U.S. STANDARDS FOR PROTECTING WEAPONS-USABLE FISSILE MATERIAL COMPARED TO INTERNATIONAL STANDARDS

by George Bunn[1]

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In the 1990s, global concern over illicit trafficking in nuclear material to terrorists and nation-states has intensified. Two major changes are responsible: the evident new intent of terrorists to wound or kill thousands of civilians and the availability of inadequately protected "loose" nuclear materials in Russia and the newly independent former Soviet republics.[2] These changes have made more likely attempts to acquire weapons-usable nuclear materials for terrorist use or for sale to state sponsors of terrorism. As a result, many efforts are being made to strengthen national and international standards for protection of nuclear material from theft and sabotage.[3] One problem with current efforts is that national standards now vary widely. Although the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) mandates that non-nuclear weapon parties accept the *safeguards* requirements of the International Atomic Energy Agency (IAEA) for their nuclear activities, the relevant international standards for *physical protection* are mostly advisory.

To strengthen physical protection, a U.S. National Academy of Sciences committee, in a 1994 report, recommended high mandatory standards. This report developed out of a study that had been commissioned originally by Brent Scowcroft when he was National Security Adviser to President George Bush.[4] The main question before this committee was how to dispose of the plutonium from the thousands of nuclear warheads being dismantled by Russia and the United States. Many of the committee's recommendations on that subject have been accepted by Russian National Academy of Sciences experts, although not yet by the Russian government.[5]

One committee recommendation is that, to the extent possible, the high standards of physical security used by the United States to protect its nuclear weapons should be maintained for the plutonium and highly enriched uranium (HEU) from weapons throughout the weapons dismantlement and materials disposition process by both Russia and the United States.[6] In addition, the Academy committee urges that this "stored weapons standard" for physical protection for U.S. weapons-usable fissile materials become a standard for protecting comparable materials in civilian use throughout the world, and that an international organization be given authority to inspect nuclear material sites to monitor whether these standards are being met.[7] This recommendation was repeated at 1997 conferences on physical protection at Stanford University and the IAEA.[8] However, the actual "stored weapon standard," to use the committee's term, was not defined except in broad outline.[9]

The purpose of this report is to provide a definition of the "stored weapons standard" that can be compared to existing international standards. In 1997, the U.S. Department of Energy (DOE) accepted the "stored weapons standard" for the U.S. weapons-usable fissile material (both plutonium and HEU) in the DOE's inventory. The DOE material to be subject to the standard included material: 1) in the DOE's ultimate material disposition program, 2) excess but not yet designated for disposition, and 3) to be retained for national defense. The DOE grades weapons-usable fissile material by attractiveness to someone wanting to make a nuclear weapon. It does so using categories such as quantity, enrichment, radioactivity, and chemical form for the plutonium or HEU. The most attractive material (for example, more than two kilograms of unirradiated pure plutonium) would get the highest standard, the stored weapon standard.[10] This grading of materials by attractiveness for making weapons appears to be consistent with the National Academy committee's approach.[11] Such grading is also part of international standards.

What other changes the National Academy stored weapons standard might produce in U.S. *national* standards for other civil or military weapon-usable materials is not yet clear. But, what will become evident below is that *international* standards for protection for the materials most attractive to would-be nuclear weapon makers are low when compared with the U.S. stored weapons standard—what the Department of Defense (DOD) requires for the storage of nuclear weapons, or even what the U.S. Nuclear Regulatory Commission (NRC) requires for protecting the civil nuclear materials most attractive for making weapons.

An Appendix summarizes the U.S. stored weapons standard as it would be applied to the stored weapons-usable fissile materials most attractive to someone wishing to make a nuclear weapon. The summary (except for the definition of the "design-basis threat" that a materials protection system must be designed to protect against) is based on the U.S. requirements found in DOD directives. The definition of design-basis threat is classified in the DOD directives; thus the Appendix incorporates the design-basis threat required by NRC regulations aimed at protecting U.S. civil materials most attractive for making weapons. Nevertheless, this part of the standard is also far higher than international standards.[12]

In brief, the Appendix describes one "design basis threat" for stored weapon quantities of plutonium or HEU (comparable to the highest graded DOE category). This design basis threat assumes a violent, external assault by a group using weapons and vehicles, possibly with inside assistance. Specific requirements for protection against such a threat include a strong, secure storage vault with a single entry surrounded by two layers of strong fences and an open, lighted area where no one could hide. Access to the vault should be limited to personnel with a need for access, who are cleared through full-field background investigations and accompanied by another such person (the "two-person" rule). Such access limitations should be enforced by both armed guards and electronic monitoring devices, supported in case of need by nearby armed backup forces. All of these personnel should be trained to deal with design basis threats, and their competence checked periodically in exercises like war games.

The two most relevant international standards for comparison are: the Convention on the Physical Protection of Nuclear Materials of 1980 (Convention) and the IAEA's guidelines for physical protection.[13] The Convention was negotiated in response to proposals made by the United States, and it now has nearly 60 states parties, most of those having nuclear materials. In the negotiation process, however, the Convention's standards for physical protection were limited to fissile materials "for peaceful purposes in international transport."[14] The Convention thus contains no mandatory physical protection standards for fissile materials that are for military use or for domestic civil use. There are no protection requirements for weapons-usable materials stored in the host country that produced them or in a recipient country that has received them—except when the storage is a temporary part of an international shipment for peaceful purposes. Moreover, even for fissile materials "for peaceful purposes in international transport," there is no provision for inspection for compliance with the required standards.

Even for the limited case where the standards are mandatory, the Convention describes generally the threat against which the protection should be aimed: Physical protection measures "should have as their object the detection and prevention of any assault, unauthorized access or unauthorized removal of material."[15] With such a general description, with no inspections even for materials in international transport, and with no standards at all for military material or for civil material not in international transport, the Convention offers little protection for nuclear materials. Protection in most countries is likely to depend in considerable part upon each government's perception of the threat to its people, its estimate of the costs of physical protection measures, and its cultural approaches to protecting against armed attack, to guards carrying guns, and to background investigations for personnel.

When the Convention does apply, it requires materials that are particularly attractive for making weapons (e.g., at least two kilograms of unirradiated plutonium) to be stored "within an area under constant surveillance by guards or electronic devices, surrounded by a physical barrier with a limited number of points of entry under appropriate control." Access to the materials must be "restricted to persons whose trustworthiness has been determined, and [is limited to material] which is under surveillance by guards who are in close communication with appropriate response forces."[16]

This is significantly less demanding than the U.S. "stored weapons standard." The Convention does *not* require a strong storage vault with only one entry point surrounded by two layers of fences, armed guards, a cleared and lighted area around the vault, the full-field background investigations of personnel, a two-person rule, nor the presence of *both* sensors and guards. Moreover, the Convention does not even apply to weapons-usable materials for military purposes or to most of those for civil purposes.

The second major international standard for physical protection is the IAEA's guidelines for protection of nuclear material.[17] These were first issued in 1972, before the Convention was adopted. They have been revised twice since then and are now undergoing review again.[18] They are *recommended* standards for protection without regard to whether the materials are civil, military, or in international transport.[19] They provide much more detail than the Convention on many points. For example, for material categories most attractive for making weapons, they recommend more than one layer of protection: usually an "inner area" ("ideally" having only one entry) with a "strong room" surrounded by a larger "protected area." They suggest that such an area and the site perimeter be cleared and lighted so intruders cannot hide. They contain recommendations on access limits and sensors. They "encourage" armed guards. They suggest a two-person rule. But they contain no recommendation for background investigations for personnel with access to materials, and no recommendation that unauthorized access to the storage vault be detectable by both guards and electronic sensors (either will do). Moreover, they are only recommendations, except in a those cases where by national legislation or agreement with nuclear-material suppliers, states have made them applicable to their nuclear activities.[20]

Probably the IAEA guidelines' most glaring deficiency in comparison with the U.S. stored weapons standard is that they contain little guidance as to the threat that should be the basis for design of the protection system. Instead, that "system should be based on the State's assessment of the threat."[21] Thus, each state is to judge its own needs for physical protection, and balance that against the costs of physical protection measures, and against any cultural aversions it may have to, for example, arming guards or conducting background investigations of personnel.[22]

Is it possible to gain sufficient international agreement to amend either the Convention or the IAEA guidelines so they approach the requirements of the U.S. stored weapons standard? How many countries would likely agree with the United States on the nature of the threat against which physical protection must defend?

Based upon statements from experts from many countries at the 1997 Stanford University and IAEA conferences that compared international practices for physical protection, finding consensus on a design basis threat would appear difficult. Practices with respect to physical protection vary considerably, and part of the reason is clearly different perceptions of the threat by the experts responsible for physical protection.[23] Under the present system, defining the threat and designing the protection system to deal with that threat is left to the state in most cases. Mandatory international standards based on the "stored weapons standard" would require major improvements in physical protection at great expense in many countries. Some countries, such as Peru, with little or no weapons-usable material to guard and major experience with domestic terrorism might be prepared to accept a new threat definition because of their experience and because they would not be required to make major changes in physical protection.[24] Other countries, however, seem unprepared to accept a change. Despite the Aum Shinrikyo nerve gas attack that injured 5,000 people in a Tokyo subway and despite the revelation that this sect had tried to secure biological and nuclear weapons, Japan seems unwilling to make major improvements in the physical protection for its significant stocks of weapons-usable material. For example, Japan still does not arm the personnel guarding this material.[25] For these reasons, international consensus on the threat facing every country with significant weapons-usable material is likely to be difficult.

Amendments to both the IAEA's guidelines and the Convention are under consideration. The IAEA held a meeting of government experts in June 1998 to consider some revisions of its guidelines. Some change is anticipated in the language that now leaves the definition of the design-basis threat to each state, although not adoption of the threat suggested by the stored weapons standard. Another meeting of these experts is scheduled for late October 1998.[26]

The U.S. government has been discussing the possibility of review and amendment of the Convention with other governments for a year or more. When a majority of the parties to the Convention agree to review or amend it, the IAEA has the duty of organizing a conference for that purpose.[27] The Convention's exceptions from mandatory physical protection standards could be eliminated without requiring agreement on the current threat or on higher standards. However, for agreement on those points, experts must achieve consensus on what the current threat is and what the best practices are to deal with it. Finally, there is a continuing attempt in a committee of the U.N. General Assembly to draft a new treaty dealing with nuclear terrorism based on a Russian proposal. This effort is not aimed primarily at enhancing physical protection, but it could have that result.[28]

International terrorism is not confined these days to the Middle East, Russia, the United States, Japan, and Europe. It has appeared in Africa, Latin America, and South Asia. Terrorists have not yet used nuclear explosives, but they might if weapons-usable materials can be stolen. Whether physical protection practices can keep up with the growing threat remains to be seen.

[1] For their help in describing the U.S. "stored weapon standard" for physical protection of nuclear weapons used in this report, the author wishes to express particular thanks to two people. The first is Wolfgang K. H. Panofsky who was chairman of the National Academy of Sciences Committee on International Security and Arms Control at the time that it recommended following the "stored weapon standard" for physical protection of nuclear material. The second is Rob Rinne, a senior scientist at Sandia National Laboratory, an organization that is concerned, among other things, with national and international standards for physical protection of nuclear material.

[2] See James Goodby, "Protection of Fissile Materials: Policy Context and Issues for Consideration," *Comparative Analysis of Approaches to the Protection of Fissile Materials* (Proceedings of the Workshop at Stanford University, July 28-30, 1997) (Livermore, Ca.: Livermore National Laboratory, 1998) [hereinafter *Comparative Analysis of Approaches to the Protection of Fissile Materials*], pp. 7-8; George Bunn, "Physical Protection of Nuclear Materials: Strengthening Global Norms," *IAEA Bulletin* 39 (December 1997) [hereinafter "Strengthening Global Norms"], pp. 4-5.

[3] George Bunn, "Strengthening Global Norms"; Bonnie D. Jenkins, "Establishing International Standards for Physical Protection of Nuclear Material," *The Nonproliferation Review* 5 (Spring-Summer 1998), p. 98.

[4] Committee on International Security and Arms Control, National Academy of Sciences, *Management and Disposition of Excess Weapons Plutonium* (Washington, D.C.: National Academy Press, 1994) [hereinafter National Academy Report], p. v.

[5] See U.S.-Russian Independent Scientific Commission on Disposition of Excess Weapons Plutonium (established at the initiative of the Russian Academy of Sciences and the U.S. President's Committee of Advisers on Science and Technology), "Final Report" of June 1, 1997 to the Russian and U.S. presidents [hereinafter "Holdren-Velikov Commission Report"].

[6] National Academy Report, p. 31. In the Holdren-Velikov Commission Report, it was agreed that the "highest standards of materials protection, control and accounting—as appropriate to the threat of theft or diversion—should be applied to excess weapons plutonium at all storage, processing, and transport steps until it reaches the spent-fuel standard." Summary of Recommendations, par. A.3.

The Holdren-Velikov Commission Report relied upon the National Academy Report and explicitly accepted another standard used by the study, the "spent fuel standard." See, e.g., p. 8. However, instead of agreeing to the "stored weapon standard," the Report called for the "highest standards of materials protection…as appropriate to the threat of theft or diversion" during the steps toward ultimate disposition. Recommendation A. 3. This was because the Russian side could not agree to the specific and demanding requirements of the U.S. stored weapons standard, but could agree to this "highest standards" compromise.

[7] National Academy Report, p. 139.

[8] Matthew Bunn, *Comparative Analysis of Approaches to the Protection of Fissile Materials*, pp. 20-24; George Bunn, "Strengthening International Norms for Physical Protection of Nuclear Material," *Physical Protection of Nuclear Materials: Experience in Regulation, Implementation and Operations: Proceedings of an International Conference, Vienna, 10-14, November 1997* [hereinafter "IAEA Proceedings"], p. 17.

[9] Matthew Bunn, *Comparative Analysis of Approaches to the Protection of Fissile Materials*, pp. 20-21. Matthew Bunn was the "Study Director" on the staff of the National Academy Committee on International Security and Arms Control at the time that committee made its stored weapons standard recommendations. See National Academy Report, p. iii.

[10] Department of Energy, *Nonproliferation and Arms Control Assessment of Weapon-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives* (Springfield, Va.: National Technical Information Services: 1997), pp. 5, 36-37.

[11] National Academy Report, pp. 31, 70.

[12] The Appendix was first drafted from these DOD and NRC unclassified sources, then submitted for comment to individuals having knowledge of U.S. practices for protecting weapons, and later modified in light of their comments. However, I take full responsibility for the Appendix and believe it to be consistent with DOD regulations and practice for protecting stored weapons in the United States from theft, sabotage, and attack by terrorists or others.

[13] For an excellent summary of international standards for physical protection, see Jenkins, "Establishing International Standards for Physical Protec-

tion of Nuclear Material."

[14] See George Bunn, "Evolving International Standards," *IAEA Bulletin* 39 (December 1997), [hereafter "Evolving International Standards"], p. 6. See the Convention on Physical Protection of Nuclear Material, IAEA Information Circular (INFCIRC)/274, Rev. 1 (1980), Art.2.1.

[15] Convention on Physical Protection, *ibid.*, par. 1(c).

[16] *Ibid.* par. 1(b) and (c).

[17] IAEA, *The Physical Protection of Nuclear Material*, Information Circular (INFCIRC)/225/Rev.3, September 1993 [hereinafter INFCIRC/225/Rev.3].

[18] George Bunn, "Evolving International Standards," p. 7.

[19] INFCIRC/225/Rev.3, par. 1.1. For protection standards for the most attractive fissile materials category for making weapons, see heading 5.2, "Requirements for Category I Materials in Use and Storage."

[20] Jenkins, "Establishing International Standards for Physical Protection of Nuclear Material," p. 98.

[21] INCIRC/225/Rev.3, par. 1.2.

[22] For differing cultural views of armed guards and background investigations for "trustworthiness" see Matthew Bunn, *Comparative Analysis of Approaches to the Protection of Fissile Materials*, p. 15; Hiroshi Kurihara, "The Protection of Fissile Materials in Japan," *Comparative Analysis of Approaches to the Protection of Fissile Materials*, p. 104; William C. Potter, "Physical Protection of Fissile Materials: The Experience of Post Soviet States," *Comparative Analysis of Approaches to the Protection of Fissile Materials*, p. 1; Kevin Harrington and Katya Drozdova, "Analysis of the Workshop on Comparative Analysis of Approaches to Protection of Fissile Materials," *Comparative Analysis of Approaches to the Protection of Fissile Materials*, p. 31; M. Gegusch, "Trustworthiness of Nuclear Power Station Employees," IAEA Proceedings, p. 305.

[23] Matthew Bunn, *Comparative Analysis of Approaches to the Protection of Fissile Materials*, p. 15. Recommendations to the IAEA conference on how to define a non-"worst case" design basis threat for a physical protection system were made by NRC officials responsible for applying NRC physical protection standards. See J.J. Davidson and R. S. Warren, "Development and Maintenance of a Design Basis Threat for Use in Designing Nuclear Physical Protection Systems," IAEA Proceedings, p. 147.

[24] For a description of the threats from terrorists for a reactor in Peru, see J.H. Medina Ramos, "Safety Strategy at the RACSO Nuclear Center," IAEA Proceedings, p. 73.

[25] Matthew Bunn, *Comparative Analysis of Approaches to the Protection of Fissile Materials*, p. 15; Hiroyoshi Kurahara, *Comparative Analysis of Approaches to the Protection of Fissile Materials*, pp. 106, 109; H. Nakata, T. Misaka, H. Tsuruta, "Experiences in the Implementation of Physical Protection Measures of Nuclear Material at the Jaeri Tokai Establishment," IAEA Proceedings, pp. 195, 200.

[26] Bernard Weiss of the IAEA, e-mail to author, August 21, 1998; Jenkins, "Establishing International Standards for Physical Protection of Nuclear Material," pp. 100-101.

[27] Physical Protection Convention, Art. 16, 20; see Jenkins, "Establishing International Standards for Physical Protection of Nuclear Material," pp. 104-106.

[28] Jenkins, "Establishing International Standards for Physical Protection of Nuclear Material," pp. 103-104; George Bunn, "Strengthening International Norms for Physical Protection of Nuclear Material," IAEA Proceedings, pp. 20-21.

Appendix:

Description of "Stored Weapons Standard" for Protecting Weapons-Usable Fissile Material

A U.S. National Academy of Sciences (NAS) committee has recommended that "to the extent possible, the high standards of security and accounting applied to storage of intact nuclear weapons should be maintained for [weapons-usable nuclear explosive] materials…" (NAS, *Management and Disposition of Excess Weapons Plutonium* [Washington, D.C.: National Academy Press, 1994], p. 31). The U.S. Department of Energy (DOE) has accepted this recommendation: "In other words, the most attractive types of material in the [DOE] graded safeguards system [graded in categories based upon quantity, enrichment, radioactivity, chemical form]—material that could be used directly in nuclear weapons or could be readily converted to such use—will, to the extent practicable, be protected and accounted for just as nuclear weapons themselves are" (DOE, *Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives* [Springfield, Va.: National Technical Information Services, 1997], p. 36).

Neither of these two reports provides a description of what the stored weapons standard would require for storage of attractive, weapons-usable materials. Both apply in principle to processing, use, and transport of such materials as well as to their storage. What follows is a description based upon the Department of Defense (DOD) directive and manual for protecting *stored* weapons (DOD, Directive 5210.41, "Security Policy for Protecting Nuclear Weapons," September 23, 1988, and the *Nuclear Weapons Security Manual* issued pursuant to the Directive). Some parts of this manual are classified. The most important classified part appears to be the definition of the threat against which physical protection measures are to defend. The description that follows therefore draws upon Nuclear Regulatory Commission regulations that are applicable to civil nuclear facilities and define the threat that should be the basis for designing *storage* protection against theft of "formula quantities" of "strategic special nuclear material," i.e., five or more kilograms of Uranium-235 enriched to 20 percent or more, and 2.5 or more kilograms of plutonium (10 Code of Federal Regulations, Part 73, Sec. 73.1 (a) (2) and 73.2). Because of a reference to the possibility of an airborne attack in the DOD *Nuclear Weapons Security Manual*, the description below adds helicopters to the NRC-assumed possible threat of an attack by land vehicles. Otherwise, the design basis threat set forth below is drawn entirely from NRC regulations for protection *during storage* of weapons-usable material, not weapons.

Based upon the DOD *Nuclear Weapons Security Manual* and these NRC regulations, the "stored weapons standard," (the standard used by the U.S. government to measure the adequacy of protection for its weapons against theft), is as follows:

1. *Design basis threat.* Each storage site's protection must be based upon the assumption of realistic threats of theft from insiders or outsiders, or from insiders and outsiders working together.

The protection system must assume the following threats:

a) a determined, violent, external assault; or attack by stealth or deceptive actions by an outside group. In each such case, the group may have the following:

(i) dedicated individuals with military training and skills;

(ii) inside assistance that may include knowledgeable individuals who can provide information, facilitate access and exit, disable alarms and communications, and participate in a violent attack;

(iii) suitable weapons up to and including hand-held automatic weapons equipped with silencers having effective long-range accuracy;

(iv) hand-carried equipment including incapacitating agents and explosives for use as tools of entry or destruction or damage to the storage site or its contents; and

(v) land vehicles or helicopters that can be used for transporting personnel and their hand-carried equipment, and the ability to operate as two or more teams;

b) an insider individual, including an employee in any position within the inside organization responsible for the site; and

c) a conspiracy between insider individuals in any positions who may have access and detailed information about the site and have items that could facilitate theft of weapons (e.g., small tools, substitute material, false documents).

2. *Limited access.* Access to a storage vault for weapons-usable material must be limited to cleared personnel with need for access who identify themselves by badges, face or fingerprint monitoring devices, or other procedures. Armed guards must be present to enforce this requirement.

3. *Two-person rule and record-keeping for vault.* The two-person rule requires that there be present when the storage vault is visited at least two authorized, cleared persons capable of detecting incorrect or unauthorized procedures with respect to the work to be done in the vault. Records should be kept of all visits to the vault and of what is stored there and removed from there. These records should be transmitted to higher authority whenever they are made.

4. *Monitoring of vault.* Access by unauthorized persons should be detectable not just by armed guards and identification devices (see 2 above), but by monitoring sensors such as closed circuit TV. Removal of nuclear material should be monitored by both armed guards and technical devices such as portal sensors. Redundant communications systems should be installed to assure command and control of guards, notification of suspicious events, and early assistance by a nearby back-up force when needed. Such a force should consist of at least 15 armed personnel.

5. *Vault.* This should ordinarily be "the most secure facility possible" with strong walls and only one entrance.

6. *Boundary barriers around the vault.* Around the vault there must be a barrier system consisting of at least two layers of strong perimeter boundary fencing, an area warning system, barriers against ground vehicle and air-borne assault, and cleared zones inside and beyond the fences so that intruders have no place to hide.

7. *Monitoring access within boundary barriers and beyond.* An intrusion detection system with electronic sensors must be able to detect movement of people and vehicles within and outside the barrier fences. At night, there must be lighting and night vision equipment for this purpose. A site boundary detection system (to monitor the area of the site outside the barrier fences) must be able to detect the movement of people and vehicles across the site boundary. This monitoring system combined with the boundary barriers and the guard force must be capable of detecting attempted entry, of deterring unauthorized entry, and of providing sufficient delay to the attacking force so that the guard force combined with the back-up force can execute the appropriate response.

8. S*ecurity clearances and training for personnel.* Personnel responsible for the security of weapons-usable material should be selected after extensive screening, including full-field background investigations to determine not just their qualifications but whether they might be security risks. This should include factors such as alcohol or drug addiction, unusual financial needs or expenditures, and associations with terrorist groups. These investigations should be repeated periodically. These personnel should be trained to do what they will be expected to do when employed. The training should include the use of individual and crew-served weapons and annual force-on-force exercises.

9. *Inspections.* Vulnerability assessment teams should periodically review the protection provided by physical protection systems. These teams should include security specialists from outside the span of control of the commander of the weapons-usable material storage site. They should concentrate on means to bypass, subvert, overwhelm, or interrupt elements of the security system, including the two-person rule. They should make a written report on their findings to the commander and to higher authority.