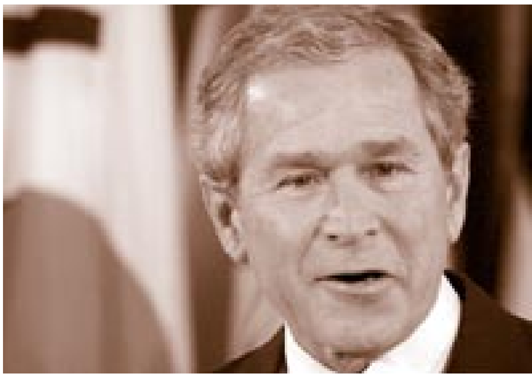
Non-proliferation hypocrisies

In 2004, the US launched the Proliferation Security Initiative (PSI).[56] Enthusiastically supported by many of its allies including Australia, the PSI is intended to counter the perceived failings of the nuclear Non Proliferation Treaty in preventing "rogue nations" from illicitly trading in nuclear technologies and to counter the "crisis of non-compliance."[57]

In February 2004, US President George Bush called on the 40 nations of the Nuclear Suppliers Group to "…refuse to sell enrichment and reprocessing equipment and technologies to any state that does not already possess full-scale, functioning enrichment and reprocessing plants."[58]

Fortunately for Silex Systems, the company had received support and equipment from US companies in the late 90's. However, if the US president is true to his word, Silex Systems may find it very difficult to obtain the equipment required for planned expansion to a pilot plant.

Australia has firmly embraced the PSI, contributing significantly both financially and militarily. Not surprisingly perhaps, the Australian government has, however, not made a call for a ban on the transfer of enrichment technology to countries that don't already possess full-scale enrichment technologies.



US President Bush
In February 2004 US President George Bush called on all countries supplying nuclear technology to "...refuse to sell enrichment and reprocessing equipment and technologies to any state that does not already possess full-scale, functioning enrichment and reprocessing plants."

AFP PHOTO / TIM SLOAN

The risk of knowledge

Silex Systems may have already demonstrated that it is impossible to contain the spread of sensitive technology. When knowledge is held by individuals it becomes difficult to contain. In the late 1990s, the South African government abandoned its enrichment program and several scientists with laser enrichment experience were rumoured to have been approached by an Australian company.[59] Shortly after, Silex Systems announced it had contracted a South African company to work on its research and development project.[60] This occurred without any of the controls put in place for the transfer of technology between the US and Australia.

At the present time, Silex Systems is seeking a third party to continue the commercialisation of the project.[61] It is possible that as part of its efforts to win investment, Silex Systems is taking prospective investors through its Lucas Heights facilities. The potential risks of taking information out of the country or of exposing sensitive technology seem obvious.

The book *Uranium Enrichment and Nuclear Weapon Proliferation*[62] claims that laser enrichment poses the most serious proliferation threat of all. According to the authors, a major contributing factor to this assessment is the size of laser enrichment plants, when compared with centrifuge and diffusion plants. A molecular laser facility capable of producing several bombs per year need be no larger than a small warehouse.

Tricastin enrichment plant, France.
Laser enrichment processing facilities could be a fraction of the size of giant enrichment plants currently operating, making uranium enrichment more accessible.

"Any country might acquire the necessary technology to set up a garage sized plant to produce weapon grade uranium anywhere in the world," 1981 declassified CIA report on threats posed by laser enrichment of uranium.[64]

An accessible technology

Silex Systems promotes the major beneficial characteristics of its laser enrichment process, as:

1. an extremely low energy process
2. based on relatively simple and practical separation modules
3. a modular technology providing versatility in deployment
4. expected to have significantly lower overall power consumption and capital costs.[63]

It is of great concern that these are precisely the identified characteristics that make laser enrichment such a proliferation risk.

Current uranium enrichment methods are expensive, technically difficult and reliant on components engineered to exceedingly high standards. The process consumes vast amounts of energy and requires a large infrastructure. These factors have limited the acquisition of enrichment plants and therefore slowed the proliferation of nuclear weapons. It is traditionally assumed that only the most economically and technologically advanced countries could ever develop enrichment capabilities and make it impossible to covertly develop enrichment plants.

However, the key characteristics of the Silex technology, mirror early concerns about the consequences of the perfection of laser enrichment. The 1981 declassified CIA report[64] *Uranium Enrichment, Threat of Nuclear Proliferation Increasing* states that upon the discovery of laser isotope separation techniques "policy makers immediately became alarmed", as the process was simple, plants small and a tenth of the cost of gaseous diffusion enrichment. "Any country might acquire the necessary technology to set up a garage sized plant to produce weapon grade uranium anywhere in the world", it wrote.

Another major proliferation problem posed by laser enrichment is that enrichment plants can be used to produce highly enriched uranium in just a few stages, as opposed to the thousands of stages required using centrifuges. A 1977 report by the US Office of Technology Assessment (OTA) highlighted this factor as one of the major proliferation problems posed by laser enrichment.[65] The report also expressed the concern that the sale of laser enrichment technology by commercial entities could hasten the proliferation of the technology.

An adaptable technology

Along with concerns that the Silex technology may contribute to the proliferation of uranium-based threats, are concerns that the technology could also be misused to other, equally dangerous ends.

In the lead up to the signing of the US-Australian Silex Agreement, President Bill Clinton gave a speech that drew attention to these alternative uses of the technology.[66] In outlining to the US Congress how non-proliferation measures would be met, Clinton specifically detailed provisions to ensure that the Silex technology would not be used in the US, as part of a military program.

Clinton made passing reference to two alternate applications of the Silex technology – firstly, the potential for the technology to be used in the production of tritium and secondly, for its potential use in materials testing.

Tritium is a key component used in the modern manufacture of advanced nuclear weapons. Whereas early nuclear weapons required massive, heavy quantities of uranium or plutonium, the use of tritium in nuclear weapons design has resulted in smaller warheads, which can be delivered by missiles. This technology is known as "boosting" and is used in various forms in all modern nuclear weapons. It has been reported that tritium has also been used in conjunction with reactor grade plutonium for the design of weapons. Clinton's reference was the first public suggestion that the Silex technology possessed the capability of producing this dangerous substance. If indeed the Silex technology has proven effective in the production of tritium, it would indicate that Australia's capacity to produce nuclear weapons is further advanced than previously assumed.

If indeed the Silex technology has proven effective in producing tritium, it would indicate that Australia's capacity to produce nuclear weapons is further advanced than has previously been assumed.

Clinton's reference to materials testing can also be seen as relating to the use of lasers in nuclear weapons research. High-energy lasers are used in the study of Inertial Confinement Fusion (ICF)[67], a technology that allows the physics of nuclear weapons to be studied on a laboratory-based scale, thereby further enabling clandestine practices of weapons research and development.[68]

LOCAL RISKS OF SILEX

A vast grey area surrounds the health and safety risks posed by the operations of Silex Systems. Insurance, liability, emergency plans, waste disposal and transport are just some of the critical issues that have escaped publicly scrutiny and that cut across both state and federal laws.

It is unclear whether Silex System's activities at Lucas Heights in suburban Sydney, pose risks to the health and safety of humans or the environment. Both the government and Silex Systems downplay or deny potential risks.

Uranium hexafluoride – UF_6

It is indisputable that Silex uses the potentially dangerous radioactive material uranium hexafluoride or UF_6, in its research. Silex may also use other, as yet unrevealed, radioactive materials.

It is well known that UF_6 is a dangerous substance. The US DOE's UF_6 Management Information Network website[69] states "uranium hexafluoride and related compounds have radiological and chemical characteristics" and that "UF_6 in storage emits low levels of radiation."[70]

When UF_6 is released into the atmosphere, the compounds that are formed are known to have toxic chemical effects on humans. If UF_6 enters the bloodstream by means of ingestion, it has a detrimental effect on the kidneys. This corrosive gas can also damage lungs, and cause death if inhaled at high enough concentrations.[71]

When UF_6 is released into the atmosphere, the compounds that are formed have been found to have toxic chemical effects on humans. If UF_6 enters the bloodstream it has a detrimental effect on the kidneys. If inhaled, the gas can damage lungs and even cause death.

Accidents and emissions

Accidents involving emissions of UF_6 have already occurred at Lucas Heights. In his book *Atomic Rise and Fall*, Dr Clarence Hardy describes an accident in 1984 as having the potential for offsite consequences.[72] The accident involved the release of UF_6 from the building in which the centrifuge enrichment program was being shut down. According to Hardy, staff on site were informed of an accident over the PA system and advised that the release was mainly contained in the lab, but that some had escaped to atmosphere. "The message ended with the comment that the management was satisfied that no persons on-site or off-site were affected,"[73] Hardy writes.

The CEO of ANSTO Professor Helen Garnett, attended a Joint Committee to discuss the proposed replacement research reactor at Lucas Heights and when questioned about the 1984 accident, Garnett said:

"UF_6 is not a radioactive material; and, secondly, it has nothing to do with the operation of a reactor. It was associated with a project that was being undertaken during the 1980s, and there was a very small quantity of UF_6, which went out into a research laboratory. But there was a very thorough investigation and monitoring, which confirmed again that there was no radiological health risk to any member of the public or any other toxicological health impact because, as I say, this was not a radioactive material."[74]

The Environmental Impact Statement (EIS) submitted by ANSTO for the replacement research reactor, makes no mention of UF_6. Nor does the EIS reveal that Silex research was underway at Lucas Heights, though the company was undoubtedly conducting work on uranium enrichment at this time.

Transportation of radioactive material

In 2003, Greenpeace discovered radioactive material was being imported into Australia by air. Questions during Senate Estimates hearings in February 2004 revealed that three shipments of UF_6 had been flown in for Silex Systems from the US, in January and August 2001.

The Australian public would be shocked and deservedly concerned to learn that Silex Systems' nuclear materials are flown into Australia and transported by road through the country's most populous city.

In an era of heightened sensitivity around airport security and the potential for terrorist attack, it is even more alarming that transport of radioactive materials is occurring without any apparent analysis of the risks. The public cannot therefore be satisfied that these risks have been considered and dealt with.

In 2003, Greenpeace became aware via the website of the US Nuclear Regulatory Commission (NRC), that on October 21st 1999, an application had been made on behalf of USEC, for a license to export UF_6 to Lucas Heights.

The order comprised 33.5 kilograms of UF_6. Greenpeace investigations revealed the NRC issued license XSNM03113, expiring on the 28th February 2005.[75]
As a result of questions on notice put to ARPANSA during Senate Estimates in February 2004, it was revealed that a special license was issued to Silex Systems on August 17th 2001. This license authorised Silex to "deal with controlled apparatus or controlled material."[76]

In the Senate Estimates questioning it was admitted that there were in fact three importations by air of "various uranium isotopes including in the form of UF_6" and that import permissions were issued on January 25th 2001, August 12th 2002 and August 27th 2002.

When asked which airport the UF_6 came through, or whether ARPANSA or the NSW emergency services were consulted in relation to the transport, ARPANSA replied, "this information is unknown to ARPANSA."[77]

ARPANSA were also asked to provide an inventory of controlled apparatus and materials held by Silex Systems. The request was denied.[78]

Whilst there is no doubt that the transportation of even small amounts of UF_6 pose a threat to public health and the environment, the lack of any comprehensive risk and consequence analysis means the precise levels of risk remain unknown.

When asked which government agency or private company was liable for damages in the event of an accident while transporting UF_6 for Silex Systems, the answer was that it would be a matter for the courts to decide.[79]

Disposal of nuclear waste

Given that Silex Systems has conducted experiments using radioactive materials since 1990, and has imported UF_6, it is reasonable to assume that the company has accumulated what could be a significant stockpile of radioactive waste.

ANSTO has stated that "all waste produced by Silex remains the responsibility of Silex. ANSTO does not receive or treat Silex waste. All waste produced by Silex is stored within their facility and a waste inventory kept."[80]

According to ARPANSA, radioactive waste generated by Silex Systems is kept in a drum on their premises, and that Silex Systems is required to provide ARPANSA with details of the form, volume and isotopic content of this waste.[81]

During Senate Estimates questioning, ARPANSA's CEO Dr Loy stated that for reasons of commercial-in-confidence, he could not disclose details relating to Silex System's waste. Exactly how much waste Silex Systems has in storage, and what it plans to do with it, are questions that remain unanswered.

Currently, Silex Systems has no legal options available, for the long-term storage or disposal of this waste. A significant environmental, health and safety legacy remains. Waste storage is also a financial liability that is not disclosed in any annual reports or announcements made to the Australian Stock Exchange.

6 INFORMATION FOR SHAREHOLDERS

Even Silex Systems shareholders, it would appear, have not been advised of key pieces of information critical to assessing the viability of the company.

Since the signing of the Silex Agreement in 2001, Silex Systems has undergone rapid growth and received significant support from the Australian government. Direct government funding between 2001 and 2003 totalled $2,376,300.[82]

Simultaneously however, the federal government and its agencies have gone to great lengths to downplay the size of the operations of Silex Systems – referring to them as very small, laboratory scale experiments using small amounts of radioactive materials.[83]

A lack of clarity in the information from the company or the government makes it difficult to determine the exact scale and scope of the existing Silex Systems operation. However, Silex Systems currently occupies some 2,217 square metres at Lucas Heights – space it leases from ANSTO.[84]

But it appears that Silex Systems have not advised their shareholders of key pieces of information critical to assessing the viability of the company– as the following examples illustrate:

MANAGING RADIOACTIVE WASTE

There is no doubt that Silex Systems generates nuclear waste – a considerable amount must have been generated since 1990. ANSTO may have managed the nuclear waste produced by Silex, however in 2003 ANSTO stated that "all waste produced by Silex remains the reponsibility of Silex."[85] Silex has never referred to this waste, or the costs associated with its long-term management and storage. Shareholders should be aware that this could be a significant cost, which must emerge in the future.

LEGAL HURDLES – BUILDING A PILOT PLANT

In 2002, an Engineering Study was said to be underway, as a precursor to building a Silex technology Pilot Plant. The plant was expected to involve "significantly larger scale equipment than was used in the previous Pilot Module stage."[86]

After the withdrawal of USEC from Silex System's activities, Silex Systems announced that negotiations were well advanced with a foreign investor that would help finance the commissioning of a uranium enrichment pilot plant. In 2004, they reported they were, "actively engaged in third party discussions with two large overseas organisations," and were, "confident these discussions will lead to new arrangements for the commercial development of Silex uranium enrichment technology."[87]

However, just when the next stage of commercial development – the construction of the pilot plant – takes place, could be a deciding factor in the future of the uranium enrichment project. The nuclear regulator ARPANSA, has made it clear that any further expansion of their operations in Australia will be subject to approval and compliance with regulations.[88]

The legal difficulties facing Silex Systems are apparent from section 10 of the ARPANS Act.[89]

Section 10 states;

> Nothing in this Act is to be taken to authorise the construction or operation of any of the following nuclear installations:
>
> (a) a nuclear fuel fabrication plant;
>
> (b) a nuclear power plant;
>
> (c) **an enrichment plant;**
>
> (d) a reprocessing facility.

To build a pilot enrichment plant, Silex Systems will have to overcome the potential difficulty of the prohibition on the construction of enrichment plants in Australia under the ARPANS Act.

Under intense questioning during a Senate Estimates Committee hearing in 2004, ARPANSA's Dr Loy said that under the ARPANS Act, "certain activities are prohibited. So, if Silex … wishes to undertake an activity that is prohibited, it would have to apply for a licence."[90]

Applying for such a licence would presumably be a time consuming and costly process.

Dr John Loy was forced to clarify that any increase in the current complement of laser devices and equipment for enriching uranium by Silex Systems, would trigger an application to extend its licence. It would then be up to ARPANSA to decide at what point its operation becomes a 'uranium enrichment plant' – which is expressly prohibited under the Act.

COMMERCIAL VIABILITY – A DOUBTFUL FUTURE

All current and potential Silex Systems shareholders should be advised of what appears to be the impending end to the demand for enriched uranium. At the World Nuclear Association Symposium in 2002, attendees were told that the world enrichment market was "harmonious and stable" with four main suppliers available, that possess "the capacity necessary to meet the demand of the reactor operators."[91]

The same year, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development reported that, "the next generation of enrichment plants is likely to be based on centrifuge technology."[92]

Many of the worlds largest enrichment companies have investigated and abandoned the application of laser enrichment technology to the commercial production of reactor fuel.

In October 2001, the Japanese government abandoned its funding of laser enrichment research after spending more than 50 billion yen (AU$784.6 million). The project, which had run since 1980, had also received some 15 billion yen from private industry investment.[93]

In January 2004, the French Atomic Energy Commission ended a 20-year laser enrichment project.[94] Independent auditors appointed by the French Government to investigate the project called it a "risky bet" that had benefited from generous financing long after its inappropriateness had become evident.[95] It was estimated that 1.1 billion euros (AU$1.84 billion) was spent on the project. The French company COGEMA which had also provided funding for the project, made the decision in 2004 to replace an aging enrichment plant with centrifuge technology, and not laser enrichment.

In the US, the development of the uranium AVLIS process was abandoned by USEC after spending approximately US$2 billion (AU$3.3 billion) in research and development.[96] A USEC spokesperson said that even if the significant technical obstacles facing the AVLIS laser enrichment process were overcome, "the market price trends for enrichment would provide too low a rate of return on investment for the risk involved."[97]

USEC then invested in Australia's Silex technology. After financially supporting the project for six years, at an approximate cost of AUD $29 million, USEC withdrew from the project. A USEC press release dated April 30th 2003 states "it is unlikely that the Silex technology can be utilized to meet USEC's needs and it would not be a prudent investment for its shareholders."[98] USEC has since proceeded with the construction of a new enrichment plant using established centrifuge technologies.

USEC walked away from the Silex technology completely, with no apparent attempts to maintain some right of return on its investment if it proved commercially successful. This clearly indicates that USEC saw few prospects for the technology.

CONCLUSION

The Australian Government allows Silex Systems Ltd to use facilities leased from the Australian Nuclear Science and Technology Organisation at the Lucas Heights reactor. This seriously undermines our Government's commitment to the eliminiation of nuclear weapons.

Greenpeace calls on the Australian Government to set an example to the rest of the world, by ending research into sensitive nuclear technologies, such as laser enrichment of uranium, that pose significant proliferation risks.

GLOSSARY

AAEC – the Australian Atomic Energy Commission

ANE - Australian Nuclear Enterprises, the former company name of Silex Systems Limited

ANSTO – Australian Nuclear Science and Technology Organisation

ARPANSA – Australian Radiation Protection and Nuclear Safety Agency

ASNO – the Australian Safeguards and Non-proliferation Office

AVLIS – Atomic Vapour Isotope Separation – US laser enrichment method

DOE - the US Department of Energy

EIS - Environmental Impact Statement

IAEA – International Atomic Energy Agency

ICF - Inertial Confinement Fusion

NPT – the Nuclear Non-Proliferation Treaty

NRC – the US Nuclear Regulatory Commission

OTA – the US Office of Technology Assessment

PSI – the Proliferation Security Initiative

Silex Systems Limited – full name of private company undertaking laser enrichment at Lucas Heights. Derived from a description of this basic laser process - Separation of Isotopes by Laser Excitation

Silex – registered name of the laser enrichment technology used by Silex Systems at Lucas Heights

U-235 – uranium 235

UF_6 - uranium hexafluoride, a gas form of uranium used for enrichment

USEC – the United States Enrichment Corporation

REFERENCES

[1] International Atomic Energy Agency (IAEA), 48th IAEA General Conference, IAEA website, **http://www.iaea.org/NewsCenter/Statements/2004/ebsp2004n008.html**

[2] Dr Clarence Hardy, *Enriching Experiences – Uranium Enrichment in Australia 1963-1996*, Glen Haven Publishing, Peakhurst NSW, 1996, p99.

[3] Uranium Isotope Separation, Proceedings of the International Conference organised by the British Nuclear Energy Society in association with Kerntechnishe Gesellschaft, London, 5-7 March 1975.

[4] Alice Cawte, *Atomic Australia 1944-1990*, NSW University Press, Kensington, 1992, p112.

[5] Australian Atomic Energy Commission, *Annual Report,* 1975-1976, p41-49.

[6] Dr Clarence Hardy, *Enriching Experiences - Uranium Enrichment in Australia 1963-1996*, Glen Haven Publishing, Peakhurst NSW, 1996, p78.

[7] Silex Systems Limited, *Annual Report*, 2004, p75.

[8] Dr Clarence Hardy, *Enriching Experiences - Uranium Enrichment in Australia 1963-1996*, Glen Haven Publishing, Peakhurst NSW, 1996, p79.

[9] *Ibid*, p80.

[10] *Ibid*, p81.

[11] Australian Atomic Energy Commission, *Annual Report*, 1982-1983, p22.

[12] Sydney Morning Herald, 14.07.1969, p 1. In Alice Cawte, *Atomic Australia 1944-1990*, NSW University Press, Kensington, 1992, p 127

[13] Australian Safeguards and Non-proliferation Office (ASNO), Definitions, ASNO website **http://www.asno.dfat.gov.au/definitions.html**

[14] B. Jasani (ed.), *Nuclear Proliferation Problems*, Stockholm International Peace Research Institute (SIPRI), MIT Press, Cambridge [Mass.], 1974, p57.

[15] Allan S. Krass, Peter Boskma, Boelie Elzen, Wim A. Smit, *Uranium Enrichment and Nuclear Weapon Proliferation*, Stockholm International Peace and Research Institute, Taylor and Francis Ltd. London, 1983, p8.

[16] Sonic Technology, *Annual Report,* 1987 p 7.

[17] Sonic Technology, *Annual Report,* 1989 p 2.

[18] Sonic Technology, *Annual Report*, 1990 p 3.

[19] *Ibid*.

[20] Sonic Technology, *Annual Report*, 1993, p 4

[21] Sonic Technology, *Annual Report*, 1994, p 3.

[22] Sonic Technology, *Annual Report*, 1995, p 7.

[23] Silex Systems 2000 annual report, p 4.

[24] Department of Foreign Affairs and Trade, *Agreement between Australia and the United States of America concerning Peaceful Uses of Nuclear Energy,* Canberra, 16 January 1981, Article 3.

[25] Department of Foreign Affairs and Trade, *Agreement for Cooperation with the United States of America concerning Technology for the Separation of Isotopes of Uranium by Laser Excitation*, Canberra, May 2000, Article 3 (1) a,b,c.

[26] *Ibid*, Article 5.

[27] *Ibid*, Article 6.3.

[28] *Ibid,* Article 8.

[29] US Department of Energy, *Federal Register 66,* June 26, 2001, p33954.

[30] Arvin S. Quist, *Security Classification of Information Volume 1 - Introduction, History, and Adverse Impacts*, Oak Ridge Classification Associates, Oak Ridge, 2002, p 89.

[31] *Ibid*, p 87.

[32] Dr. Paul T. Cunningham, *Report of the Fundamental Classification Policy Review Group*, Los Alamos National Laboratory, 1997, Section 2.3, Appendix G, Federation of American Scientists website, **http://www.fas.org/sgp/library/repfcprg.html**

[33] US Department Of Energy, "Sensitive Subjects List - Revised June 2001", Lawrence Livermore National Laboratory Export Control, Lawrence Livermore National Laboratory website, **http://www.llnl.gov/expcon/SSL.pdf**

[34] US Department of Energy, *Federal Register*, January 15, 1997, Volume 62, Number 10, p 2251.

[35] Department of Health, *Health and Ageing portfolio, Community Affairs Legislation Committee*, Senate Estimates, February 18 2004, Hansard p103.

[36] *Ibid.*

[37] *Ibid.*

[38] *Ibid.*

[39] *Ibid*, p 105.

[40] *Australian Radiation Protection and Nuclear Safety Act 1998 (as amended),* Part 1, Section 3.

[41] The Hon. B.O Jones, *Nuclear Energy Research and Development (Question No. 1954),* August 17 1989, p 271.

[42] Australian Nuclear Science and Technology Organisation (ANSTO), *Program of Research 1990-1991*, p 15.

[43] *Ibid*, p 33.

[44] Dr Clarence Hardy, *Enriching Experiences - Uranium Enrichment in Australia 1963-1996*, Glen Haven Publishing, Peakhurst NSW, 1996, p 155.

[45] Silex Systems Limited, *Annual Report,* 2003, p 6.

[46] J. Carlson, *Department of Foreign Affairs and Trade: Program 1 - International relations, trade and business liaison: Subprogram 1.7- Global issues*, Committee name Foreign Affairs, Defence and Trade Legislation Committee, February 16 1999.

[47] Australian Safeguards and Non-proliferation Office (ASNO), *Annual Report,* 2003, p 32.

[48] Australian Nuclear Science and Technology Organisation, Our Community – Local Community Updates, ANSTO website, **http://www.ansto.gov.au/ansto/community/qajune2004.html**

[49] The Parliament of the Commonwealth of Australia, House of Representatives, Non-Proliferation Legislation Amendment Bill 2003 Explanatory Memorandum, (Circulated by authority of the Minister for Foreign Affairs, the Honourable Alexander Downer MP).

[50] Andrew Leask, *Senate Foreign Affairs, Defence and Trade Legislation Committee, Reference: Non-Proliferation Legislation Amendment Bill 2003*, September 8 2003, p16.

[51] *Treaty on the Non-Proliferation of Nuclear Weapons (London, Moscow and Washington, 1 July 1968) Entry into force for Australia: 23 January 1973*, IV (1,2).

[52] Joop Boer, Henk van der Keur, Karel Koster and Frank Slijper, *A.Q. Khan, Urenco and the proliferation of nuclear weapons technology: the symbiotic relation between nuclear energy and nuclear weapons*, Greenpeace International, Amsterdam, May 2003.

[53] J. Dauth, Opening Address to the Third Preparatory Committee for the 2005 NPT Review Conference, Department of Foreign Affairs and Trade website, **http://www.dfat.gov.au/security/statements/npt_statement_040526.html**

[54] *Ibid*.

[55] *Ibid*.

[56] The US Department of State, The Proliferation Security Initiative, US DOS website, **http://www.state.gov/t/np/rls/other/34726.htm#statement**

[57] John R. Bolton, *US Seeks Better Enforcement of Nuclear Non-Proliferation Treaty*, Statement to the Third Session of the Preparatory Committee for the 2005 Review Conference of the Treaty on the Non-Proliferation of Nuclear Weapons, New York, April 27 2004.

[58] The White House, *President Announces New Measures to Counter the Threat of WMD - remarks by the President on Weapons of Mass Destruction Proliferation*, News, The White House website, **http://www.whitehouse.gov/news/releases/2004/02/**

[59] M. Barletta, C. Bowen, K. Jamison, and G. Kampani, "Nuclear and missile related trade and developments for selected countries", *The Non-proliferation Review*, November 1997-February 1998, Monterey, p 150.

[60] Goldsworthy. M, "Laser Development Contract Signed" Tue 23 Jun 1998, Australian Stock exchange, Document No:161933. **http://www.asx.com.au/asx/statistics/showSignalgDetail.do?issuerId=3900&announcementId=343025**

[61] M. Goldsworthy, *ASX Announcement, Project and Operational Updates*, Sydney, August 26 2004.

[62] Allan S. Krass, Peter Boskma, Boelie Elzen, Wim A. Smit, *Uranium Enrichment and Nuclear Weapon Proliferation*, Taylor and Francis Ltd, London, 1983, p 24.

[63] Silex Systems Limited, *Annual Report*, 2000, p 6.

[64] CIA, *Uranium Enrichment, Threat of Nuclear Proliferation Increasing*, CIA website, **http://www.cia.gov**

[65] Emilio Q. Daddario, *Nuclear Proliferation and Safeguards*, Office of Technology Assessment, US Congress, Washington, June 1977, Woodrow Wilson School of Public and International Affairs website, **http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/disk3/1977/7705/7705.PDF,** p 14

[66] Bill Clinton, Office of the Press Secretary, The White House, November 3 1999, Federation of American Scientists website,**http://www.fas.org/news/australia/991103-australia-wh1.htm**

[67] James Glanz, "Steep budget rise saves project to use lasers for nuclear tests", *New York Times*, October 5, 2000

[68] Dr. Andre Gsponer and Dr. Jean-Pierre Hurni, *The Proliferation Risks of ITER,* WISE/NIRS Nuclear Monitor #603, February 13 2004, **http://www.antenna.nl/wise/index.html?http://www.antenna.nl/wise/603/5574.php**

[69] The Environmental Assessment Division of Argonne National Laboratory, Depleted UF Guide, Health Effects Associated with Uranium Hexafluoride (UF_6), Argonne National Laboratory website, **http://web.ead.anl.gov/uranium/guide/UF/health/index.cfm**

[70] *Ibid*.

[71] *Ibid.*

[72] *Dr Clarence Hardy, Atomic Rise and Fall – The Australian Atomic Energy Commission 1953-1987, Glen Haven Publishing Peakhurst, 1999, p 214.*

[73] *Ibid.*

[74] Garnett. H, *Joint Committee on Public Works, Replacement nuclear research reactor, Lucas Heights*, Sydney May 14 1999, p 1019
http://parlinfoweb.aph.gov.au/PIWeb/view_document.aspx?id=27484&table=COMMJNT

[75] NRC form 7, Edlow International applicant, Date of application October 21 1999.

[76] Health and Ageing Portfolio, *Senate Community Affairs Legislation Committee, Answers to Estimates Questions on Notice, Additional Estimates 2003-2004*, Question: E04-142, February 18 2004.

[77] Health and Ageing Portfolio, *Senate Community Affairs Legislation Committee, Answers to Estimates Questions on Notice, Additional Estimates 2003-2004*, Question: E04-141, February 18 2004.

[78] Health and Ageing Portfolio, *Senate Community Affairs Legislation Committee, Answers to Estimates Questions on Notice, Additional Estimates 2003-2004*, Question: E04-142, February 18 2004

[79] Health and Ageing Portfolio, *Senate Community Affairs Legislation Committee, Answers to Estimates Questions on Notice, Additional Estimates 2003-2004*, Question: E04-141, February 18 2004.

[80] Education, Science and Training, *Senate Legislation Committee, Questions on Notice 2003-2004 Supplementary Budget Estimates Hearing,* Question No. E401-04, November 6 2003.

[81] Health and Ageing Portfolio, *Senate Community Affairs Legislation Committee, Answers to Estimates Questions on Notice, Additional Estimates 2003-2004*, Question: E04-143, February 18 2004.

[82] Department of Parliamentary Service, Questions on Silex and Research Reactor Fuel, 27 April 2004.

[83] A. Leask, Joint Committee on Treaties: Treaties tabled on March 7, 2000, discussion date April 3, 2000.

[84] Education, Science and Training, Senate Legislation Committee, *Questions on Notice, 2003-2004 Supplementary Budget Estimate Hearing – Australian Nuclear Science and Technology Organisation,* Question No. E399-04, November 6 2003.

[85] Education, Science and Training, *Senate Legislation Committee, Questions on Notice 2003-2004 Supplementary Budget Estimates Hearing,* Question No. E401-04, November 6 2003.

[86] B. Goldsworthy, *Project Update & Financial results for period ending 31/12/01*
Document date: Mon 11 Mar 2002 Published: Tue 12 Mar 2002, Australian Stock Exchange.

[87] Silex Systems Limited, *Annual Report*, 2004, p 3.

[88] Health and Ageing portfolio, *Senate Estimates, Community Affairs Legislation Committee*, February 18 2004, Canberra.

[89] *Australian Radiation Protection and Nuclear Safety Act 1998 (as amended)*, Section10.

[90] Health and Ageing portfolio, *Senate Estimates, Community Affairs Legislation Committee*, February 18 2004, Canberra.

[91] Jean-Jacques Gautrot, "The Harmonious Market for Uranium Enrichment Services", The World Nuclear Association website, **http://www.world-nuclear.org/sym/2002/gautrot.htm**

[92] Nuclear Energy Agency, *Trends in the Nuclear Fuel Cycle - Economic Environmental and Social Impacts*, Organisation for Economic Co-operation and Development (OECD*) publications,* Paris, 2001, p 33. **http://www1.oecd.org/publications/e-book/6602011e.pdf**

[93] The Japan Times Online, "Long, costly effort to enrich uranium with laser tech will now be scrapped", The Japan Times, October 4 2001, **http://www.japantimes.co.jp/cgi-bin/getarticle.pl5?nn20011004c2.htm.**

[94] Ann MacLachlan, "CEA says Silva demo shows laser enrichment has a future", *Platts Nuclear Fuel*, Volume 29 / Number 2 / January 19, 2004.

[95] Ann MacLachlan, "French auditors say CEA funded Silva despite doubts about its future", *Platts Nuclear Fuel*, Volume 29 / Number 4 / February 16, 2004.

[96] Uranium Information Centre (UIC), Nuclear Issues Briefing Paper 33, UIC website, **http://www.uic.com.au/nip33.htm**.

[97] Vincent Kiernan, "US Enrichment Corp. shuts down AVLIS", *Laser Focus World*, August 1999.

[98] USEC Press Release April 30, 2003.

CONCLUSION

The Australian Government allows Silex Systems Ltd to use facilities leased from the Australian Nuclear Science and Technology Organisation at the Lucas Heights reactor. This seriously undermines our Government's commitment to the eliminiation of nuclear weapons.

Greenpeace calls on the Australian Government to set an example to the rest of the world, by ending research into sensitive nuclear technologies, such as laser enrichment of uranium, that pose significant proliferation risks.

Greenpeace Mission & Values

Greenpeace is an independent campaigning organisation which uses non-violent creative confrontation to expose global environmental problems and to force solutions which are essential to a green and peaceful future, including a world free of the threat of nuclear weapons.

INDEPENDENCE.
We do not accept money from governments, corporations or political parties because it would compromise our core values.

BEARING WITNESS.
We follow the Quaker tradition of bearing witness. Philosophically and tactically, our publications and peaceful protests work to raise awareness and bring public opinion to bear on decision-makers.

NON-VIOLENT DIRECT ACTION.
We strongly believe that violence in any form is morally wrong and accomplishes nothing.

GREENPEACE

www.greenpeace.org.au

PO Box 3307
Sydney
NSW 2001

Phone: 02 9261 4666
Fax: 02 9261 4588
Email: nuclear@au.greenpeace.org

Printed on 100% recycled, elemental chlorine free paper with vegetable oil based inks using an alcohol free production process.