Paper presented to the Annual Meeting of the Institute of Nuclear Materials Management, Baltimore, Maryland, 11-15 July 2010

DEVELOPMENTS IN THE IAEA'S NUCLEAR SECURITY SERIES AND PHYSICAL PROTECTION GUIDANCE DOCUMENT INFCIRC/225

Craig Everton, Stephan Bayer, John Carlson
Australian Safeguards and Non-Proliferation Office
RG Casey Bldg, John McEwen Crescent, Barton, ACT 0221, Australia

ABSTRACT

The IAEA's guidance document *The Physical Protection of Nuclear Material and Nuclear Facilities* (INFCIRC/225) has long been considered the internationally accepted standard for nuclear physical protection, and the practical complement to the *Convention on the Physical Protection of Nuclear Material*. It is not a legally binding instrument as such, but it is given legally binding effect in some bilateral nuclear safeguards agreements that prescribe INFCIRC/225 as the standard to be applied to nuclear material supplied under such agreements.

INFCIRC/225 has been updated several times, the current version being INFCIRC/225/Rev.4. Revision 4 is undergoing a major revision, and the new document, INFCIRC/225.Rev.5, will become a key recommendations document in the IAEA's newly launched Nuclear Security Series.

This paper will focus on two aspects of the development of INFCIRC/225 and the IAEA's Nuclear Security Series (NSS), from the perspective of a nuclear security regulator and administrator of bilateral nuclear safeguards agreements. First, the main differences between INFCIRC/225/Rev.4 and INFCIRC/225/Rev.5 will be described, focusing on what these changes may mean for a facility operator and regulator. Second, the paper will discuss the evolving philosophy behind the NSS, how Revision 5 fits within this structure, and the possible direction of future revisions of Revision 5 to fit this structure. Given the centrality of INFCIRC/225 in many bilateral nuclear safeguards agreements, any future evolution of this document would need to be managed carefully.

1. INTRODUCTION

The subject of nuclear security (or, in the parlance of the nuclear industry, physical protection) has taken on greater prominence over the last ten years since the terrorist attacks on the United States on 11 September 2001 demonstrated the willingness of terrorist groups to escalate to new scales of mass destruction. Just this year nuclear security has been given more emphasis with the Nuclear Security Summit US President Obama convened in Washington in March. This was the largest gathering of world leaders convened by a US president since the end of World War II[1], and resulted in an outcomes document with several important undertakings on securing nuclear materials. However, nuclear security is not new – nuclear operators, policy makers, regulators and the International Atomic Energy Agency (IAEA) have been setting international standards for nuclear material and facilities since the early 1970s. The primary resource is the IAEA's guidance document *The Physical Protection of Nuclear Material* (INFCIRC/225), and its subsequent amendments up to INFCIRC/225/Rev.4[2].

INFCIRC/225, in all its revisions, is not legally binding, though in some bilateral safeguards agreements it is given legally binding effect (discussed later). The first legally binding instrument dedicated to physical protection was the *Convention on the Physical Protection of Nuclear Material* (CPPNM), which was opened for signature in 1980 and came into force in 1987. An amendment to the CPPNM was adopted by states parties in 2005, however as of the date of writing this paper, had not yet received the requisite two-thirds ratifications to enter into force[3]. Since the conclusion of the CPPNM, several other legally binding instruments related to physical protection have also come into effect, such as the International Convention for the Suppression of Acts of Nuclear Terrorism (Nuclear Terrorism Convention) and UN Security Council Resolution 1540.

The provisions contained within the CPPNM are high level and focussed primarily on what nuclear material to protect (and what to report), rather than how to protect, and is primarily limited to international transport. The Amended CPPNM, when in force, will expand the scope of obligations to cover domestic use, storage and transport. By contrast, INFCIRC/225 has always covered domestic use, storage and transport of nuclear material. It is seen as the complement of the CPPNM by going into much more detail on physical protection implementation requirements. The combination of the CPPNM and INFCIRC/225 has long been considered the international standard on nuclear physical protection.

The CPPNM and INFIRC/225 have tended to evolve in step with one another. The CPPNM incorporates many elements of the INFCIRC/225 in place at the time it was written, INFCIRC/225/Rev.1, such as a table on the categorisation of nuclear material. The third revision of INFCIRC/225, completed in 1993, was initiated in part to bring INFIRC/225/Rev.2 into line with the newly in force CPPNM. INFCIRC/225 would go through a further revision to Revision 4 before it again influenced the CPPNM. This was completed in 1999, following the first comprehensive review in about ten years[4]. It included significant changes in structure and clarity, and introduced important concepts such as **design basis threats**[5] (DBTs). Significantly, it made clearer distinctions between requirements to protect against unauthorised removal and against sabotage, including a new chapter on sabotage of nuclear facilities and nuclear materials. As such, INFCIRC/225/Rev.4 goes by an expanded title, *The Physical Protection of Nuclear Material and Nuclear Facilities*.

Around the time of the conclusion of INFCIRC/225/Rev.4 some states parties to the CPPNM, including Australia, began encouraging the IAEA to convene a meeting to consider whether a revision of the CPPNM might be required. This led to the convening of an Expert Meeting which charged a Working Group to examine the issues, which was finalised in a report to DG IAEA adopted by the Expert Meeting in May 2001[6], and distributed to all IAEA member states and parties to the CPPNM. The report concluded there was "a clear need to strengthen the international physical protection regime", and recommended the CPPNM be strengthened through an amendment. One of the recommendations was that the Amendment should include a statement of Physical Protection Objectives and Fundamental Principles. The Report also recommended a set of fundamental principles of physical protection be compiled from INFCIRC/225/Rev.4, which the Expert Group produced[7] as twelve **Physical Protection Objectives and Fundamental Principles**, which was adopted by the IAEA Board of Governors (BoG) in September 2001.

The Amendment to the CPPNM was the next major development in nuclear security instruments. Work on the Amendment began in December 2001, not long after the publication of INFCIRC/225/Rev.4, and was concluded in 2005. The Amended CPPNM represented a fundamental change in scope and structure from the original CPPNM. The scope was expanded to

cover domestic use, storage and transport, as well as sabotage of nuclear facilities. It also provided for expanded cooperation between and among states regarding rapid measures to locate and recover stolen or smuggled nuclear material, mitigate any radiological consequences of sabotage, and prevent and combat related offences. The structure was also improved by listing the Physical Protection Objectives and twelve Fundamental Principles adopted by the IAEA BoG in September 2001 as guiding physical protection foundations.

The development of physical protection instruments have now come full circle once more, with a review underway on updating INFCIRC/225/Rev.4 to INFCIRC/225/Rev.5. This review was initiated for a combination of reasons: a desire to harmonise the structure of Revision 5 with the Amended CPPNM[8]; the parallel development in physical protection standards through the IAEA's Nuclear Security Series[9]; and, the need to accommodate the changed threat environment following the terrorist attacks on the United States in 2001.

INFCIRC/225 is a guidance document, not a legally binding agreement, but is given legally binding effect in many bilateral nuclear safeguards agreements. For example, all of Australia's bilateral safeguards agreements for the supply of uranium require each party to apply the recommendations in INFCIRC/225 to all nuclear material subject to the agreement. Similar provisions are contained in the bilateral safeguards agreements of other countries such as the US and Canada. Because INFCIRC/225 is embedded in many bilateral safeguards agreements, it is important that any revision consider carefully the impact it may have on the legally-binding obligations on protecting obligated nuclear material contained in so many nuclear trade relationships.

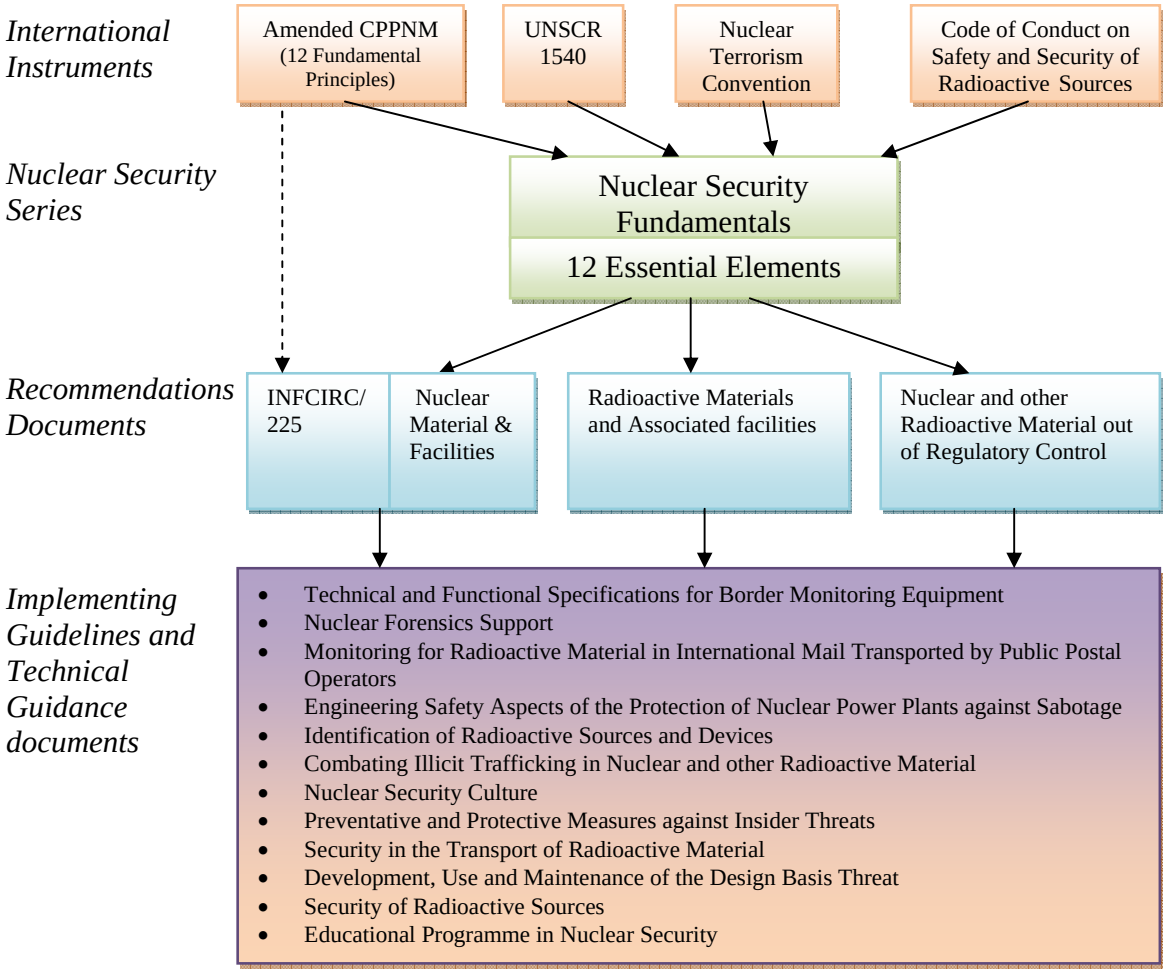
2. THE IAEA'S NUCLEAR SECURITY SERIES (NSS)

As part of its responsibility to provide guidance to states in their efforts to implement international nuclear security instruments (such as the CPPNM and the Nuclear Terrorism Convention), the IAEA began developing guidance documents in a **Nuclear Security Series** (NSS) in 2006. This is ongoing and will comprise several categories of documents in hierarchical strata. The categories are: **Nuclear Security Fundamentals** containing objectives, concepts and principles of nuclear security and the basis for nuclear security recommendations; **Nuclear Security Recommendations** presenting best practices to adopt in the application of the Fundamentals; and **Implementing Guidelines and Technical Guidance** documents providing elaboration on implementation and technical details relevant to the Recommendations. This structure is outlined in the following figure.

The Nuclear Security Fundamentals document is a higher level document that establishes the foundations of nuclear security[10] from which the other documents in the NSS are based. The twelve **Essential Elements** in the draft Fundamentals document are not a complete one-to-one relationship with the Amended CPPNM's twelve Fundamental Principles, but draw heavily from, and cover all, of the Fundamental Principles, plus concepts (e.g. risk management, border monitoring) from other nuclear security instruments.

The Recommendations documents outline best practice steps for applying the Fundamentals. There are currently three Recommendations documents in development: radioactive materials and associated facilities; detection of and response to material out of regulatory control; and nuclear material and facilities. The Nuclear Material and Facilities Recommendations document is INFCIRC/225/Rev.5, but contains more detail than the other Recommendations. Because

INFCIRC/225 pre-dates the NSS, Revision 5 is not a complete fit in the Recommendations strata. It contains some guidance more suited to implementing guides (implications of this discussed below).



The NSS is early in its development but is close to finalising the top-tier documents that will serve as the building blocks for the series. The draft Recommendations documents, including INFIRC/225/Rev.5, have been through the final technical meeting of participating IAEA Member States, and have been distributed to all Member States for a 120 day Member State review period (closing 11 August 2010). The Nuclear Security Fundamentals document has likewise been through a technical meeting, but has not yet been distributed for a 120 day Member States review. The number of Implementing/Technical Guidelines is not fixed, but are produced as needed. Twelve of these Guidelines have been produced, with several others in the drafting stage, and others planned.

3. INFCIRC/225/REV.5 – BACKGROUND AND FUNDAMENTALS

In October 2007 the IAEA convened a meeting of 20 experts (including one author of this paper) from 14 states for the development of the NSS Recommendations documents and Revision 5 of

INFCIRC/225. As discussed above, the purpose of an Revision 5 was in part to harmonise with the Amended CPPNM and the NSS. For states using INFCIRC/225 in bilateral safeguards agreements, there was also the need to ensure Revision 5 retained sufficient implementation detail to define an appropriate standard of physical protection for obligated nuclear material and equipment.

The Amended CPPNM and NSS cover the same themes however there are enough differences to make it difficult to harmonise Revision 5 with both. For instance, while the Essential Elements of the Fundamentals document follow closely the Amended CPPNM's Fundamental Principles, they are not identical. For example, the Essential Elements include the concept of risk-based security systems and measures, whereas the Amended CPPNM (which reflects the Objectives and Fundamental document adopted by the IAEA BoG in 2001) makes no mention of risk-based measures. In reaching a compromise the structuring of Revision 5 is divided into sections under Essential Element titles, with corresponding Fundamental Principles referenced where applicable.

As noted above, INFCIRC/225 has long been used as the legally-binding standard for defining appropriate physical protection levels in many bilateral safeguards agreements. If Revision 5 had been designed to fit completely into the strata of the NSS, much of the implementation detail on applying physical protection systems and infrastructure to different categories of nuclear material would be lost. Whether this is critical to the objective of safeguards agreement suppliers to ensure appropriate physical protection standards are applied is a matter for each such state to determine. A purely NSS-based INFCIRC/225 document would present best-practices recommendations – but would these be sufficient for the purposes of bilateral safeguards agreements?

Many bilateral safeguards agreement just mandate INFCIRC/225 as the standard, but some go further to allow for assessing or consulting on adherence to this standard[11]. For example, the recently concluded US-India Arrangements and Procedures pertaining to reprocessing under the US-India Nuclear Cooperation Agreement[12] provides for consultation visits to listed reprocessing facilities[13]. These visits permit several activities, such as: observing protected area perimeters and access control points; visiting central alarm stations; finalising a confidential joint visit reports.

Given the unique status of INFCIRC/225 as a complete and stand-alone reference document for bilateral safeguards agreements, Revision 5 has retained the level of implementation detail from Revision 4. It is not a perfect fit as the NSS Nuclear Material and Facilities Recommendations document, but the technical meeting that reviewed the final draft considered it a well crafted compromise, and as such a sound basis for proceeding with a 120 day review process by all Member States. Whether Revision 5 is sustainable in the long term when future developments of this document and the NSS are considered, will be discussed below.

Revision 5 was not all about harmonisation, it was also important to modernise the document to reflect contemporary threats (such as terrorism) and industry practices. Given Revision 5 is the first since the terrorist attacks in the US on 11 September 2001, it may come as a surprise that it contains no mention of the words "terrorism" or "terrorist"[14]. This reflects the fact that the fundamentals in Revision 4 were sound, and in particular the provision on using design basis threats (DBTs) in designing security systems gave the flexibility necessary for accommodating a full range of threats.

One area of Revision 5 that was crafted, in part, with terrorist threats in mind is a small but fundamentally important qualifier to footnote "e" on radiation levels in the table of categorisation of nuclear material (same footnote unchanged in Revision 4 and 5). The **categorisation table** lists different types of nuclear material (plutonium, uranium-235, uranium-233, and irradiated fuel)

against three categories, according to proliferation risks – with category I being high risk nuclear materials, such as unirradiated plutonium over 2kg or unirradiated high enriched uranium over 5 kg, and category III covering similar types of nuclear material only in gram or kilogram quantities.

A long-standing feature in INFCIRC/225 categorisation tables, since Revision 1 of 1977, is the provision to reduce material from category I to II or category II to III in circumstances where it has a high degree of self-protection by virtue of high radiation levels in excess of 100 rad/hr. Revision 5 qualifies this re-categorisation provision by stating that "if the threat assessment or [DBT] includes an adversary who is willing to die to accomplish their mission, States should carefully consider whether or not to reduce the categorization levels of the material on the basis of radiation levels sufficient to incapacitate the adversary before the malicious act is completed" (emphasis added). The impact of this provision will be elaborated in the following section.

4. INFCIRC/225/REV.5 – WHAT IT MEANS FOR INDUSTRY

The draft INFCIRC/225/Rev.5 represents more of an evolutionary change from Revision 4 than a revolutionary change – it is certainly not as large a change as the update from Revision 3 to 4. Whether the adoption of Revision 5 will require substantial changes to national nuclear security frameworks will depend on how national systems are currently structured and operated. The following outlines some of the changes that may require consideration by regulators and operators.

Threat Assessments and DBTs

As discussed above, Revision 4 was the first to incorporate the concept of DBTs. While this is a valuable tool, there are circumstances where the quantities or types of nuclear material are of low proliferation sensitivity so designing systems against defined adversary attributes and characteristics may not be necessary. Revision 5 recognises more flexible fit-for-purpose approaches in security design by allowing for security requirements and systems to be defined on the basis of a DBT or a threat assessment, which is defined as "the evaluation of the threats – based on available intelligence, law enforcement, and open source information – that describes the motivations, intentions, and capabilities of these threats". This may appear similar to the DBT definition, but it is more flexible and potentially less resource-intensive, as it allows flexibility in the type of information used and does not require defined adversary attributes and characteristics.

Limited Access Areas

INFCIRC/225/Rev.5 introduces for the first time the concept of a **limited access area**, defined as a "designated area containing a nuclear facility and nuclear material to which access is limited and controlled for physical protection purposes." A limited access area provides a buffer for the long-established security area concepts of the **protected area**[15] and the **vital area**[16] from previous INFCIRC/225 documents. Importantly for operators, a limited access area does not require the high level of physical protection systems and infrastructure used for protected areas and vital areas. Rather, it gives credit to general site fences already commonly found at facilities and ensures that protected area boundaries are not freely accessible to the public. As such, for most nuclear facilities the limited access area concept in INFCIRC/225/Rev.5 would likely require limited change, if at all.

The "Self Protection" Value of Highly Radioactive Material

Once adopted, the part of INFIRC/225/Rev.5 that could potentially have the greatest impact on security systems is the small but significant change to the physical protection credit that can be

given to the “self-protecting” attribute of highly radioactive nuclear material (e.g. spent fuel). As described in section 3, the long-established provision on reducing from Category I/II to II/III when nuclear material has radiation levels in excess of 100 rad/hr, has been qualified to accommodate terrorist-type threats where adversaries are “willing to die to accomplish their mission”.

Given the increased profile of terrorism in national security planning over the last ten years, many nuclear facilities likely already factor this type of threat into physical protection systems. For those that have not, re-categorising nuclear material up from Category III to II or Category II to I, could require significant changes in physical protection systems and infrastructure. That being said, it is the responsibility of the appropriate state authorities, using all credible sources of information available to the state, to assess and define the nature of the threat, and the extent to which the threat from adversaries willing to die to accomplish their mission, needs be accommodated.

Performance Testing

INFCIRC/225/Rev.5 gives much greater emphasis to performance testing of the physical protection system than previously. So called force-on-force exercises are explicitly mentioned for the first time as an example of performance testing for the protection of Category I material. This may require additional security exercises to be performed by operators and regulators.

5. THE FUTURE – INFCIRC/225/REV.6?

The unique and important status of INFCIRC/225 as a complete and standalone reference document for bilateral safeguards agreements complicates its placement in the structure of the IAEA’s Nuclear Security Series (NSS). However, while the development of the NSS as a full and structured series of nuclear security guidance documents will be an important tool in guiding operator and regulators and disseminating standards, it is not yet complete. As such, it was probably prudent to retain the structure and level of detail from INFCIRC/225/Rev.4 to Rev.5, at least until such time as the utility of Revision 5 and the completed NSS can be observed and tested in operation.

Once the NSS is completed it should become the standard set of nuclear security guidelines adopted by facilities around the world. When it comes time to review and amend the Fundamentals and Recommendations NSS documents in the future, will it be sustainable for the NSS’s Nuclear Materials and Facilities Recommendation document (i.e. an INFCIRC/225/Rev.6) to retain its hybrid structure of Fundamentals-like, Recommendations-like and Implementing Guidelines-like elements? At this point this is a rather abstract question, as in the short to medium term the more important priority will be promoting and implementing the NSS (including INFCIRC/225/Rev.5), but this question will need to be re-visited at some point.

If an INFCIRC/225/Rev.6 becomes a pure NSS Nuclear Material and Facilities Recommendations document (i.e. loses detailed implementation guidance as currently contained in Revision 4 and 5), then governments that incorporate INFCIRC/225 into bilateral nuclear safeguards agreements will need to consider whether this can still meet requirements. If the level of detail is not sufficient to assess adherence to security standards, one solution could be to prescribe a combination of the Nuclear Materials and Facilities Recommendation document and one or more Implementing Guidelines. This might not be achievable as the Implementing Guidelines may be too prescriptive for use as legally binding guidelines in bilateral safeguards agreements. Furthermore, the full process of amending treaties, even if the textual changes are minor, is not trivial. Another option might be to excise INFCIRC/225 from the NSS while retaining a parallel Nuclear Material and

Facilities Recommendations document that fits the structure of the Recommendations strata. This solution is not ideal either as it could create difficulties of competing parallel standards. It is not only in the context of bilateral safeguards agreements that adherence to physical protection standards is assessed, as the IAEA will likely use the NSS for its international physical protection advisory service (IPPAS) missions. As such, a circumstance where states have to prepare for reviews and consultation against the standards in INFCIRC/225 for a bilateral partner, and against the NSS if it invites the IAEA to conduct an IPPAS mission might not be sustainable.

If fielding all options, one that would need to be considered seriously is to accept the NSS as the standard, and to allow INFCIRC/225/Rev.6 to have lower levels of detail as with the other Recommendations-level documents. Under this model, adherence to security standards could still be assessed in bilateral consultations, but assessments would be at the systems-level, rather than the details of implementation. A variation on this model could be to use a graded approach. In circumstances where the highest category of nuclear material is nuclear fuel of less than 10% enrichment (i.e. Category III for fresh fuel and Category II for spent fuel) – as would be the case for majority of civil nuclear facilities – the model described here could be used. In circumstances where Category I material is used (e.g. unirradiated plutonium or high enriched uranium) then the INFCIRC/225/Rev.6 as described here, could be supplemented with implementation-level guidelines (from the NSS or annexed to the bilateral safeguards agreement), against which more implementation-level assessments of adherence to standards could be conducted.

6. CONCLUSIONS

While nuclear security's profile has recently taken centre stage (*viz*. the Nuclear Security Summit) nuclear security's primary guide, INFCIRC/225/Rev.5 is an evolutionary, not revolutionary, change from Revision 4. On the whole, its adoption and implementation by most operators and regulators should not require significant effort or changes. Two possible exceptions stand out. First, there is the new recommendation, related to reducing categories for "self protecting" highly radioactive material, that assessments of threats consider adversaries that may be willing to die to accomplish their mission. For some nuclear security systems this could require significant changes, but the authors of this paper are not privy to how threats are assessed in other countries. Second, the recommendation on performance testing, including force-on-force exercises for Category I materials, if not already in practice would require additional resources and organisation.

INFCIRC/225/Rev.5 is not a complete fit into the Recommendations strata of the Nuclear Security Series, but the technical group that reviewed the final draft considered it a well crafted compromise suitable for proceeding with the 120 day review process by all IAEA Member States. After INFCIRC/225/Rev.5 and the NSS have been observed and tested in operation, it will come time for another review, at which point Member States will need to decide whether an INFCIRC/225/Rev.6 should be completely aligned into the structure of the NSS. But as noted earlier, the ideas presented in this paper for the future of INFCIRC/225 and the NSS are mostly abstract at this point, as the most important priority is to promote the application of good standards of nuclear physical protection through the adoption of INFCIRC/225/Rev.5 and the Nuclear Security Series.

1. Opening Remarks by Ambassador Susan E. Rice, U.S. Permanent Representative to the United Nations, at press conference, 30 April 2010 – usun.state.gov/briefing/statements/2010/141253.htm
2. The latest published revision, INFCIRC/225/Rev.4, *The Physical Protection of Nuclear Material and Nuclear Facilities*, was the first to include nuclear materials and nuclear facilities in the title.
3 As of 19 May 2010 there were 36 contracting parties to the Amended CPPNM. As of 10 May 2010 there were 143 parties to the CPPNM.
4. The review from Revision 2 to Revision 3 was limited in scope.
5. A design basis threat (DBT) is the definition of the attributes and characteristics of potential insider and/or external adversaries, who might attempt unauthorised removal of nuclear material or sabotage, against which a physical protection system is designed and evaluated.
6. IAEA General Conference document GC(45)/INF/14 of 14 September 2001.
7. Board of Governors document GOV/2001/41 (15 August 2001), reprinted in GC(45)/INF/14.
8. See *2005 Amendment to the Convention on the Physical Protection of Nuclear Material and the International Recommendations on Physical Protection of Nuclear Material and Facilities in INFCIRC/225/Rev.4*, Patricia A. Comella, 47th Annual Meeting of the INMM, July 16-20, 2006.
9. Details at www-ns.iaea.org/security/nuclear_security_series.htm.
10. The term nuclear security is used here, rather than physical protection, as the nuclear security series goes beyond protection of nuclear material to protection of all radiological materials.
11. The Australia-US bilateral safeguards agreement (updated in 2010) includes the provision: "The adequacy of physical security measures … with respect to material and equipment transferred pursuant to this Agreement … shall be subject to review and consultation by the Parties periodically and whenever either Party is of the view that revised measures may be required to maintain adequate physical security."
12. *Arrangements and Procedures Agreed Between the Government of the United States and the Government of India, Pursuant to Article 6(iii) of Their Agreement For Cooperation Concerning Peaceful Uses of Nuclear Energy.*
13. Section I of the Agreed Minute to the *Arrangements and Procedures*.
14 Though the preface to INFCIRC/225/Rev.5 has not yet been written.
15. INFCIRC/225/Rev.4 defines a "protected area" as: "An area under surveillance, containing Category I or II nuclear material, and/or vital areas surrounded by a physical barrier." INFCIRC/225/Rev.5 has a slightly different definition: "Area inside a limited access area containing Category I or II nuclear material and/or sabotage targets surrounded by a physical barrier with additional physical protection measures." In application these are essentially the same, as the implementation recommendations for vital areas in Revision 4 includes protecting against sabotage.
16. The definition of a "vital area" remains the same in INFCIRC/225/Rev.4 and Rev. 5 as: "An area inside a protected area containing equipment, systems or devices, or nuclear material, the sabotage of which could directly or indirectly lead to unacceptable radiological consequences."