DBT – Basis for developing a European physical protection concept

A. Hagemann

Office of Nuclear Security
Department of Nuclear Safety and Security
International Atomic Energy Agency
Wagramer Strasse 5, P.O. Box 100, A 1400 Vienna, Austria

ABSTRACT : It is one of the security fundamentals that a State's physical protection system should be based on the State's current evaluation of the threat. An internationally accepted methodology for the design and evaluation of physical protection of nuclear material and facilities is the Design Basis Threat methodology. This methodology uses a definition of a threat, which is developed from the State‘s evaluation of the threat.
Open borders inside the European Union enable those individuals, who could create a potential threat to nuclear material or nuclear facilities, to move from one Member State to another without restrictions or the realistic opportunity for relevant authorities to be informed timely about such possible movements. Taking into account this in the States‘ threat evaluation the results have got a potential to become more and more similar inside the Europe Union. The similarity in the results may put in question the idea of defining *national* Design Basis Threat, DBT, in each State. The similarities in the threat evaluation and the DBT will then contribute to more similarity in the design basis for physical protection concepts. The DBT is an important basis, but there are more factors, which determine the design and the evaluation of a physical protection concept. These factors are related to the State‘s physical protection system, which consists of elements like the State‘s response capabilities to malevolent acts against nuclear material or facilities, the culture and the legal and regulatory framework of physical protection.
The development of a European physical protection concept would clearly be part of the efforts and policy in order to harmonize rules, regulations and standards within the European Union. This document will not touch the political aspects and potential problems related of harmonization in the European Union and will not speculate upon the possibilities. The DBT methodology will be explained. The relevant elements which would be subject for harmonization will be identified and their functions will be explained.

1 INTRODUCTION

The requirements on physical protection contained in INFCIRC 225/Rev.4, “The Physical Protection of Nuclear Material And Nuclear Facilities“ [1] reflect a broad consensus among Member States of the IAEA on the requirements, which should be met by systems of the physical protection of nuclear material and facilities. Together with the Physical Protection Objectives and Fundamental Principles [2], which were mainly extracted from INFCIRC 225 a sound guidance for a establishing a physical protection concepts exists. The requirements contained in have the character of a recommendation because this document has no legal binding character, even though some countries have based their legal framework of physical protection on INFCIRC 225.

The Security Fundamentals [2] were approved by the Board of Governors and were adopted by the General Conference in 2001. The Security Fundamentals have therefore a higher level in hierarchy of Agency documents but still don‘t have a legal binding character. The Convention on Physical Protection of Nuclear Material, CPPNM, [3] is an international legal binding document. It is focused on the physical protection of nuclear material against unauthorized removal during international transport. The existing revision 1 of the CPPNM from 1980 does not cover domestic use, storage and transport of nuclear material and does not cover the protection of nuclear material and facilities against sabotage. A draft amendment to the CPPNM, considering physical protection during domestic use, storage and transport and of nuclear facilities, including the physical protection against sabotage, has been prepared by an open ended working group of legal and technical experts in summer 2002. A proposal for amendments to the CPPNM, which is a prerequisite to convene a conference to revise the CPPNM, has not been made yet. A legal binding document of the European Union concerning physical protection does not exist.

An international guidance to establish a physical protection concept is presently provided by the Security Fundamentals [2], INFCIRC 225/Rev.4 and the existing technical documents, TECDOCS [4], [5], which are based on INFCIRC 225. Additional TECDOCS concerning IT-Security, DBT Development and maintenance, protection against sabotage and the insider threat are in the process of being drafted and will be issued in 2004. These guidance documents will contribute to strengthen and to adjust the level of physical protection and in a limited scale also adjust methods, measures and concepts of physical protection.

2 THE SYSTEM OF PHYSICAL PROTECTION

2.1 Physical Protection Objectives and the Allocation of Responsibilities

The objectives of physical protection are defined in [1] and [2] as to establish and to maintain conditions to

- Protect against unauthorized removal of nuclear material in use and storage, and during transport;
- Ensure the implementation of rapid and comprehensive measures by the State to locate and recover missing or stolen nuclear material;
- Protect against sabotage of nuclear facilities and sabotage of nuclear material in use and storage and during transport; and
- Mitigate or minimize the radiological consequences of sabotage.

These objectives comprise 3 lines of defense against malevolent acts:

- Prevention of any interference caused by malevolent acts;
- Response to such interference acts and recovery of control;
- Emergency procedures to mitigate the consequences of loss of control.

Feasibility reasons result in the principle that the prime responsibility for the implementation of physical protection rests with the holder of the license, respectively the operator. The license holder is therefore responsible for providing appropriate protection measures to prevent undesirable consequences of a malevolent act. The responsibility of the licensee is situated in the above-mentioned first line of defense and partly in the second line, supported by off site response provided in most cases by State organizations, respectively Police forces.

The physical protection measures of the operator are understood as the physical protection concept. INFCIRC 225/Rev.4 describes a concept of physical protection as „one which requires a designed mixture of hardware (security devices), procedures (including the organization of guards and the performance of their duties) and facility design (including layout). The level of the physical protection measures should be specifically designed to take into account the nuclear material or nuclear facility and the State's design basis threat. Emergency procedures should be prepared to counter effectively the State's design basis threat."

It is understood that the term „emergency" is used here for a situation during a malevolent act, which is different from a safety related emergency situation. The „emergency procedures" mentioned here is therefore part of the physical protection concept the license holder is responsible for. The physical protection concept is designed to counter effectively the DBT. The DBT is a definition to define a common basis for the design and the evaluation of the physical protection concept. It is a regulatory tool and is not a real threat. In order to achieve the physical protection objectives the physical protection concept, the operator is responsible for, has to be embedded into a State's physical protection system. The State's physical protection system should be based on the State's evaluation of the threat. Other factors should also be considered, including the State's emergency response capabilities and the existing and relevant measures of the State's system of accounting for and control of nuclear material [1]. It is understood that the emergency response of the State includes measures to respond to a malevolent act as well as the capabilities to recover lost material and to mitigate the radiological consequences of a malevolent act.

The responsibilities for implementing the various elements of physical protection within a State should be clearly identified. The DBT is a significant tool and a critical element in the process to establish, implement and maintain a physical protection system.

2.2 The Definition of a DBT

The main elements of a State's physical protection system are shown in figure 1. The desire for security in principle is a result of a concern about perceived threat and about a potential hazard. The objective of security measures is the perception that consequences of malevolent acts are prevented or minimized to an acceptable level.

A threat can be defined as the potential to cause an undesirable consequence. The result of a threat assessment is represented in box 1. It then documents the result of an analysis of the credible motivations, intentions, and capabilities of potential adversaries that could cause undesirable consequences to nuclear materials in use, storage, or transport and nuclear facilities.
The consequences represented in box 2 are defined as the potential level of impact on the interests of the public, the State, key interest groups, and the international community. Consequences could be defined in relation to the level of a potential release of radioactive substances and potential exposure to radiation. For the protection against unauthorized removal of nuclear material the categorization table in [1] and [3] expresses the concern, namely the potential of material to be misused for the creation of a nuclear explosive device. The concern on potential consequences will influence policy of the decision making process in the development of a DBT. This decision making process is represented in diamond 3, which represents the State's responsibility to decide with the definition of a DBT on the level of protection.

Whereas the results of the threat assessment may become similar in the European Union with free movement within, the concern about consequences, particularly about the

radiological consequences and the loss of nuclear material is an individual matter. The decision making process represented by diamond 3 is not only based on political concerns. Technical and resource issues as well as and the interrelationships between State, local official, and Operator responsibilities for physical protection are to be taken into account, too. This reduces the influence of emotions on the concern and opens provides opportunities to adjust existing definitions of the DBT.

The key elements in the creation of a DBT are threat assessment and decision making considering potential consequences. Threat assessment and decision-making are separate and different processes even though in practice they may be carried out at the same time. The threat assessment process, and the document that describes the conclusions, scopes all the realistic and credible threats that the Competent Authority needs to take into account.

Some threats may not be manageable in terms of a DBT because some aspects of a State's physical protection system fall outside the responsibility of the Competent Authority. These threats are described as being "beyond DBT". "Beyond DBT" does not necessarily describe a magnitude of threat above that described in the DBT, it describes those threats that it is inappropriate to include in a DBT, whose principle aim is to provide threat criteria for Operators to design the physical protection system against. However, these threats still need to be taken account to ensure the protection of nuclear materials and facilities. The Competent Authority will need to discuss these with other State authorities. The diamond 13 represents this additional decision making process the Competent Authority is responsible for. The decisions symbolized by diamond 13 could be of high relevance for the holder of the license, because the original design of the physical protection concept did because it was not included in the design basis. The potentially resulting requirements on upgrades could e.g. cause significant costs and in some cases could result in the withdrawal of the license.

As an example for threats that have not been a design basis for the physical protection concept, is given by the threat of an intentional aircraft crash as an attack against a nuclear facility. This has been taken into account as a potential threat to nuclear facilities and States have taken the responsibility to provide measures in order to reduce this risk to an acceptable level. A real demonstration of this kind of threat happened in 1972, when a hijacked aeroplane was threatened to crash intentionally into the Oak Ridge Laboratories. After the events of 9/11 this threat has been reconsidered in all countries. The threat has not become a DBT yet, but certain measures have been required from the licensees to reduce the potential vulnerability of facilities against this kind of threat. Anti aircraft units, security measures at airports and in airplanes were measures outside the physical protection concept provided by the States to achieve the acceptable risk (box 12), which stands for the physical protection objectives.

The foundation for a physical protection system, including the DBT, is a legislative and regulatory structure. This enables a Competent Authority to take the actions that are necessary to create a DBT and to involve State Authorities, particularly other Ministries and Departments, in the process. The Competent Authority relies on other organizations, including the Ministry of Interior, Ministry of Defense, State Intelligence Organizations, State Police Organizations, local Law Enforcement, and other Government Regulatory Authorities to provide intelligence, information, and data to support development of the Threat Assessment Document and support maintenance of the DBT. The Competent Authority needs the input from diverse and reliable sources to adequately describe the motivations, intentions and capabilities of potential adversaries. The full and open participation of all concerned Ministries and Agencies is critical to the definition and maintenance of the DBT. Each Ministry and Agency brings relevant expertise and information that is necessary for the definition of the DBT.

The task to initiate and to manage the cooperation to define, establish and maintain a DBT represents a challenge to a national Competent Authority and even more to an international Organization, which first has to be established. This is clearly a political issued and will not elaborated herein.

2.3 The Physical Protection Concept

The concept of physical protection is shown in box 6. The concept has to be designed against the DBT and will be evaluated by the Competent Authority using the definition of the DBT. The objectives, which are specific for the particular physical protection concept of certain nuclear material in use, storage and transport or for a certain nuclear facility, should be defined. This is a prerequisite for an effective design process as well as for the evaluation of a physical concept by the Competent Authority. The definition of these specific objectives can vary e.g. from prevention of intrusion or unauthorized access to certain areas, to the prevention of certain facility conditions or the protection of vital functions. In any case the security functions in box 6b, detection, delay, response and recovery have to be defended against the DBT.

Applying the principle of a graded approach as

- taking into account the current evaluation of the threat, the relative attractiveness, the nature of the material and potential consequences associated with the unauthorized removal of nuclear material and with the sabotage against nuclear facilities or nuclear material [2]
- and defense in depth as
- providing several layers and methods of protection (structural or other technical, personnel and organizational that have to be overcome or circumvented by an adversary in order to achieve his objectives [2],

could result in a different consideration of system design, facility layout engineered, safety measures and physical protection measures might be different in different countries. The resulting physical protection concept there for might differ in different countries. Also the consideration of the measures of material control and accounting can vary from country to country.

The weight given to safety systems component capacities and post core damage crisis management in providing appropriate physical protection might also vary between States, depending on the State‘s regulation and the understanding of the Security Fundamentals by the competent authority. These potential differences are relevant in particular for the protection against sabotage of nuclear facilities, where complex processes have to be protected. The definition of a Vital Area highlights the potential spectrum of solutions: “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” [1]. Additional guidance on the protection of systems and devices, which could lead indirectly to unacceptable radiological consequences is in the process of being drafted.

For the physical protection of nuclear material against unauthorized removal the safety system design features are of less relevance. A potential for different concepts of physical protection against a similar DBT exists here too. The objective can be achieved by preventing unauthorized access to material, can be achieved by immobility of the material, it can also be achieved by regaining the control on the material timely. The different possible

ways to achieve the physical protection objectives could result in different measures and in a potential variety of physical protection concepts.

The requirements on the security function „Delay“ can vary very much, depending on the response time, the response capability and method. The delay can be provided by a building structure, as one structure or in combination with a graded system of barriers; can be supported by guard force or can be provided by guard forces solely. The requirements on providing intrusion delay can vary. They can be very strict, if the prevention of any intrusion during the response time is required. The can differ with the estimated or agreed response time. They can also differ when the delay provided by e.g. a process is considered in the measures to regain control. It depends also on the credit, which is given to force on force capabilities of the guards.

2.4 Competent Authority

The State should designate a competent authority under its legislation, which is empowered to establish and ensure the proper implementation of the State’s system of physical protection. If the elements of the State's system of physical protection are divided between two or more authorities, arrangements should be made for overall co-ordination. Clear lines of responsibility should be established and recorded between the relevant entities [1]. All European Member States with a nuclear program have designated their National Competent Authority.

For the European Union the Directorate General “Energy and Transport” (TREN) ensures that users keeps all materials - in their custody and which fall under the Rome Treaty from 1957 that set up EURATOM - in a secured and accountable manner [6]. In the light of an increased threat situation and with view on the enlargement of the European Union the report [6] of a high level expert group appointed by the European Commission recommends to assign the European Safeguard Office, ESO a specific role in physical protection of nuclear materials.

This requires clearly a European political decision and will not be discussed here.

3 CONCLUSION

The DBT is clearly a basis for a potential European physical protection concept, because the definition of a DBT is an international accepted tool to design and to evaluate physical protection concepts. Even identical definitions of DBT‘s in European Member States would not lead solely to identical physical protection concepts for similar nuclear materials or facilities, because the State‘s systems of physical protection and the performance and prescriptive requirements on physical protection differ in the European Union. This does not mean that the level of physical protection in one country is significant higher than in the other country. The existing international guidance for physical protection, INFCIRC 225/Rev. 4, defines objectives and recommends a methodoly, but does not prescribe a certain way to achieve common the physical protection objectives.

Different ways to achieve the physical protection objectives will provide different experiences with the operation of different physical protection concepts. The European Union provides a basis of confidence for an exchange of experiences among the national physical protection experts. This could lead to an adjustment of the DBT and could on the long run lead to

adjustments of the national systems of physical protection. European projects like the EPR provided a technical basis for harmonization not only of safety design requirements, but also for the harmonization of the physical protection concepts. The final decision on harmonization clearly remains as a political challenge.

4 REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC 225 Rev.4 (Corrected), Vienna (1999)

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Physical Protection Objectives and Fundamental Principles, GOV/2001/41,Vienna (2001)

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Convention on the Physical Protection of Nuclear Material, INFCIRC 274/Rev.1, Vienna (1980)

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance and considerations for the implementation of INFCIRC 225 Rev.4 (Corrected), The Physical Protection of Nuclear Material and Nuclear Facilities, TECDOC 967 Vienna (2000)

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on the physical protection of nuclear materials and facilities, TECDOC 1276, Vienna (2002)

[6] Review of the EURATOM Safeguards Office by a High Level Expert Group Appointed by the European Commission, Directorate-General for Energy and Transport Main Report, Final Version 15. February 2002

APPENDIX

Elements of a Physical Protection System

Box 1
The Threat Assessment is defined here as an analysis that documents the credible motivations, intentions, and capabilities of potential adversaries that could cause undesirable consequences to nuclear materials during use, storage, or transport and nuclear facilities The result of the threat assessment process describes the credible threats.

Box 2
Consequences are defined here as the potential level of impact on the interests of the public, the State, key interest groups, and the international community. Consequences could be defined in relation to the level of a potential release of radioactive substances and potential exposure to radiation. A scale for consequences is given for nuclear Material by the table of categorization in [1], [3]. The concern on these consequences will influence policy of the decision making process in the development of a DBT.

Diamond 3
A **decision making process** considering the results of the threat assessment, the consequences and the policy leads to definition of the DBT. The Competent Authority coordinates the development of a DBT and is responsible for its maintenance.

Box 4
Beyond DBT describes those threats identified in the Threat Assessment that will not be included in the DBT, but still remain as a credible threat. The threats beyond DBT need also to be taken into account to ensure the physical protection of nuclear facilities.

Box 5
The Design Basis Threat, **DBT** describes the attributes and characteristics of potential insider and/or external adversaries, who might attempt unauthorized removal of nuclear material or sabotage, against which a physical protection system is designed and evaluated. It is a regulatory tool based on a decision making process.

Box 6
The physical protection against unauthorized removal or sabotage requires a designed mixture of hardware (security devices), procedures (including the organization of *guards* and the performance of their duties) and facility design (including layout).

Box 6 a
Specific objectives for the physical protection concept should be defined like prevention of unauthorized access, prevention of facility conditions, protection of critical safety functions, protection of vital areas.

Box 6 b
The physical protection System should be designed to perform **Detection** and **Delay** of a malevolent act and to **Response** appropriately to this act by a DBT. These primary functions are typically provided by physical protection measures like

- Detection and access control systems
- Barriers
- Response forces

But also process parameters or e.g. radiation measurement can provide detection, the process behavior can e.g. also provide delay for measures to regain control.
An analysis of the facility design including an evaluation of existing safety measures and the consideration of the spatial separation and the redundancy of systems will provide a basis for the design of appropriate physical protection measures. In order to respond appropriately the immediate on-site actions of the operator related to the recovery of disabled systems or functions have to taken into consideration.

If the DBT includes malevolent acts resulting in loads on plant structures, systems and components and/or measures against which they are not designed against, then an **evaluation** of the **capacity** of these needs to be carried out. The acceptance criteria to be used in this evaluation process should be determined by the Competent Authority.

Post core damage **crisis management** as a response to an attempt of sabotage involves plant actions to mitigate consequences. These may also include considerations for the possibility of continuing adversary presence on site hindering and trying to disrupt the mitigation activities.

Box 7
Emergency Response is required to mitigate the radiological consequences of a malevolent act, which has led or has the potential to lead to the loss of control over the nuclear process by the loss of the designated safety systems. This includes all actions performed by the operator and State organizations in cooperation with the operator organization to cope with the situation including specific measures to counter malevolent acts to disrupt emergency response. For a potential loss of material the box 7 represents the efforts to recover the material or to mitigate consequences.

Box 8
The **responsibility** for physical protection rests with a **State**. The State should ensure that the prime responsibility for the implementation of physical protection of nuclear material or of nuclear facilities rests with the holders of the relevant licenses. The DBT is a[1] tool used by the Competent Authority for evaluating physical protection and for the operator for planning, designing physical protection.

Box 9
The **Response** by State Authorities or organizations may include the active force on force response by e.g. Police forces to an attack on the facility. Response also includes the actions of emergency organizations in the State.

Box 10
State's Security includes measures, which acknowledge a credible threat as Beyond DBT. These measures are to be taken together with the emergency response capabilities in order to keep the remaining risk on an acceptable level. The spectrum of measures can include intelligence, air traffic security and military defence (and many other measures…).

Diamond 11
The State's Competent Authority decides how to respond to situations, when the credible threat, which was not included in the DBT, becomes a matter of concern. The objective of the physical protection of vital areas is to provide those critical safety functions, which prevent radioactive release beyond prescribed limits. Taking into account the Beyond DBT and the results of an extreme loads evaluation the Competent Authority may decide to include this in

the physical protection design and evaluation process and/or take over the remaining part in its responsibility.

Diamond 12
The diamond represents the decision, which have to be made during the design or the evaluation process of the physical protection measures whether the specific objectives are achieved or not. It represents the decision making process on upgrading, redesigning or post core damage crisis management.

Diamond 13
This diamond represents the decision making process in a competent authority during licensing or supervising a nuclear facility in order to achieve a level of risk that can be accepted, after consideration of emergency response measures.

Box 14
It represents the objectives of physical protection. The term **Risk** in this context is used as the likelihood that a threat will be able to bring about an undesirable consequence. The risk can be reduced, but cannot be eliminated. All the judgments and decisions imply the acceptance of a degree of risk. There is no database for the statistics of malevolent acts, which allow the calculation of the risk as a product of the probability of a successful attack based on the statistics and the ensuing consequences. However some States have chosen to estimate a conditional risk, e.g. given that an attack will occur, what will be the risk.

Appendix 1

Elements of a Physical Protection System