Hungarian Atomic Energy Authority

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Guideline PP-8

Design of the physical protection system of nuclear facilities (with the exemption of those operating with a reactor having less than 1 MW thermal power) and radioactive waste temporary storage and final disposal facilities

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FOREWORD FROM THE DIRECTOR GENERAL

The Hungarian Atomic Energy Authority (hereinafter referred to as HAEA) is a central state administration organ (a so-called government office) having nation-wide competence in the field of peaceful use of atomic energy; it operates under the direction of the Government, it has independent tasks and scope of authority. The HAEA was established in 1990 by the Government of the Republic of Hungary with Govt. decree 104/1990. (XII. 15.) Korm. on the scope of tasks and competence of the Hungarian Atomic Energy Commission and the HAEA.

The public service of the HAEA as defined in law is to perform and coordinate, independently of organizations having interest in the application of atomic energy, the regulatory tasks in relation to the peaceful and safe use of atomic energy, including the safety of nuclear facilities and materials, nuclear emergency response and nuclear security, and the corresponding public information activity, and to make proposal to develop and amend, and to offer an opinion on proposed legislations corresponding to the use of atomic energy.

The fundamental nuclear safety objective is to ensure the protection of individuals and groups of the population and of the environment against the hazards of ionising radiation. This is ensured with effective safety measures implemented and adequately maintained in the nuclear facility.

The radiation protection objective is to keep the radiation exposure of the operating personnel and the public all times below the prescribed limits and as low as reasonable achievable. This shall be ensured in the case of radiation exposures occurring during design basis accidents, and as far as reasonably possible during beyond design basis accidents and severe accidents.

The technical safety objective is to prevent or avoid the occurrence of accidents with high confidence, and the potential consequences occurring in the case of every postulated initiating event taken into account in the design of the nuclear facility shall remain within acceptable extent, and the probability of severe accidents shall be adequately low.

The HAEA determines the way how the regulations should be implemented in guidelines containing clear, unambiguous recommendations in agreement with the users of atomic energy. These guidelines are published and accessible to every members of the public. The guidelines regarding the implementation of nuclear safety, security and non-proliferation requirements for the use of atomic energy are published by the director general of the HAEA.

Hungarian Atomic Energy Authority

FOREWORD

The internationally accepted bases of physical protection are represented by the Law Order 8 of 1987 on the promulgation of the International Convention on the Physical Protection of Nuclear Materials, the Act LXII of 2008 on the promulgation of the Amendment to the Convention on Physical Protection of Nuclear Materials approved in the frame of the International Atomic Energy Agency and promulgated by Law-decree 8 of 1987 amended by a Diplomatic Conference organized by the IAEA signed on July 8, 2005, and the Act XX of 2007 on the promulgation of the International Convention for the Suppression of Acts of Nuclear Terrorism.

The realization of the stipulations undertaken by Hungary, at the highest level, is represented by the Act CXVI of 1996 (hereinafter referred to as Atomic Act), which includes the fundamental security principles and establishes the frame of the detailed physical protection regulations.

The Govt. decree 190/2011. (IX. 19.) Korm. published based on the authorization of the Act (hereinafter referred to as Government Decree) establishes the legal requirements for the physical protection of the use of atomic energy and for the connecting licensing, reporting and inspection system.

The HAEA is authorized to develop recommendations regarding the implementation of requirements established in laws, which are published in the form of guidelines and made accessible on the website of the HAEA.

For the fast and smooth conduct of licensing and inspection procedures connecting to the regulatory oversight activity, the Authority encourages the licensees to take into account the recommendations of the guidelines to the extent possible.

If methods different from those laid down in the regulatory guidelines are applied, then the Authority shall conduct an in-depth examination to determine if the applied method is correct, adequate and full scope, which may entail a longer regulatory procedure, involvement of external experts and extra costs.

The guidelines are revised regularly as specified by the HAEA or out of turn if initiated by a licensee.

The regulations listed are supplemented by the internal regulations of the licensees and other organizations contributing to the use of atomic energy (designers, manufacturers etc.), which shall be developed and maintained according to their quality management systems.

Before applying a given guideline, always make sure whether the newest, effective version is considered. The valid guidelines can be downloaded from the HAEA's website: http://www.oah.hu.

TABLE OF CONTENTS

1. INTRODUCTION

1.1. Scope and objectives of the guideline

The guideline contains recommendations on how to meet the provisions of Government decree.

This guideline provides detailed guidance with regard to the design of the physical protection system of nuclear facilities (with the exemption of those operating a reactor having less than 1 MW thermal power), and radioactive waste temporary storage and final disposal facilities; and thus supports the compliance with the legislative requirements.

Guidance regarding the design of the physical protection against the unauthorized removal and sabotage of nuclear materials, radioactive sources and radioactive wastes is provided in the PP-7 Guideline.

1.2. Corresponding laws and regulations

The legal background of the nuclear safety requirements is established in the Atomic Act and the Government decree, as well as the following documents:

a) Convention on The Physical Protection of Nuclear Material and Nuclear Facilities, IAEA, CPPNM/AC/L.1/1, 2005.

b) Nuclear security recommendations on Physical protection of nuclear material and nuclear facilities (INFCIRC/225/Rev5), IAEA Nuclear Security Series No. 13, IAEA, 2011.

c) Nuclear Security Recommendations on Radioactive material and associated facilities, IAEA Nuclear Security Series No. 14, IAEA, 2011.

2. TERMINOLOGY

This guideline used the following terminology in addition to the terms determined in Section 2 of the Atomic Act and Section 2 of the Government decree.

Administrative measures:

The entirety of all those procedures, which determine the operation and use of the facility, nuclear and other radioactive material.

Unacceptable radiological consequences:

The consequence of a sabotage against a nuclear facility, nuclear material, radioactive source or radiative waste is unacceptable, if it causes or may cause a nuclear emergency; and if the sabotage entails significant exceedance of the dose limit of certain individuals or a group of individuals, or it can induce such overexposure.

Authority:

The HAEA and the Hungarian Police Headquarters.

3. RECOMMENDATIONS OF THE GUIDELINE

Section 18 of the Government decree regulates the design process as follows:

"Section 18

(1) The obligant shall develop a physical protection plan to describe the structure and operation of the physical protection system according to the specifications of Annex 4.

(2) The obligant, as part of the physical protection plan, shall prepare a contingency plan, which specifies the scope of possible events, including also the events that may cause inappropriate operation of the physical protection system, as well as the procedure of necessary measures and interventions.

(3) The obligant shall prepare for the measures to introduce advanced level physical protection if ordered for according to point d) and da) of paragraph (1) of Section 3.

(4) The obligant shall harmonize the management of nuclear and non-nuclear emergencies with the operation of the physical protection system.

(5) If nuclear emergency occurs due to sabotage or other reason, the physical protection system shall not hinder the implementation of the emergency response plan."

The establishment of a physical protection system requires regulatory authorization, which is based on the physical protection plan to be submitted by the obligant. In line with Section 32 (1) of the Government decree:

"Section 32

(1) Regulatory license is required:

a) to construct the physical protection system of nuclear facility, interim store and final repository of radioactive waste, nuclear material, radioactive source and radioactive waste according to the physical protection plan,

b) to extend the license of the physical protection system of nuclear facility, interim store and final repository of radioactive waste, nuclear material, radioactive source and radioactive waste,

c) to transport nuclear material, radioactive source and radioactive waste requiring level A, B or C physical protection,

d) to modify a licensed physical protection system, if the modification needs modification of the physical protection plan.

Annex 4 of the Govt. decree specifies the content requirements for the physical protection plans as follows:

"1. The physical protection plan of a nuclear facility, a radioactive waste storage or disposal facility, nuclear material, radioactive source or radioactive waste shall contain:

1.1. General data:

1.1.1. administrative data: name, address and contact details of the obligant, contact persons, copy of the ownership registry of the real estate, or if the real estate is rented then the contribution declaration of the renter;

1.1.2. identification of the activity;

1.1.3. description of the close environment of a nuclear facility, and a radioactive waste storage and disposal facility: site with coordinates, scaled map with the indication of physical protection important buildings, access routes, routes, rails and waterways in the vicinity;

1.1.4. description of nuclear material, radioactive source and radioactive waste: its type, quantity, activity, physical state, category, use;

1.1.5. description of the management and storage rules of keys for storage equipment and rooms;

1.1.6. identification of technology systems, structures and components that are significant to radiological consequences;

1.1.7. detailed layout with the indication of the artificial barriers, physical protection zones, nuclear and radioactive materials to be protected, physical protection systems, structures and components, guards points, patrol routes, central alarm station; layout of the storage room and rooms of application;

1.1.8. identification of potential adversary pathways; and

1.1.9. description of insider tactics;

1.2. data on the organization sub-system of physical protection:

1.2.1. organizational structure of physical protection;

1.2.2. physical protection roles and responsibilities within the organization (mangers, assigned contact person);

1.2.3. description of the rule of guarding, and the applied mechanical and electronic asset protection system;

1.2.4. category, organization structure, tasks and rules of operation of armed security guards (if appropriate), number and date of the ordering resolution;

1.2.5. selection of the members of the internal response force; conditions for them;

1.2.6. physical protection training of the members of the internal response force and the entire organization;

1.2.7. preparation, conduct and evaluation of physical protection exercises; and

1.2.8. arms, tools and vehicle (number, type and description) of the internal response forces;

1.3. rules of access and regress;

1.4. physical protection procedures, quality management data:

1.4.1. documentation system (policy, instructions, procedures); and

1.4.2. accountancy for nuclear materials, radioactive sources and radioactive wastes; description of the rules of use;

1.4.3. rules of access, access rights and the recording of access time points;

1.4.4. security plan of programmable systems;

1.4.5. reporting procedure of events in relation to the operation of the physical protection system;

1.4.6. procedure of investigation of reportable events;

1.4.7. verification of the effectiveness of the physical protection system (exercise programme); and

1.4.8. method, regularity, approval of the revision of the physical protection plan, its storage, name and positions of those having access to the physical protection plan;

1.5. data on the technical sub-system of physical protection:

1.5.1. design and operational specification,, components and their functions;

1.5.2. description of deterrence, detection, delay and response tools; and

1.5.3. maintenance and testing programme;

1.6. external response forces, cooperation with the internal response forces;

1.7. comprehensive evaluation of the physical protection system in reflect to the potential adversary pathways and adversary tactics;

1.8. harmony with plans identified in Section 6 (6);

1.9. plans and procedures of response actions (contingency plan);

1.10. presentation of measures to be implemented if elevated level of physical protection is ordered; and

1.11. special rules with regard to regulatory inspections.”

Annex 4 of the Govt. decree identifies the compulsory content elements of a physical protection plan. This Guideline provides support to the elaboration of certain content elements, to the design process of the physical protection system as well as to the establishment of a particular system.

The general aspects of the preparation of a physical protection plan are discussed in PP-11 Guideline "Preparation and submittal of physical protection plans".

3.1. General considerations

Chapter VI of the Govt. decree regulates the establishment of a concrete physical protection system as follows.

”Technical design of the physical protection system

Section 29

(1) To design the physical protection system the obligant shall:

a) identify the type, amount and activity of the used, stored or transported nuclear material, radioactive source, or of the processed, stored or transported radioactive waste, as well as the systems and components important from the point of view of radiological consequences;

b) determine the respective categories based on Section 4;

c) determine the minimum level of protection based on Section 7;

d) survey the potential adversary pathways, and the potential tactics of insiders; and

e) meet all the requirements determined in Annex 2 and 3 for each potential intrusion routes in relation to all of the physical protection functions specified in Sections 9–12.

(2) The obligant may apply higher level physical protection solutions compared to the minimum required protection, may meet higher level requirements or may apply different physical protection solutions in addition to that required in Annex 2 and 3. The physical protection solutions pertaining to higher level physical protection, or using more than minimum required additional different solutions can be regarded as part of the elevated level physical protection.”

The fundamental principles to be considered during the design are discussed below:

A physical protection system should be based on the defence in depth approach with regard to preventive and protective measures. A physical protection system consists of the appropriate combination of hardware elements (security equipment), procedures (organization and performance of guards), and the design of the facility (the layout).

The physical protection requirements should follow a graded approach with the consideration of the actual threat level, the applicability of the material to build a nuclear weapon or to use it for malicious purposes, the physical and chemical characteristics of the material, as well as the potential consequences in connection with a successful theft of nuclear or other radioactive materials or a sabotage to nuclear or other radioactive materials or facilities.

The physical protection system should be able to effectively and timely eliminate the adversary capabilities defined in the Design Basis Threat.

The prime responsibility for the establishment of a physical protection system providing effective protection against the Design Basis Threat rests with the obligant.

In the case of any facility, the design of the physical protection system should reflect the Design Basis Threat defined to the given facility, with the consideration of the local specifics.

During the design the obligant should strive after the establishment of a response capability that provides effective response to those security events (including sabotage as well as unauthorized removal of nuclear and radioactive materials) that are covered within the Design Basis Threat.

The coordinated operation of components should prevent, under any condition, the successful performance of acts having unacceptable radiological consequences.

The licensee has the exclusive responsibility for the implementation of an effective physical protection system against the design basis threat. The threats beyond the design basis threat and the protection against them, as well as the capabilities of state organizations should also be assessed. In the case of a threat requiring more physical protection than the design basis threat (i.e. larger number of adversaries, better equipped adversaries, more trained adversaries then those defined in the design basis threat, or attempt of sabotage instead of unauthorized removal) the physical protection of the licensee, if justified, should be supported by state forces. The state actions to be implemented in the case of a threat beyond the design basis threat are initiated based on the proposal of the HAEA.

The physical protection system should comply with the legislative requirements, as well as the conditions of the regulatory license and the international recommendations.

The physical protection system should be designed by taking account of the spcifics of the facility, the location where the radioactive materials are in use and the specifics of the use, storage and management of the radioactive materials.

Continuous consultation should be conducted with the licensing authorities during the design of the physical protection system.

3.2. The design process

The design process consists of the following major steps:

1. Identification of the organizational unit that is responsible for the physical protection
2. Detailed assessment of the legal requirements
3. Determination of the minimum level of physical protection to be established
4. Identification of areas that are vital from physical protection point of view
5. Determination of the level of guarding
6. Technical design of the physical protection system
7. Determination of the administrative rules of physical protection
8. Elaboration of the physical protection plan

The steps of the design process are discussed in detail below.

3.2.1. Identification of the organizational unit responsible for physical protection

The persons as well as the organizational unit responsible for physical protection, as well as the obligations of the employees to be taken in order to comply with the physical protection regulations should be clearly defined within the organization of the obligant in its organizational rules and procedures.

3.2.2. *Detailed assessment of the legal requirements*

It is essential in the first phase of the design process that the designers should take account of individual legal requirements to be complied with during the activity of the obligant and their correlations, focusing on their compliance in the mirror of the local specialties.

3.2.3. *Determination of the minimum level of physcial protection*

The Government decree regulates that:

"Section 30

The obligant shall realize the physical protection of the nuclear facility, except for that equipped with a nuclear reactor of less than 1 MW thermal power, interim storage and final repository of radioactive waste, such a way that ensure the effective protection against the design basis threat prescribed for the specific facility by regulatory decision."

In accordance with Section 32/A of the Government decree the determination of the design basis threat shall be requested from the HAEA by the obligant. The application should include:

a) the type, quantity and activity of the used, stored or transported nuclear material, radioactive source, and processed, stored or transported radioactive waste, and the list of systems and components important from the viewpoint of radiological consequences, and
b) physical protection assessment of the suitability of the site.

Detailed guidance on the assessment of the suitability of a new site is provided in Guideline PP-19 (Physical protection related assessment of the site of a nuclear facility or a radioactive waste repository planned to be constructed, as required for the application to be submitted to obtain the design basis threat).

In addition to comply with the stipulations estasblihed in Section 30 of the Government decree the solutions applied in a physical protection system providing adequate protection against the design basis threat shall comply with the minimum requirements as defined in Sections 5-7 of the Government decree for the use, storage and transport of nuclear materials and radioactive sources, and for the processing, storage and transport of radioactive wastes.

In the case of nuclear facilities (with the exemption of those operating a reactor with less than 1 MW thermal power), and radioactive waste interim storage and final disposal facilities the target of a sabotage can be not only nuclear materials, radioactive sources and radioactive wastes, but those systems and components, which have importance from the viewpoint of radiological consequences. Accordingly, Section 7 (6) of the Government decree regulates that:

"(6) Concerning systems, structures and components significant to radiological consequences the level of physical protection shall be identical to that of the used or stored nuclear material and radioactive source, or processed, disposed radioactive waste, determined according to Sections (1)–(5)."

The compliance with the above requirements is verified by the Authority through the authorization of the physical protection plan and the inspection of the functioning of the system established, which are based on the assessment of the functional performance of the physcial protection system in the mirror of the design basis threat defined by the State for nuclear facilities (with the exemption of those operating a reactor with less than 1 MW thermal power), and radioactive waste interim storage and final disposal facilities.

The inspection of the effectiveness of the physical protection system of the facilities should be based on those principles that are described in PP-9 Guideline "Evaluation of the suitability of the physical protection systems established in nuclear facilities (with the exemption of those operating a reactor having less than 1 MW thermal power), and radioactive waste interim storage and final disposal facilities"; additionally, these principles serve as basis for the design of the technical systems of physical protection.

The required level of physical protection should be determined depending on the specific facility, the systems and components having role in the work processes and the category of the material to be protected.

The categorization of materials in storage, use or transport is discussed in detail in PP-1 Guideline "Categorization of nuclear material, radioactive sources and radioactive wastes".

3.2.4. Determination of areas vital to physcial protection

3.2.4.1. Data gathering

The identification of the vital areas should be commenced with the gathering of the following basic data:

credible attack scenarios for the given work process (analyses of the design basis threat), the placement of the nuclear and other radioactive materials, as well as of systems and components performing safety functions within the facility,

transport routes within the site,

service states of the nuclear facility (usually more than one operatiung states can be identified; different systems and components perform the safety functions in different service states),

isotope composition of potential discharges, discharge routes and source terms,

site characteristics (i.e. terrain and meteorological data) and population data (i.e. localization of the population, distribution of the population) needed for the assessment of consequences.

3.2.4.2. Identification of events leading to nuclear emergencies

A nuclear emergency situation can be induced either directly or indirectly. Those systems and components should be identified during the evaluation of the evolution of a nuclear emergency situation, the sabotage to which can lead to nuclear emergencies.

In the case of direct triggering of an emergency situation, those systems and components shall be identified, the damage to which (e.g. explosion) may directly lead to a nuclear emergency. The areas accommodating such systems and components should be identified as vital areas, if the subsequent steps of the analysis credibly justify that the adversary capabilities defined in the design basis threat are sufficient to induce an emergency situation.

Indirect triggering of an emergency situation is, if the sabotage does not directly lead to an emergency situation, but is able to cause a serious accident situation through the gradual degradation of technological properties. Such sabotage acts belong to here, which:

can cause such damage to the technology that cannot be recovered by the safety and support systems,

in addition to damaging the technology, can make a part or the entire safety and support systems inoperable.

Those technology events should be evaluated as indirect triggering of a nuclear emergency situation, which may occur with a certain probability without the sabotage, but also as a result of the sabotage. The methods discussed below can be used to identify such initiating events:

Analysis of safety reports

Such technology events identified in probabilistic safety analyses that are induced by internal technology causes like fire, explosion or earthquake usually may be induced by sabotage as well. Those events should also be taken into account during the physical protection assessment, which are screened from safety analyses due to their very low occurrence probability.

Engineering analyses

The engineering analyses of the use and storage of nuclear and other radioactive materials or systems and components of the nuclear facility may also be applicable to identify such sabotage events that could lead to emergency situations.

Assessment of vital areas identified in the case of other similar work processes

Sabotage events identified in the case of similar work processes and the assessment of the belonging vital areas should also be utilized to a specific work performance. This method is very much hindered by the fact that the physical protection related analyses have very limited publicity.

The initiating events applicable to indirectly trigger emergency situations, as identified by the above methods, should be further analysed in order to assess whether the abilities of the safety and support systems are sufficient to manage the event scenario.

Those initiating events, the consequences of which cannot be made up by the installed safety and support systems, should be taken into account during the identification of vital areas.

If the analysis reveals that the consequences of the given initiating event can be managed by the installed safety and support systems and components, then those safety and/or support systems and components should be identified, the damage to which, together with the initiating event, is needed for the occurrence of a nuclear emergency. These systems and components, including those safety and support systems and components the unavailability of which should be induced by sabotage, should be taken into account during the identification of vital areas.

Consequently, the following event groups should be determined based on the above described analyses made regarding the induction of a nuclear emergency:

a) initiating events leading directly to a nuclear emergency,

b) such initiating events, whose consequences cannot be managed by the installed safety and support systems, thus may indirectly lead to a nuclear emergency,
c) such initiating events, which may lead to a nuclear emergency if certain safety and support systems become simultaneously inoperable.

3.2.4.3. Assessment of initiating events inducing nuclear emergencies based on the DBT

The adversary capabilities needed for sabotage induced occurrence should be associated with each event leading to nuclear emergencies as identified according to Section 3.2.4.2. The adversary capabilities should be compared to those defined in the design basis threat.

Those initiating events should be screened out, which cannot be credibly induced by sabotage based on the adversary capabilities defined in the design basis theat. Similarly, those initiating events should also be screened out, which can be triggered by the adversary capabilities defined in the design basis threat, but which may lead to a nuclear emergency only if certain safety and support systems become inoperable and the adversary capabilities defined in the design basis threat are not sufficient to cause inoperability thereof.

3.2.4.4. Designation of vital areas

Those areas should be identified regarding each event remained after the comparison with the credible adversary capabilities defined in the design basis threat, which accommodate those systems and components relevant for a successful sabotage, as well as those systems and components, whose simultaneous inoperability is also required for the occurrence of a nuclear emergency.

The areas designated accordingly consist of the set of vital areas for the given activity.

3.2.4.5. Designation of physical protection zones

The Government decree requires the designation of a physical protection zone or zones in protected areas established for the physical protection of nuclear material, radioactive sources or radioactive wastes, as follows:

"14. Physical protection zones

Section 14

(1) Following the concept of protection-in-depth, physical protection zone or zones shall be developed within the area established for the physical protection of the nuclear facility, interim store and final repository of radioactive waste, nuclear material, radioactive source and for radioactive waste.

(2) The physical protection zones are as follows:

a) limited access area;

b) protected area;

c) vital area; and

d) inner area.

(3) Protected area shall be designated inside the limited access area; vital area shall be designated inside the protected area; while inner area shall be designated inside vital area.

(4) The physical protection areas shall conform to the physical protection levels determined in Section 7 as specified in paragraphs (5)–(8).

(5) As minimum, level D protection shall be ensured within limited access area. Nuclear material, radioactive source, radioactive waste requiring level D physical protection shall be located within limited access area.

(6) As minimum, level C protection shall be ensured within protected area. Nuclear material, radioactive source, radioactive waste that requires level C physical protection and such systems, structures and components, which are significant to radiological consequences and so require level C protection, shall be located within protected area.

(7) As minimum, level B protection shall be ensured within vital area. Nuclear material, radioactive source, radioactive waste that requires level C physical protection and such systems, structures and components, which are significant from the point of view of radiological consequences and so require level C protection, shall be located within vital area.

(8) Level A protection shall be ensured within inner area. Nuclear material requiring level A physical protection shall be located within inner area.

(9) Movement between two physical protection zones shall be possible only via access points in a controlled manner."

The designation of the physical protection zones is discussed in detail in PP-5 Guideline "Designation of physical protection zones".

Every transport and movement routes of nuclear and other radiative materials should be identified within the planned facility. The movement routes of the materials should be planned in a way that materials should not move from a zone providing the necessary minimum protection to the material to a less protected zone. If this is not applicable, then appropriate complementary measures should ensure the compliance with the requirements established in law as minimum for the relevant protection level.

PP-15 Guideline provides detailed guidance on the compliance with the physical protection requirements to be performed during transports off the site (e.g. transport of fresh fuel to the site, transport of radioactive wastes from the site).

3.2.5. Determination of the level of guard protection

It should be determined whether armed security guards, armed guards or unarmed guards or their certain combination, or just external response forces are required for the performance of the response physical protection function; or what type of personal rules and responsibilities should be established without guards. The required management system of documents, plans and operational rules should be established.

3.2.6. Technical design of the physical protection system based on the DBT

The technical design process includes the identification of a set of adversary pathways with the determination of the potential targets and their accessibility.

3.2.6.1. Identification of sabotage targets

In addition to nuclear materials, radioactive sources and radioactive wastes used and stored in nuclear facilities (with the exemption of those operating reactor having less than 1 MW thermal power) and radioactive waste temporary storage and final disposal facilities, the systems and components significant to radiological consequences are also potential sabotage targets.

The identification process of sabotage targets within the facility is started by a safety analysis, which includes the probabilistic safety analysis of external events and if available other sources that may facilitate to identify the potential accident scenarios leading to significant radiological consequences to the workers, the population and the environment. The accident scenario is a sequence of events started with an initiating event (i.e. human error, a single or multiple failure of components or functions), which leads the facility to an unsafe state despite of the installed safety systems and protective actions.

The probabilistic safety analyses do not consider sabotage to systems and components; thus it should be taken into account that other events may be induced intentionally and lead to significant radiological consequences. For example, the parallel failure of redundant safety systems is not probable in probabilistic safety analyses, but could be triggered by sabotage and thus could result in radiological consequences. All those systems and components, as well as functions should be identified, the loss or serious failure of which caused by an adverse act may lead to severe radiological consequences.

This approach ensures the identification of the most sensitive systems, components and functions, as well as their locations (see Section 3.2.4 as well).

In order to prevent sabotage in a facility, the functions of the physical protection system should work as described in the below table. Additionally, the table includes the applicable technical solutions of each function.

Table 1. Design of Level A physical protection against sabotage to a facility

Function	Goal	Solution	Means
I. Detection	I.1. Immediate detection of instruction to the controlled area	I.1.a. Intrusion detection system or I.1.b. Continuous surveillance	Technical (electronical) or human
	I.2. Monitoring the access to controlled area (insiders!)	I.2.a. Continuous metal detection I.2. b Occasional explosive detection I.2.c. Continuous surveillance	Technical (electronical) or human
	I.3. Immediate assessment of the detected event	I.3.a. CCTV or I.3.b.Personal assessment	Technical or human
	I.4. Immediate alerting of response forces	I.4. Rapid, reliable and alternative communication means (phone, mobile, radio, etc.)	Technical

II. Delay	II.1. Provision of sufficient delay time for the response forces to prevent sabotage	II.1. Provision of at least two-layer delay (e.g. fence, reinforced building, etc.)	2 times technical (Technical barrier)
III. Response	III.1. Provision of sufficient number of human force in due time after the confirmed alert to stop the adversaries	III.1. Application of human force having adequate number, equipment and qualification	Human
IV. Administrative measures	IV.1. Only persons having authorization may enter the protected area	IV.1. Adequate access control system (access controlled by ID card)	Technical or human

3.2.6.2. Potential targets for unauthorized removal

The identification of potential targets of unauthorized removal of nuclear material should be taken into account:

a) The repetitive unauthorized removal of small amount of nuclear material during several occurrences (by insider, subsequent removals),

b) The unauthorized removal of large amount of nuclear material at one occurrence (single theft).

In order to consider both options, the inventory of nuclear and other radioactive materials within the facility as well as of those being in transport should be considered. The inventory list should include the total weight, form, type, location and physical condition of the nuclear materials being used, stored or transported. The targets of unauthorized removal should be identified according to the information and criteria system defined on State level.

As alternative, the target materials should be categorized as Category I, Category II or Category III) according to the categorization provided in Annex 1 of the Government decree. This categorization is based on the suitability of the material for building a nuclear weapon, depending on its type (e.g. plutonium, uranium), isotope composition, physical and chemical form, level of enrichment, weight and the level of radiation.

The physical protection system should apply the following conditions and technical solutions to provide protection against theft and other unauthorized removal.

Table 2. Design of Level A physical protection against theft

Function	Goal	Solution	Means category/group
I. Detection	I.1. Immediate detection of intrusion to the controlled area and the repository	I.1.a. Intrusion detection system or I.1.b. Continuous surveillance	Technical (electronical) or human
	I.2. Immediate detection of the attempt to remove the source	I.2.a. Theft detection system or I.2.b. Continuous surveillance	Technical (electronical) or human
	I.3. Immediate assessment of the detected event	I.3.a. CCTV or I.3.b.Personal assessment	Technical or human
	I.4. Immediate alerting of response forces	I.4. Rapid, reliable and alternative communication means (phone, mobile, radio, etc.)	Technical
	I.5. Ensuring the detection of loss through checks	I.5. Daily check (physical, CCTV, sign of theft detection, etc.)	Technical and/or human
	I.6. Monitoring regress from the controlled area	I.6.a. Continuous metal detection I.6. b Radiation portal I.6.c. Continuous surveillance	Technical (electronical) or human
II. Delay	II.1. Provision of sufficient delay time for the response forces to prevent theft	II.1. Provision of at least two-stage delay route (e.g. locked and fastened container or source	2 times technical (Technical barrier)

		holder, and lockable room)	
III. Response	III.1. Provision of sufficient number of human force in due time after the confirmed alert to prevent theft	III.1. Application of human force having adequate number, equipment and qualification	Human
IV. Administrative measures	IV.1. Only persons having authorization may enter the room containing the source	IV.1. Adequate access control system (access controlled by ID card or controlled access to keys	Technical and human

3.2.6.3. Identification of potential adversary pathways

The potential adversary pathways are the set of routes between the potential intrusion points and the potential targets. The components performing the functions of the physical protection system should be chosen in such a way that ensures effective protection against the Design Basis Threat through each adversary pathway. In order to achieve this objective, it is reasonable to apply technical solutions complying with the highest level of physical protection for each function.

The most important principle is that the delay time of the physical protection system subsequent to detection should be greater than the time period required for the response. The adversary pathway specific effectiveness of the physical protection system should be verified with the methodology described in Guideline PP-9 “Evaluation of the effectiveness of the physical protection of nuclear facilities (with the exemption of those operating reactor having less than 1 MW thermal power), and radioactive waste temporary storage and final disposal facilities”.

The topography and geology characteristics of the site should be taken into account during the assessment. For example such an aspect is whether hidden tunnels or holes exist under the surface, which allow hidden approach to the site or even undetected access to the site, and which require special surveillance and detection instruments.

3.2.6.4. Consideration of the topography of the site

The obligant should take into account the topography conditions of the site during the technical design of the physical protection system, including:

The topology of the site,

The civil engineering structures planned to be constructed on the site (building, fences, roads),

The surrounding transport routes (public road, water and air),

The surrounding pipelines,

Existing and planned pipelines on the site (e.g. sewage discharge line),

Placement of systems and components important from the viewpoint of radiological consequences,

Surrounding hazardous facilities,

Location of surrounding settlements,

Location of the planned water intake plant,

Boundary of the planned protected area,

Planned control and access points,

Planned placement of the guard force.

The topography of the site should be assessed from the viewpoints of view, hidden access, possible construction of external physical barriers (fences, access points), and implementation of area protection.

The extreme meteorological conditions postulated on the proposed site should be assessed, whether they can influence the continuity of physical protection.

The principle of balanced protection does not mean only that the physical protection system should ensure timely detection and delay for each adversary pathway, but it should be independent of the weather, part of the day and the phase of operation. The extreme weather conditions (e.g. fog, snow, extreme high or low temperature) can adversely influence the operation of the applied detectors and may cause a false alarm or reduce their sensitivity to such a level that they would be not capable to detect an intrusion. Consequently, the occurrence probability and frequency of extreme weather conditions determined during preliminary analyses should be taken into account during the selection of equipment.

During the design of the physical protection system and development of physical protection measures it is important to consider the geology and seismology conditions of the site. The geology and seismology conditions can influence the physical protection system of the site. An earthquake may make certain elements of the physical protection system inoperable; thus, the principle of balanced protection and the principle of defence in depth might be compromised.

The population density in the immediate vicinity of the site, and e.g. the resulting traffic is important not only from nuclear safety, but also from nuclear security point of view, since (in harmony with the defence in depth principle) in addition to the designation of protection zones is important within the site, the timely detection of adversaries off the site, before they reach the site has great relevance in increasing the effectiveness of response. The timely detection requires the monitoring of the given off-site area with instruments being appropriate under the existing conditions.

The influence on physical protection of the planned facility of economic activities (hazardous industrial facilities, airports, power plants) conducted in the wider vicinity of the proposed site should be assessed. An accident occurring at these hazardous facilities may negatively influence the physical protection system of the site. An explosion or airplane accident can make a part of the system inoperable for a sooner or longer period of time, and thus both the principle of balanced protection and defence in depth might be compromised. It should be then assessed whether the domino effect of a sabotage committed against a hazardous facility in the vicinity of the site could endanger the planned facility (external domino effect).

The following considerations should be taken into account during the design of the physical protection system to prevent risks resulting from the operation of a hazardous facility being in the vicinity of the site, in order to maintain the necessary physical protection measures operable, reliably available and effectively functioning:

a) The placement of physical protection related civil structures, shooting positions in adequate distance should prevent potential negative effects.

b) Placement of physical protection instrument in a way that the continuous operation of the physical protection system should be sustained event in the case of an accident.

c) The protection of the physical protection instrument (including digital and electronic systems) with such engineering solutions, which should provide adequate protection even in the case of the most severe accident within the design basis.

d) The weapons and armed personnel in the hazardous facility should be considered.

e) An effective physical protection system requires that adequate size of land should be available around the inner zone, in order to allow efficient application of the necessary physical protection measures and systems.

f) Currently, international accepted norm for the minimum land size required for an effective physical protection system does not exist. The regulatory guide of the NRC (Regulatory Guide 4.7 - General Site Suitability Criteria for Nuclear Power Stations) recommends 110 m between the inner zone and the closest zone boundary, above which the size characteristics cannot negatively affect the effective implementation of the physical protection functions (i.e. detection, delay and response).

3.2.7. Determination of administrative rules of physical protection

The content elements and concrete description of procedures regulating the operation of the facility and the performance of the activities should be determined, including especially: access/regress rules, asset protection rules, rules of guarding, rules of transport, accountancy rules, and rules of protection of classified and sensitive information.

A potential information leak of physical protection related data may have negative impacts on the safety of the facility; consequently, the number of people having access to the plans and procedures should be minimized, if appropriate, they should be periodically vetted.

3.2.8. Development of the physical protection plan

The aspects of the development of the physical protection plan are discussed in Guideline PP-11 “Preparation and submittal of physical protection plans”.