Nuclear Non-Proliferation Treaty

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Verification of nuclear disarmament: first interim report on studies into the verification of nuclear warheads and their components

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Introduction

1. At the 2000 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons the United Kingdom identified three areas relevant to nuclear arms control measures, including, ultimately, the global elimination of nuclear weapons. These were the ability to verify:

> i. that States are not testing nuclear weapons or other nuclear explosive devices;
>
> ii. that States are not producing fissile material for nuclear weapons or other nuclear explosive devices;
>
> iii. reductions and dismantlement of nuclear weapons and warheads in any State that might have produced or otherwise acquired them, and disposition of the fissile material arising.

2. The United Kingdom is well known for its long-standing support of international efforts being made in the first two of these areas. The United Kingdom contributed significantly to the negotiation of a Comprehensive Nuclear- Test Ban Treaty and it has ratified the Treaty, being, jointly with France, the first of the Nuclear Weapon States to do so. It fully supports the efforts being made by the Preparatory Commission of the Comprehensive Nuclear-Test Ban Treaty Organisation in Vienna to develop and establish an effective verification regime for this Treaty - for example, by conducting research into events-screening methods, providing technical and other experts at appropriate meetings, attending workshops and contributing to the debate on the civil and scientific benefits of verification systems. The United Kingdom also supports the work of the International Atomic Energy Agency, including its work on safeguards. The United Kingdom continues to support negotiations on a Fissile Material Cut-Off Treaty and announced in 1995 that it had ceased the production of fissile material for explosive purposes. The purpose of this paper, therefore, is to provide information about the work in the third area, which is particularly relevant to the 13th "practical step" as set out in the NPT 2000 Review Conference Final Document, Article VI, paragraph 15.

3. At the 2000 Review Conference, the United Kingdom announced that it had just commenced a programme to consider technologies that could be used in the verification of any future arrangement seeking to reduce and ultimately eliminate stockpiles of nuclear weapons. The programme includes work on:

- the authentication of warheads and their components, i.e. establishing that an item declared to be a nuclear warhead or a component from a nuclear warhead is consistent with those declarations;
- the dismantlement of warheads and their components;
- the disposition of the fissile material arising, to ensure that it can no longer be used in nuclear weapons or other explosive nuclear devices; and
- the monitoring of nuclear complexes.

4. Initial studies into some of these areas are being conducted at the United Kingdom's

Atomic Weapons Establishment (AWE), Aldermaston.[1] The United Kingdom intends to present the consolidated findings of these at the 2005 Review Conference of the Treaty on the Non-Proliferation of Nuclear Weapons. However, following the interest shown at the 2002 Preparatory Committee meeting, the United Kingdom has decided to give an interim report on some aspects of the work conducted to-date, principally on the technical approaches potentially applicable to the authentication of nuclear warheads and their components. The United Kingdom's work to date has focused on warhead authentication, because this will almost certainly be the most technically challenging verification task arising from any potential arrangements to control nuclear warheads directly.

Technical approaches to Authentication

5. Technical approaches to authentication could rely on identifying characteristic "signatures" associated with nuclear warheads. Alternatively, or in parallel, the establishment of provenance and subsequent maintenance of a robust chain of custody could also be used to good effect. Nuclear warheads have various signatures. Passive and active radiation signatures are likely to contain the most information about them and have therefore been an important subject of the United Kingdom's work to date.

6. All nuclear warheads contain the fissile isotopes of plutonium or uranium, and these all emit radiation, either spontaneous neutron or gamma radiation. Depending on their energies, and also the amount of shielding (both by the item itself or by additional external shielding), this radiation can be detected passively and externally to the nuclear device. By measuring passively these "radiation signatures" valuable deductions can be made about the existence, type, distribution and quantity of the radioactive materials present within the item under examination. The detection and identification of such radiation therefore offers a step in the process of authenticating or disproving that an object is a nuclear warhead.

7. Nuclear warheads may also contain components made of, or containing, various low atomic number elements such as, for example, deuterium, tritium and beryllium. These do not give off characteristic radiation signatures which can be passively detected and measured. But when actively irradiated by gamma or X-rays, some of these elements can undergo various reactions resulting in the emission of neutrons. These neutrons can then be detected externally to the warhead using simple detectors, and, if some energy resolution is applied, can be used to indicate the presence of some specific elements and hence to increase confidence that the object under consideration is a nuclear warhead.

Studies conducted to date

8. During the first three years of the research programme the radiation signatures from a number of United Kingdom nuclear warheads, both those recently decommissioned (WE177[2] and Chevaline[3]) and those in-service (Trident), have been examined using both passive and active techniques.

9. The items investigated have included:

- WE177 primary and secondary sub-assemblies in containers;
- Chevaline Re-entry Bodies (ReB) in various configurations e.g. direct, close access or uncontained and in various containers;
- Chevaline ReBs in storage containers through earth mounded magazines and metal doors;
- Chevaline primary and secondary sub-assemblies in various containers;
- A Trident Re-entry Body assembly (RBA) in a storage container;
- Trident primary and secondary sub-assemblies in various containers.

10. Different approaches have been adopted for passively detecting and measuring radiation from either the warheads or their components. These have included low and high resolution gamma ray spectroscopy and timecorrelated neutron spectroscopy. Active interrogation techniques have included using X-radiation to determine the presence of low atomic number elements in warheads or their components. The experimental work on both passive and active measurements has been supplemented by modelling/computer calculation.

Conclusions from the Technical Authentication work conducted to date

11. The interpretation of the measurements made during this programme is difficult and often requires detailed knowledge or understanding of the relevant nuclear warhead designs. Much of this information is sensitive and classified and thus detailed conclusions cannot be revealed fully. Nevertheless, the studies to date suggest that:

- fissile material in a number of different types of nuclear warheads or nuclear warhead components can be detected externally using relatively simple instrumentation;
- detection can be made of a nuclear warhead in a number of locations such as in storage and various containers;
- in many instances detection requires access close to the item, often of the order of a few metres;
- the number of warheads inside containers can be assessed;
- in some cases isotopic composition, fissile material mass, and some geometrical dispositions of nuclear materials can be estimated using high resolution spectroscopic techniques;
- it may be possible to "reverse engineer" design information from raw radiometric data, which means that great caution would need to be exercised in using technical transparency technology within any dismantlement verification arrangements;
- X-ray interrogation of components is a technique that could be used to verify non-fissile strategic materials often found in nuclear warheads, but requires further investigation.

12. Overall the information obtained so far should be of significant value in discussing verification arrangements for any decommissioning of nuclear warheads that may be required by some future Treaty. However, in developing technologies and technical approaches applicable to such arrangements, consideration will need to be given to how far such instruments and information are sensitive from non-proliferation and national security points of view.

Other verification aspects of the United Kingdom's work

13. As well as authentication, the United Kingdom is considering other aspects of verification, such as chain of custody, provenance, and managed access techniques.

14. The technical approaches to authentication would need to be carefully supported by verifying the maintenance of the chain of custody of warheads and their components and materials, during the decommissioning, dismantlement, demilitarisation and disposition sequence. Maintaining an adequate chain of custody of key items and materials through these processes would also be a demanding task. The work conducted so far has included conceptual studies relating to tags and seals, and has considered how various signatures could play a role.

15. A potential alternative or addition to authentication would be to establish the provenance of an item, to build confidence that an item comes from its declared origin. Approaches to establishing the provenance of an item could include measures to establish that it has come from place that supports the declaration, for example from a submarine returning from deployment to base. This could be achieved, through inspection or remote monitoring, by tagging and then tracking the item from such a point through the remainder of the processes. Increasing confidence about provenance could also involve inspection of manufacturing, service deployment, and transport records, as well as any authentication activities.

16. As these approaches might require the presence of an international verification team, the United Kingdom has also examined managed access processes that could allow such a team to enter sensitive nuclear facilities, so as not to reveal sensitive information. As part of this study the United Kingdom conducted an exercise at its nuclear weapons' assembly and disassembly facility at the Atomic Weapons Establishment, Burghfield in order to examine representative managed access arrangements for such a sensitive facility. Making arrangements to allow access for a verification team into warhead disassembly facilities is likely to be difficult. Considerable effort would be needed to overcome the formidable

challenge of enabling any such access without compromising sensitive information. The future

17. The United Kingdom is continuing to fund this work through its Ministry of Defence through to the year 2005. The aim is to continue to develop an information and knowledge base of technologies potentially applicable to the verification of any international arrangement for the decommissioning and dismantlement of nuclear warheads and the disposition of any resulting surplus material. It is our intention to produce another interim report at the 2004 Preparatory Committee meeting and a consolidated report on our work at the 2005 NPT Review Conference.

Footnotes:

1. Research has concentrated on the unique aspects of warhead verification in the warhead complex. However, it is recognised that there is much experience in other areas that may contribute to future treaty verification, e.g. work related to IAEA and Euratom Safeguards, and in the context of the United States-Russian Federation-IAEA Trilateral initiative.

2. WE177 was a free-fall nuclear bomb or nuclear depth charge deployed by the Royal Air Force and the Royal Navy respectively.

3. Chevaline was the nuclear warhead for the Royal Navy's submarine-deployed Polaris missile system.

Source: The United Nations Disarmament website at http://disarmament.un.org/wmd/npt/2005/PC2-listofdocs.html

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