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Guidance and considerations for implementation of INFCIRC/225/Rev.3, The Physical Protection of Nuclear Material

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FOREWORD

The Physical Protection of Nuclear Material, INFCIRC/225/Rev.3, provides recommendations for the physical protection of nuclear material against theft in use, storage and transport, whether national or international and whether peaceful or military, and contains provisions relating to the sabotage of nuclear material or facilities. The recommendations contained in INFCIRC/225/Rev.3 detail the elements that should be included in a State's system of physical protection. It also recognizes the adverse health and safety consequences arising from the theft of nuclear material and the sabotage of nuclear material or facilities. Most industrial and developing countries use these recommendations to some extent in the establishment and operation of their physical protection systems.

Physical protection against the theft or unauthorized diversion of nuclear material and against sabotage of nuclear material and facilities by individuals or groups is a matter of national and international concern. Although responsibility for establishing and operating a comprehensive physical protection system for nuclear material and facilities within a State rests entirely with the Government of that State, the IAEA has long contributed recommendations in this area. Discussions with experts in this field indicate that the meaning and intent of INFCIRC/225/Rev.3 is not always well understood by regulators and that additional guidance for implementing those portions of the recommendations which are open to varied interpretations would be quite useful.

The need for Government authorities to give nuclear operators (licensees) and applicants specific guidance on how to implement national requirements in a manner consistent with the recommendations in INFCIRC/225/Rev.3 was raised by several representatives of eastern European countries at the International Conference on Physical Protection held in St. Petersburg in April 1995. Although INFCIRC/225/Rev.3 provides recommendations for protecting materials and facilities from theft or sabotage, it does not provide in-depth details for these recommendations. How these recommendations are implemented can have significant implications on the effectiveness of systems and on cost.

In June 1996, the IAEA convened a consultants meeting to consider this matter. The primary objective of this meeting was to identify and prioritize those recommendations for which guidance is most needed. During the initial phase of the meeting, each participant provided their views on the need for such guidance to implement INFCIRC/225/Rev.3 based on their experience. The focus of the meeting was on developing guidance to assist in implementing INFCIRC/225/Rev.3, not on making changes to that document.

This report is the result of continuing discussions and drafts over a period of nine months. The intent of this guidance is to provide a broader basis for relevant State organizations to prescribe appropriate requirements for the use of nuclear materials which are compatible with accepted international practice.

EDITORIAL NOTE

In preparing this publication for press, staff of the IAEA have made up the pages from the original manuscript(s). The views expressed do not necessarily reflect those of the governments of the nominating Member States or of the nominating organizations.

Throughout the text names of Member States are retained as they were when the text was compiled.

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1. INTRODUCTION

101. In order to promote uniformly high standards for the physical protection of nuclear material, the IAEA provides recommendations in INFCIRC/225/Rev.3, The Physical Protection of Nuclear Material, on the protection of these materials in use, transit and storage. This following guidance is an effort to assist in assuring that the recommendations of INFCIRC/225/Rev.3 are applied uniformly and rigorously throughout the international nuclear community. The text of INFCIRC/225/Rev.3 is provided in the appendix.

102. Section 2, Objectives and Elements of States' Systems for Physical Protection, describes in more detail the recommendations for the establishment of a State system of physical protection to protect against the theft of nuclear material or the sabotage of nuclear material or facilities. Section 3, Categorization of Nuclear Material Activities, provides some additional guidance on how this system of categorization can best be applied and utilized. Section 4, Physical Protection Concepts, provides a clearer description of the principles of physical protection used in the field and which underlie INFCIRC/225/Rev.3. These explanations are contained in three subheadings which emphasize the three different applications of these physical protection principles and concepts, i.e. (a) theft of nuclear material; (b) sabotage of nuclear facilities; and (c) transit of nuclear material. Because of the prominent role of States in the international transfer of nuclear material, the section on transit additionally highlights the part States play in regulating physical protection aspects of transportation and notes obligations placed upon States party to the Convention on the Physical Protection of Nuclear Material (INFCIRC/274/Rev.1).

103. In order to clarify the relationship between INFCIRC/225/Rev.3 and this guidance, the relevant paragraph number(s) in INFCIRC/225/Rev.3 has been given in brackets at appropriate places throughout the report.

2. OBJECTIVES AND ELEMENTS OF STATES' SYSTEMS FOR PHYSICAL PROTECTION

INTRODUCTION

201. Because of differences in States' perceived threats, culture, legal systems and history, there will be reasonable and necessary variations in physical protection practices between different countries. The time taken for State response forces to arrive on the scene and their degree of responsibility for dealing with an attack against a nuclear facility or nuclear material in transport will also have great impact on physical protection practices in different countries. Therefore, there will be differences in the implementation of international guidance contained in The Physical Protection of Nuclear Material (INFCIRC/225/Rev.3), obligations required in the Convention on Physical Protection of Nuclear Material and commitments made by States under the Nuclear Suppliers Group Guidelines (INFCIRC/254/Rev.2).

202. For these reasons, and because each Member State is ultimately responsible for the physical protection of nuclear materials and facilities on its own territory [3.2.1.1], it is neither realistic nor proper to expect regulatory organizations to require the identical implementation of the provisions of INFCIRC/225/Rev.3 as in other States.

203. However, it is in the interest of all States to require the implementation of physical protection systems that are as compatible as possible with the recommendations of INFCIRC/225/Rev.3, which should be considered as a baseline for any physical protection system. This section provides supplementary guidance to aid in a better understanding of the provisions of INFCIRC/225/Rev.3 with respect to the following activities of State authorities:

- Governmental Organization and Nuclear Physical Protection Legislation
- Role and Responsibility of the Competent Authority
- Regulations and Guides
- Licensing Process
- Integration and Participation of Other Organizations
- Assessment of the Threat
- Review and Assessment
- Inspection and Enforcement
- Development of Emergency Plans.

204. The IAEA has no responsibility for the supervision, control or implementation of a State's physical protection system and assistance will be provided only when so requested by a State [2.2]. Assistance in the form of the International Physical Protection Advisory Service (IPPAS) is available to States on request to the IAEA. The role of IPPAS missions is to provide advice and assistance to Member States to help strengthen and enhance the effectiveness of the State physical protection system through interpreting and applying INFCIRC/225/Rev.3 recommendations to the needs of requesting States. Further details of this service can be obtained from the IAEA.

GOVERNMENTAL ORGANIZATION AND NUCLEAR PHYSICAL PROTECTION LEGISLATION

205. The physical protection of nuclear material and facilities within the Member State rests on the fundamental basis of government organization and legislation. Governments need to discharge their responsibilities to regulate the physical protection of nuclear activities in order

to protect nuclear material from theft and public health and safety from undue radiological risk as a result of sabotage. The Member State therefore needs to have an adequate and supportive governmental organization and statutory legislation. The legislation should provide for a competent authority [3.2.1.3], which needs to have sufficient staff, funding and legal powers to perform its duties and the freedom to do so without undue interference. The government should also encourage international exchanges aimed at improving physical protection and seek to minimize any impediments to such exchanges.

Objectives

206. The government or state legislature of the Member State should establish a system for the physical protection of nuclear material and facilities within which the physical protection competent authority can exist and operate effectively, has adequate legal powers and sufficient funds for its activities, and can pursue its regulatory task without undue interference.

207. The government should ensure an adequate hierarchy of authority and responsibility to enable the nuclear competent authority to fulfil its physical protection functions. In particular, the competent authority should be separated in the governmental organization and be independent from the bodies responsible for developing, promoting or operating nuclear facilities.

ROLE AND RESPONSIBILITY OF THE COMPETENT AUTHORITY

208. The primary objectives of the physical protection competent authority are to ensure that nuclear material is protected from theft and public health and safety is protected from possible adverse effects arising from the unauthorized removal of nuclear material or the consequences arising from acts of sabotage of nuclear material or a nuclear facility, including nuclear material in transit. To fulfil this objective the competent authority needs:

(a) To establish a system to define and maintain acceptable levels of physical protection to counter the defined threat; to monitor the licensees to ensure that they fulfil their physical protection responsibilities; to evaluate the implemented physical protection systems and to ensure that the licensees provide appropriate levels of physical protection;

(b) To have a clearly defined legal status and independence from the applicant(s)/licensee(s) and to have the legal authority to enable it to perform its responsibilities and functions effectively;

(c) To establish clear regulatory objectives, and to understand how these are achieved and how they compare with international standards and good practices. The competent authority will also need to establish a system for effective interaction, liaison and cooperation with other nuclear regulatory bodies and with international bodies and organizations.

Objectives

209. All staff of the competent authority should clearly understand the legal authority which provides the basis for their activities, and how this governs their activities in regulatory development, assessment, licensing, inspection, enforcement, planning, etc.

210. In exercising their authority in matters of physical protection, all staff of the competent authority should understand their organization's regulatory role and objectives, how these are achieved and how they compare with international standards and practices.

211. The competent authority should establish any necessary arrangements for coordination with other regulatory organizations and those responsible for national security, for the provision of external (off-site) response forces and for other affiliated agencies to ensure an integrated approach to physical protection.

REGULATIONS AND GUIDES

212. The competent authority needs to establish a clear framework of requirements for those nuclear activities permitted by the State. The requirements with which applicant(s)/licensee(s) should comply should be consistent with INFCIRC/225/Rev.3 and provide guidance amplifying how regulatory obligations may be fulfilled [3.2.1.2/3.2.4.1/3.2.5.1]. Comprehensive regulations and guides are not obligatory for all situations. The competent authority may consider it appropriate to develop them in step with the development of the national nuclear programme.

213. The competent authority should endeavour to ensure that regulations, codes, guides etc. explicitly address the possibilities for unauthorized removal of nuclear material or for sabotage of nuclear material or facilities as the main reason for their production.

Objectives

214. The competent authority should establish a clear policy regarding the approach taken to developing and producing regulations and guides. This policy should be developed to suit both the licensing system and the system of government in the Member State.

215. The competent authority should ensure that an applicant/licensee is made aware of and held accountable to regulations and guides that are applicable.

LICENSING PROCESS

216. While responsibility for physical protection rests with each applicant/licensee, control over physical protection by the competent authority, at all stages of the life of nuclear installations and during transportation, is exercised primarily through governmental licence(s) [3.2.2.1]. Hence, a primary task of the competent authority is to consider whether to approve (or not) applications for new licences and renewals or amendments to existing licences. The licence itself should be an official document authorizing an activity or activities and approving the licensee's physical protection plan describing how it will implement its physical protection programme.

217. Licensing needs to be kept as a live issue throughout all stages of the life of a nuclear facility. The licence may be changed or modified as circumstances dictate but always by and under the control of the competent authority [3.4.1].

Objectives

218. The competent authority should ensure that any licence issued is:

(a) In compliance with the relevant national legislation;

(b) Accurately specifies the activity or activities to be licensed; and
(c) Clearly identifies any constraints regarding the activities, i.e. requirements, conditions or time limits.

219. The competent authority should ensure that it has received and assessed adequate documentary evidence from each applicant/licensee regarding the physical protection plan for activity or activities to be licensed before the licence is issued. Assessment may be supported by a review of physical protection measures employed on the ground.

220. Any change to a licence should be controlled by the competent authority to ensure that the change receives appropriate levels of consideration and assessment before being implemented.

INTEGRATION AND PARTICIPATION OF OTHER ORGANIZATIONS

221. The State System of Physical Protection will encompass not only physical protection regulations and the associated competent authorities but also the participation of other State organizations, agencies and official bodies. Their participation in the system will be essential to ensure that:

(a) The threat is assessed, kept up to date and communicated to those regulatory bodies and authorities responsible for the arrangements for the physical protection of nuclear materials and facilities;

(b) Response forces with the necessary legal and constitutional authority are made available to respond to incidents which could threaten nuclear material at facilities or in transit and that these response forces have prepared the necessary contingency plans and are exercised in their role; and

(c) That the responsibility for criminal investigation and recovery of nuclear materials is clear.

Objectives

222. The State should establish a clear policy and procedures to ensure that State bodies, agencies and other official organizations provide the necessary support to protect nuclear materials from theft and to counter sabotage of nuclear materials and facilities.

ASSESSMENT OF THE THREAT

223. The competent authority should define the basis for the level of physical protection which will be required to protect against theft of nuclear material and sabotage at nuclear facilities under its responsibility and during nuclear material transportation. This is accomplished by making an assessment of the intentions and capabilities of criminal/terrorist groups known to pose a threat to national security or a serious threat to law and order in the country [3.1.2]. Measures to counter the assessed capabilities should then be incorporated into physical protection standards and regulatory requirements, due consideration being given to a conceivable aggravation of the threat situation in the future.

224. This assessment should take into account the possibility of these groups being assisted by or formed of individual(s) who have authorised access to the facilities, the tactics employed

by these groups, their technical competence, size and the equipment available to them for use in any attack. The assessment should be reviewed on a regular basis and the implications of any change taken into account in reviewing the adequacy of existing physical protection standards and regulatory requirements.

Objectives

225. A national authority should clearly define and review on a regular basis the potential threat(s) to nuclear facilities and nuclear material in transit in sufficient detail to allow regulators, physical protection system designers and nuclear facility licensees to develop adequate systems for protecting nuclear materials from theft and sabotage, both when in use and storage at facilities and when in transit.

REVIEW AND ASSESSMENT

226. It is the responsibility of the competent authority to confirm that the physical protection arrangements at any proposed nuclear facility, at all stages of its life, and during the transport of nuclear material meets the standards contained in national regulations. To fulfil this requirement the competent authority needs to acquire a complete understanding of the physical protection approach, design and quality assurance program of the facilities, and the proposed operating principles of the applicant(s)/licensee(s). The competent authority will also need to perform a thorough review of these issues to ensure that they comply with the competent authority's own physical protection objectives [3.5.1]. Consistent application of regulations at similar nuclear facilities is important so that one facility is not viewed as being more vulnerable than another.

227. Following suitable review, the competent authority may require modifications to be implemented in physical protection programmes where necessary.

228. The competent authority should establish a system for reviewing, at the appropriate level, all of its licensing decisions.

Objectives

229. The competent authority should establish a regime to ensure that review and assessment decisions are followed up by subsequent supervisory, inspection and evaluation activities to ensure that the decisions are appropriate and implemented effectively.

INSPECTION AND ENFORCEMENT

230. An inspection and enforcement regime should be established by the competent authority that complements its review and assessment activities [3.5.1/5.2.21/5.3.15/5.4.6]. This regime should be able to satisfy the competent authority that each licensee complies with national legislation and maintains the nuclear facility(s), throughout all stages of its life, and/or carries out the transport of nuclear material in conformity with the physical protection system approved by the competent authority and that the licensee is fulfilling the conditions set out in the licence. The competent authority will require correction of any situation where there is not proper compliance with the licence through the application of appropriate enforcement action(s) [3.2.1.5].

Objectives

231. The competent authority should establish a structured inspection and enforcement system for evaluating and systematically following up all inspection findings and an enforcement system to ensure that all aspects of legislation, including the licence, are fully complied with by each licensee, that this compliance is verifiable and that experience gained is fed back to the licensee.

232. The competent authority should ensure that the responsible persons in an licensee's organizations are qualified to discharge their physical protection functions at a licensed nuclear facility and for transports of nuclear material.

233. The competent authority should ensure that the required quality and performance are achieved by each licensee at all times.

DEVELOPMENT OF EMERGENCY PLANS

234. An emergency plan should be established at all facilities and activities where physical protection measures are required by the competent authority. This plan should provide guidance to licensee personnel for accomplishing specific defined objectives in the event of threats, thefts or sabotage relating to licensed activities involving nuclear material or nuclear facilities [5.2.19/5.3.13/5.4.5].

235. The goals of the emergency plan for responding to threats, thefts and sabotage are:

(a) To identify a range of credible emergency situations that may occur;

(b) To organize the response effort at the licensee/operator level;

(c) To identify predetermined, structured responses by the licensee/operator to an emergency situation;

(d) To ensure the integration of the licensee/operator response with other entities; and

(e) To achieve a measurable performance in response capability.

236. Licensee/operator emergency planning should result in organizing the licensee/operator's resources in such a way that possible emergency events will be identified with preplanned responses, the various emergency responders will be identified, their responsibilities specified and the responses coordinated in a timely manner. Planning should take account of the need for prompt and controlled access to facilities by off-site emergency responders. It is also important to note that the licensee/operator emergency plan is intended to be complimentary to other emergency plans in place for responding to other safety-related radiological incidents or accidents. Periodic response exercises should be conducted with emergency responders to demonstrate effectiveness and to provide familiarization and training.

Objectives

237. The competent authority should require each licensee/operator of a facility where physical protection measures are required to develop and implement an emergency plan which should, as a minimum, contain:

(a) The criteria for initiation and termination of responses to security emergencies together with the specific decisions, actions and supporting information needed to bring about such responses;

(b) An identification of the data, criteria, procedures and mechanisms affecting emergency planning that are specific to the facility or means of transportation involved and are necessary to efficiently implement the emergency plan; and

(c) A designation of the individual, group or organization responsible for each decision and action associated with specific responses to security emergencies.

238. The competent authority should require that response exercises for the nuclear activity are conducted with the off-site emergency responders frequently enough to ensure facility familiarization and appropriate integration with licensee/operator response.

3. CATEGORIZATION OF NUCLEAR MATERIAL ACTIVITIES

301. Paragraph 3.2.3.1 of INFCIRC/225/Rev.3 concisely states that the rationale for the categorization of nuclear material is to provide a basis to establish "an appropriate relationship between the material concerned and the protective measures." The State should define the categorization of nuclear material to ensure that appropriate protection measures are implemented. Since implementation of physical protection measures requires extensive resources, State regulators need a coherent basis for the measures being required of facility operators. However, paragraph 3.2.3.1 and other portions of INFCIRC/225/Rev.3 provide minimal explanation of how the recommendations are to be carried out. This section provides additional guidance for understanding the intended process of material categorization.

302. INFCIRC/225/Rev.3 notes that "physical protection measures should be implemented for nuclear facilities which may be subject to sabotage regardless of the categorization of nuclear materials" [3.2.5.2]. No relationship is intended for the categorization levels in the table of INFCIRC/225/Rev.3 and the facilities and activities that may be subject to sabotage. The table is related only to the theft scenario. However, a regulatory organization can utilize all or portions of the requirements provided in Section 5 of INFCIRC/225/Rev.3 as a basis for physical protection measures against sabotage for such facilities or activities (see paragraph 429 below).

303. In using the Table: Categorization of Nuclear Material, the original fissile content of material is the approach which is used by many States to determine the appropriate level of physical protection prior to irradiation of the material. For instance, 15 kg of research reactor fuel comprising uranium enriched to 20% = 3 kg U-235 fissile weight for categorization purposes. Similarly, 10 kg of uranium fuel enriched to 90% = 9 kg U-235 fissile weight.

304. The table indicates that "fuel which by virtue of its original fissile material content is classified as Category I or II before irradiation may be reduced one category level while the radiation level from the fuel exceeds 1 Gy/h (100 rad/h) at one meter unshielded." The method of making such measurements has not been provided in INFCIRC/225/Rev.3. A determination of the radiation level can be made by measurement in air or water or by calculational means. It is preferable to estimate the absorbed dose rate on the basis of direct measurements in water (spent fuel pond) and then calculate the radiation level at one meter unshielded. Where possible, measurements should be made on individual fuel elements. A constraint on this type of measurement is the necessity of moving or lifting elements in order to isolate individual elements from neighbouring spent fuel. However, if that is not possible, measurements of a number of fuel elements would be satisfactory. In all cases, measurements should be made by means of underwater probe (e.g. shielded G-M counter) at a certain distance from the vertical axis of the item and at the mid point at several positions around a fuel element or a fuel assembly. Then recalculation for one meter distance and air absorber should be performed.

305. Where calculations are performed instead of actual measurements (e.g. by means of Monte Carlo code), the fuel structure, isotopic composition, initial fissile content, burn-up and cooling time should be taken into account to calculate the absorbed dose rate.

306. Nuclear material in a form that is no longer usable for any nuclear activity, minimizes environmental dispersal and is practicably irrecoverable (e.g. encapsulated, immobilised or vitrified wastes) can be protected with prudent management practices, i.e., practices which require no special physical protection measures except for normal industrial security or safety

practices based on the material's level of concern, attractiveness and radiological consequences [3.2.3.1].

307. In some facilities nuclear material can be distributed in several buildings. When this is the case, it is suggested that if there are several buildings within a small area, the total amount of nuclear material should be added together to determine the protective arrangements which should be applied to these buildings as required by the categorization table [4.2.2].

4. PHYSICAL PROTECTION CONCEPTS

GENERAL APPROACH

401. A system may be defined as a collection of components or elements designed to achieve an objective. The designer of any system should have the system's ultimate objective in mind. The ultimate objective of a nuclear physical protection system is to prevent the theft of nuclear materials or sabotage of nuclear materials or facilities.

402. Theft and sabotage can be prevented in two ways: by deterring threats or by defeating them should groups or individuals attempt to steal nuclear materials or sabotage nuclear facilities. Deterrence is achieved by implementing a physical protection system that criminals/terrorists perceive as too difficult to defeat; the physical protection measures make the protected nuclear material or facility an unattractive target.

403. In Section 5 of INFCIRC/225 Rev.3, the stated goals of physical protection against theft and sabotage are combined without a clear distinction made between the protective objectives of each. While protection against both theft and sabotage requires consideration of a number of factors (including the threat, the potential consequences of malevolent activities involving nuclear materials, the facility layout, hardware, on-site guard force size, training and procedures and the off-site response force size, timeliness and capabilities), the protection philosophy differs. For theft, the primary objective is to protect against unauthorised individuals obtaining access to nuclear material and removing it from the facility. For sabotage the primary objective is to prevent attackers from even gaining access to the material or vital equipment. While similar concepts are employed for detection and assessment of a potential intrusion, the use of delay features and emergency procedures, including the response force philosophy, can be quite different. For protection against theft, the use of penetration delay in barriers securing the material provides time for the on-site guard force to call for assistance, and contain or delay the attackers until the arrival of the off-site response force. For protection against sabotage, the use of delay features is needed at the time of intrusion, or sufficient distance to the target is needed, to allow time for the on-site guard force or off-site response force to interpose themselves between the attackers and the material or vital equipment in order to preclude access to the potential sabotage targets.

404. In order for a physical protection system to counter a threat to steal nuclear material or sabotage nuclear material or activities, it should perform the following primary functions:

- Deter
- Detect
- Assess
- Delay
- Respond.

405. Detection is the discovery of an attempted or actual intrusion which could have the objective of stealing or sabotaging nuclear material or facilities. Detection can be accomplished by sensors or personal observation, for example by an employee or guard. In a narrow sense, detection is a physical phenomenon, i.e., a sensor or person determines that something is wrong at a given location. To be useful, detection needs to be coupled with an assessment of what has been detected. Did a sensor detect an animal or a person? Was the sensor triggered by weather conditions to give a nuisance alarm? Is the person seen (detected)

by an entrance guard assessed as someone authorized to enter the facility, or does the individual pose a threat to the facility?

406. Sensors are an important part of a detection system. By activating alarms they provide an indication of an activity that requires assessment. The ultimate goal of any detection system is to maximize the probability of detection while minimizing the rate of nuisance alarms. This can be accomplished by providing a continuous line of detection using multiple and complementary sensors.

407. Assessment is frequently provided through closed circuit television (CCTV) coverage of each sensor sector, complemented by visual checks from guards, either static or mobile. In addition to determining the cause of a detection alarm, assessment should provide specific details such as what, who, where, when, and how many. This information is vital if the response force is to react effectively.

408. A communication, alarm and CCTV display centre, frequently called a central alarm station (CAS), is required to collate detection and assessment information and communicate it to response forces. A reliable communications system between the CAS and the guard force and off-site response force is an essential part of a physical protection system. The CAS should be hardened, i.e., constructed and located in such a manner so as to allow it to continue operating at all times, even when under attack.

409. Delay is the third function of a physical protection system. Since it is usually not possible to maintain a sufficient number of guards at all points to provide immediate protection against all types of threats, some form of delay is needed to slow down intruders in order to provide the guards time to react after the intrusion has been detected and to call for assistance. This delay can be achieved by such measures as barriers, fences, walls, and locks. Delay should slow the intruders sufficiently to provide time for the guards to interpose themselves between the attacker and his target and using force, including weapons where guards are armed, to stop or delay the attack before the intruders can accomplish their objective.

410. Guards and the off-site response force need to respond more rapidly to prevent sabotage than to prevent theft. They may be able to prevent an attacker from removing nuclear material from a site even though he is able to access the material; but to prevent sabotage, the guards and/or the response force needs to stop the attacker before he can access the nuclear material or a vital piece of equipment that could be sabotaged to cause a radiological release. The speed with which knowledgeable attackers could attack a facility and damage critical equipment could negate the effectiveness of an off-site response for protection against sabotage. Delay barriers or mechanisms may not provide sufficient delay time for an effective off-site response. Therefore, guards should be self-sufficient during the critical early stages of an attack. If a facility requires assistance from an off-site response force for protection, a "time-line" analysis should be conducted to determine if the response force could provide a timely response. Moreover, periodic exercises which include the off-site response force could be conducted to establish the effectiveness of such a response and be utilized as a tool to develop, correct or modify facility defensive strategies.

411. Guards and off-site response forces need to survive in order to prevent an intruder from accomplishing his objective. Many factors contribute to guard and off-site response force capability and survival including tactical planning, weapons, training and exercises. Drills should be conducted to demonstrate their effectiveness and improve response capabilities.

Consideration may be given to the strategic placement of defensive barriers to provide cover for the guards and response force attempting to interdict an attack.

412. An effective physical protection system has several specific characteristics. Besides being compatible with a facility's safety system, the physical protection system should provide:

- Defence in depth;
- Minimum consequence of component failure;
- Balanced protection; and
- Graded protection in accordance with the significance or potential radiological consequences of the material.

413. Defence in depth means that for an attacker to accomplish his objective, he should be required to avoid or defeat a number of different protective devices in sequence. For example, an attacker might have to penetrate two or more separate barriers before gaining access to a reactor control room. From a facility standpoint, defence in depth eliminates dependency on one barrier or system (which might fail at the critical period) to counter an attack. The effect produced on an attacker by a physical protection system that provides defence in depth will be to:

- Increase uncertainty about the physical protection system (and thus possibly deter an attack);
- Require more extensive preparation prior to attacking the facility (with the associated greater risk of these preparations being discovered before the attack);
- Require different techniques and different tools to penetrate barriers; and
- Create additional steps that could cause the attacker to fail or abort his attack.

414. Minimum consequence of component failure is an important physical protection system characteristic because it is unlikely that a complex system will ever be developed and operated that does not experience some component failure during its lifetime. Causes of component failure in a physical protection system can range from environmental factors to tampering by an attacker. It is important that contingency plans are provided so that the system can continue to operate effectively in the event of component failure. Redundant equipment that takes over automatically is highly desirable in some cases. An example is an emergency power supply that activates automatically should the primary power source fail.

415. Balanced protection implies that no matter how an attacker attempts to accomplish his objective, he will encounter effective elements of the physical protection system. For example the building fabric that surrounds a reactor control room may consist of:

- Walls, floors, and ceilings of several types;
- Doors of several types; equipment hatches in floors and ceilings; and
- Heating, ventilating, and air conditioning openings with various types of grilles.

416. For a completely balanced system, the minimum time to penetrate each of these barriers would be equal, and the minimal probability of detecting penetration of each of these barriers should be equal. However, complete balance is probably not possible or necessarily desirable. Certain elements, such as walls, may be extremely resistant to penetration, not because of physical protection requirements, but because of structural or safety requirements. The penetration delay provided by doors, hatches, and grilles may be considerably less than that provided by the walls and yet still be adequate if designed as a barrier to provide an

appropriate amount of delay. The delay element is extremely important when developing a defensive strategy for sabotage contingencies. Although there are very few systems which can stop or sufficiently delay a well-equipped attacker, strategically placed delay barriers can provide sufficient time for response force arrival and successful interdiction.

417. There is no advantage in over designing by, for example, installing a costly vault door that would take several minutes to penetrate with explosives, if the wall were corrugated asbestos which could be penetrated in a few seconds with hand tools. Both the walls and the doors should provide the appropriate level of protection.

418. Features designed to protect against one form of threat should not be eliminated because they overprotect against another threat. The objective should be to provide adequate protection against all threats on all possible paths and to maintain a balance with other considerations, such as cost, safety, and structural integrity.

REQUIREMENTS FOR PHYSICAL PROTECTION OF NUCLEAR MATERIAL IN USE AND STORAGE

419. The primary objective in protecting against theft is to prevent an attacker from gaining access to the nuclear material and removing it from an authorised area. To aid in limiting access to the nuclear material, INFCIRC/225/Rev.3 recognises the need for defence in depth and prescribes several protective layers: Protected Area, Inner Area, and "strong room". The designation of a Protected Area around buildings containing Category I and II quantities of nuclear material accomplishes a number of objectives. The Protected Area barrier should normally consist of a physical barrier which demarcates the area of protective concern, limits access to the buildings, and provides some delay to any attempted intrusion. The Protected Area barrier could be a fence, a separate solid wall, a building wall or a combination of barriers, with openings secured with material of sufficient strength that the integrity of the barrier is not lessened by any opening. Access into the Protected Area should be controlled and limited to only those with a valid need whose trustworthiness has been predetermined [5.3.3]. Consideration should be preferably given to searching individuals and vehicles prior to their entering the Protected Area to ensure that they are not introducing any items that could be used to commit or assist theft, particularly if an Inner Area is located within the Protected Area. The search should detect items that could be concealed in the vehicle or on the body, as well as hand carried items. Vehicles, individuals, or any items exiting the Protected Area should be searched to ensure that nuclear material is not being removed from the area [5.2.5/5.3.5/5.3.6]. (It is preferable that means used to detect the unauthorised removal of nuclear material are located as close as possible to where the nuclear material is held, for example at the Inner Area boundary, as this is usually more effective than at a more outer boundary). Since vehicles are very difficult to search and could aid an attacker in quickly escaping with material from the facility, the objective should be to prohibit, escort or tightly control their access in the Protected Area [5.2.6/5.3.7].

420. Intrusion detection and assessment should be conducted at the Protected Area barrier with the objective of detecting any intrusion by stealth or force with a high degree of confidence so that the on-site guards and/or off-site response force can be notified and emergency procedures implemented as soon as possible [5.2.12/5.3.12]. The objective of the intrusion detection system should be to detect any intruder going over, through or under the Protected Area barrier. Actions should be taken to identify and correct any conditions that contribute to false/nuisance alarms of the intrusion detection system. Assessment of an intrusion detection alarm needs to be done promptly so as to determine if an actual intrusion

has occurred. The assessment process is aided by having clear areas around the intrusion detection equipment and on either side of the Protected Area barrier so as to provide an unobstructed view of the area. Adequate illumination is important to allow observation and assessment after dark by patrolling guards and/or those operating CCTV monitors. Care should be taken when designating building walls as Protected Area barriers so that there is an appropriate area outside the building wall for intrusion detection and assessment.

421. The objective of Inner Areas is to provide another layer of access control, detection and delay around Category I quantities of nuclear material. Inner Areas should provide additional penetration delay in order to prevent the area being penetrated before the arrival of an effective response. Any openings should be of sufficient strength such that the integrity of the wall is not lessened by the opening beyond what is needed to provide appropriate delay. The aim should be to minimize the access points to one. Whenever the Inner Area is unoccupied the access door(s) should be locked and alarmed. If an emergency exit is necessary, then it should always be alarmed [5.2.13]. CCTV cameras should preferably cover the exterior of these doors in order to assist assessment of any alarm condition and enable monitoring of the area when the Inner Area is occupied.

422. Access to the Inner Area should be limited to only those individuals who have a legitimate need for access and whose trustworthiness has been predetermined [5.2.3]. Individuals granted access to the Protected or Inner Area should be positively identified and should meet entry criteria before being badged or permitted entry. Control measures should be in place to initiate response measures to deny unauthorized entry. The objective of the badge should be to provide an easy and quick means to distinguish whether an individual is an employee or a visitor, whether they are authorized unescorted access, and to what areas access has been approved. Badges should be visibly displayed on all individuals at all times. Picture badges for employees aid in positive identification and different types of badges aid in distinguishing different levels of access. Visitor badges should clearly distinguish visitors from employees and indicate that an escort is required. Badges should be difficult to counterfeit and should preferably remain on-site at all times [5.2.4].

423. Visitor-escort ratios should be limited to that which enables the escort to exercise positive control over the location and actions of the visitors. To protect against the insider threat, whenever the Inner Area is occupied the area should be under constant surveillance [5.2.7]. The objective should be that activities of any authorised employee are always monitored by at least one other knowledgeable, authorised employee in order that unauthorized activities on the part of one can be immediately detected and reported.

424. Category I quantities of nuclear material should be stored within a "strong room" when not undergoing processing [5.2.14]. The objective of the "strong room" should be to provide sufficient penetration delay to prevent entry by any one act in a forced entry attempt, except if such an act would both destroy the barrier and render the nuclear material inside incapable of being removed, or delay entry long enough for the arrival of a response force capable of preventing the theft. When nuclear material is undergoing processing it is recommended that consideration be given to keeping the material in locked compartments or locked/sealed process equipment except when personally attended. When the "strong rooms" are not occupied, it is recommended that they be locked and protected with an intrusion detection system (preferably supplemented by CCTV) which will alarm upon entry of individuals anywhere into the area, and upon movement of an individual within the area. When material processing areas are not occupied it is recommended that they be patrolled in a random manner

by guards or be protected with an interior intrusion detection system (preferably supplemented by CCTV).

425. All keys, key-cards, combinations and related equipment used to control access to a Protected Area, Inner Area or "strong room" should be protected and controlled on-site to prevent unauthorized use and to reduce the possibility of system compromise. A written record should be kept of all individuals having access to or possession of such items [5.2.10/ 5.3.10]. Whenever there is evidence that a key, key-card, combination or related equipment has been compromised, it should be changed. Upon termination of employment of any employee with access to any key-card, combination or related equipment, it is recommended that it be changed.

426. Procedures should be established and strictly followed for the transfer of nuclear material. Employees should always be alert to any unauthorized activities involving nuclear material and immediately report the information to appropriate authorities [5.2.9/5.3.9]. Nuclear material should be protected while it is being transferred between Inner Areas at a level that would provide comparable protection to that provided within an Inner Area. Movement of material between Protected Areas should be protected in compliance with requirements for nuclear material in transit taking into consideration such factors as distance, protective arrangements provided for the facility as a whole and the threat environment [5.2.11/5.3.11].

427. A guard force should be established which provides 24-hour coverage and is trained to perform security related functions such as controlling access, searching, patrolling, detecting and responding to indications of theft [5.2.15].

REQUIREMENTS FOR PHYSICAL PROTECTION AGAINST SABOTAGE AT FACILITIES

428. Although there are strong similarities between the approach to physical protection against theft and sabotage, there are also some significant differences. Therefore, the protection measures against sabotage may differ from those against theft. In particular, the attractiveness of nuclear material as a target for each of these scenarios can be very different. The protection of nuclear material from theft is enhanced by high radiation levels. However, these identical high levels of radioactivity increase the attractiveness of the same material for sabotage.

429. States should define a hazardous level of radiological consequences resulting from an act of sabotage for which physical protection measures above normal industrial security are needed. Existing national nuclear safety standards and accident scenarios are good references in defining this level. Depending on the potential radiological impact to the public from a malevolent release, the State can require that physical protection measures to protect against theft of Category I, II or III standards be applied at the facility without regard to that which would normally be required for the nuclear material held if protected in accordance with the categorization table. The extent of the physical protection measures required should correspond to the level of possible off-site impact and relative risk of radiological consequences [3.2.5.3].

430. The layout and design of the facility should be taken into account in designing the physical protection system to provide protection against radiological sabotage [4.3.2]. Areas containing any equipment, systems or devices, the failure or destruction of which, alone or in combination, could lead to a radiological release which could directly or indirectly endanger

public health and safety need to be identified as Vital Areas [5.1.3]. Equipment or systems which would be required to function to protect public health and safety following such failure or destruction also could be considered to be vital. States may agree that these Vital Areas should be protected to the same standards as a Protected Area. Because of the possibility of malevolent actions by those authorised access to the facility, Vital Areas will require additional measures to limit and control authorised access to these areas. This can be achieved by both administrative, physical and technical measures [5.1.2].

431. Consideration should be given to searching individuals prior to entering a Vital Area to ensure that they are not introducing any items that could be used to commit sabotage. The search should detect items, such as explosives, that could be concealed on the body, as well as hand carried items. Consideration should be given to excluding vehicles from Vital Areas. If vehicles must enter these areas, they should be searched prior to entry.

432. Keys and key cards concerned with the protection of Vital Areas should be kept under special management to limit access to authorised individuals and they should not be removed from the facility.

433. The visitor-escort ratio should be limited to that which enables the escort to exercise positive control of the location and actions of the visitors. Doors providing direct access to vital equipment should be locked wherever possible. Emergency exits should be secured and all doors fitted with alarms to detect unauthorised opening.

434. The barrier of the Vital Area should mark the perimeter of the area and deter intruders. The degree of delay to be provided by this barrier should take account of the State's threat assessment. The objective should be to delay any attempted intrusion into the Vital Area until the arrival of an adequate response force which is able to contain and control the attackers.

435. It is preferable that the surveillance of the Vital Areas be assisted by an electronic detection system acting in combination with a system for verifying and assessing the situation by the guard force. Additional patrols may be necessary to detect intrusion and to be able to respond in a timely manner.

436. There should be specially trained personnel (preferably part of the guard force) available to operate the electronic equipment used in the physical protection system. There should be a separate and adequately protected room where it is possible to monitor the condition and status of all the physical protection equipment and which is able to communicate with the guard force and the off-site response force.

437. When establishing physical protection measures, there should be frequent consultations with those responsible for nuclear material safety to ensure that physical protection measures do not adversely affect the associated nuclear material safety. Conversely those responsible for nuclear material safety should consult with those responsible for physical protection when safety operations change to the extent that physical protection systems or protective strategy needs modification [5.1.3].

REQUIREMENTS FOR PHYSICAL PROTECTION DURING TRANSIT OF NUCLEAR MATERIALS

438. Nuclear material is probably most vulnerable to theft and sabotage when it is being transported between facilities when the usual protective measures cannot be applied. It is

therefore important that compensatory measures be provided "in depth", so that for an attacker to accomplish his objective, he would be required to defeat a number of these measures in sequence [6.1.1]. The protection measures which may be applied to provide this defence in depth are:

- Limiting advance knowledge of transport operations and protecting the confidentiality of this information (in part, through predetermining the trustworthiness of all individuals involved in the transportation);
- Providing as appropriate escorts (or guards) for the shipment who are able to communicate with response forces, either directly or through a communications centre monitoring the movement;
- Transporting packages inside closed and locked vehicles, railway wagons or holds of ships (with vehicles involved in movements of Category I quantities of nuclear material preferably being designed to resist forcible attack and equipped with immobilization devices);
- Locking or sealing packages and ensuring, where necessary, that the package design takes account of the potential for sabotage; and
- Having plans in place for response and recovery operations in the event of any threatened or actual theft or sabotage of nuclear material in transit.

439. The competent authority should define requirements for the physical protection of nuclear material in transit, taking into account the particular circumstances prevailing in the State [3.2.4.1]. This is necessary in order that those involved in planning the transportation of nuclear material may know, at least in broad terms, the physical protection requirements which will need to be incorporated into any shipment plan. In defining these requirements, the competent authority will not only wish to take account of the recommendations in Section 6 of INFCIRC/225/Rev.3, but should also take account of State's obligations to comply with the requirements of the Convention on the Physical Protection of Nuclear Material for nuclear material in international transportation and/or any commitments made by the State (either as a supplier, or as a recipient under the terms of a Supply Agreement) to protect nuclear material in accordance with Annex C of the Nuclear Suppliers Group Guidelines (INFCIRC/254/Rev.2). In addition, the competent authority should consider in defining these requirements what steps need to be taken from the outset to ensure appropriate protection of detailed information concerning proposed transport operations. Knowledge of the schedule and route, in particular of Category I and II shipments, should be strictly limited to the minimum number of persons necessary. Any wider dissemination of this information to other official bodies should be made as close to the time of departure as possible so as to reduce the risk of compromise and these bodies requested to keep the information confidential [3.2.7.1/6.1.2(f)/6.1.3]. If secure communications are not available, the introduction of codes for information on dates and places of shipments should be considered [6.2.12.3].

440. In three important areas, load carriers, escorts and communications, the competent authority will wish to define more clearly than INFCIRC/225/Rev.3 the State's physical protection requirements to take account of local circumstances, including the State's assessment of the threat. Particularly where Category I material is involved, there is a close inter-relationship between these three areas to ensure that the escort can summon immediate assistance from a response force who will arrive before attackers have time to remove the nuclear material, hijack the vehicle carrying it, or carry out an act of sabotage leading to a radiological release. The larger and better armed the escort, the less likelihood there is of it being overwhelmed. However, where there are constraints on the size or arming of the escort,

then increased dependency must be placed on providing a load carrier that is capable of resisting forcible attack or hijacking until the expected arrival of the response forces.

441. The competent authority should establish a minimum size of an escort for each of the various modes of Category I transport and its distribution between load vehicles and escort vehicles. States are encouraged to use armed escorts to the extent that laws and regulations permit [6.2.9.1]. This may involve coordinating the provision of armed guards through another State body such as the police. It may be decided that escorts are required also for the transport of other categories of nuclear material, depending upon local circumstances. Although it is recommended that a single designated vehicle should be used for each Category I consignment in order to concentrate the material into one vehicle [6.3.2.2], this may not always be possible because of the size of the load. The competent authority may wish to stipulate that where additional load vehicles are required, they are limited in number for any one shipment and that escort numbers are increased accordingly. Whereas it is recommended that shipments of Category I material by sea should be accompanied by one or more escorts [6.3.4.1], experience suggests that as voyages tend to last protracted periods, sufficient escorts should be provided to ensure that at least one (and preferably more than one) escort is on duty at all times in order to maintain communications with response forces and keep surveillance on the cargo hold and surrounding seas.

442. When armed escorts are not used for Category I shipments, compensatory measures should be applied [6.2.9.1]. These compensatory measures should be designed to delay an attacker long enough for the response force to arrive and thus prevent successful theft or sabotage. Essentially they consist of barriers which provide delay to attackers attempting to gain access to the nuclear material and immobilization (or disabling) systems which further delay any attempt to hijack the load vehicle. Even where armed escorts are used, vehicles preferably should be specially designed to provide penetration delay and be equipped with an immobilization (or vehicle disabling) system in order to provide the defence "in depth" explained in paras 443 and 444 below [6.3.2.1].

443. Delay may be provided by constructing the load compartment of the vehicle, train or ship similar to a "strong room" through the use of armour plating and other barrier materials to delay or mitigate a forcible or explosive attack. The door to the compartment should be of similar standard fitted with multiple locking pins and special locks. Nuclear material packages may be further secured within the compartment by cargo tie-down systems, and packages designed to provide thermal protection against the consequences of an explosive or ballistic attack.

444. In order to prevent attackers from simply driving a captured vehicle away, the driver's cab should also be made secure through armouring and the fitting of special locks and the vehicle should be fitted with at least one immobilization system operated from the driver's cab for use in an emergency. Systems available include ones that cut off the fuel supply, lock the gears or the wheels, disable the accelerator or shut-off the air brakes. Any immobilization device fitted preferably should be of a design that is not capable of being disengaged easily and quickly.

445. INFCIRC/225/Rev.3 recommends that domestic physical protection measures should include communication facilities between a vehicle carrying Category I or II material and the shipper, receiver and/or a designated agent [6.2.8.1/6.4.7.1]. As for international shipments [6.2.11.1/6.2.11.4/6.4.8.1/6.5.5.1], the purpose of communications between the vehicle/train/ship/aircraft carrying the nuclear material and a central communications centre

is to enable the latter to monitor the continued integrity of the shipment and relay emergency reports to designated response forces. It is the responsibility of competent authorities to ensure that a suitably manned and equipped communications centre to monitor Category I and II shipments is established by the shipper, receiver, transport company involved or an independent State authority. Current technology now makes it possible to install an automatic data transmission tracking system on load carriers which enables a communications centre to note and investigate immediately any unplanned stops or deviation from the planned route. These tracking systems may incorporate short pre-assigned data messages which can be transmitted in an emergency by the driver or on-board escort. However, it is important in the case of Category I shipments that the escort is able also to communicate verbally by radio, mobile telephone or satellite system to the communications centre in order to provide detailed information in the case of emergencies. It is also advantageous if the escort is able to communicate directly by radio with designated response forces in an emergency.

446. INFCIRC/225/Rev.3 also recommends that radio communications should be established between the Category I load vehicle and the escort vehicle [6.3.2.6]. Prudent practice would indicate that there should be at least two escort vehicles, one to provide close protection to the load vehicle and a second adopting a stand-off position, equipped to raise the alarm direct with the communications centre in the event of an attack. In the case of rail movements (6.3.3.2), prudent practice would suggest that the escorts on the train are able to communicate with the train driver in order to establish the reason for, and anticipated duration of, unscheduled stops. (Reference to a "goods train" in 6.3.3.1 means a freight train which does not carry passengers. If the use of trains for Category I shipments is necessary, a dedicated freight train should be used, the use of passenger trains not being encouraged because of the opportunities this would present to a potential attacker).

447. In addition to keeping shippers and receivers updated concerning the progress of a shipment, the communication centre has a key role in alerting response forces to any emergency. It is the role of the competent authority to ensure that emergency procedures are prepared to handle effectively any possible threat to nuclear material in transit [6.1.1]. This involves ensuring that armed response forces are identified who are prepared to arrive rapidly enough to prevent the unauthorised removal or sabotage of a Category I shipment [6.2.10.1/6.2.11.1] and who may rapidly recover a lost Category II or III shipment [6.4.8.1/6.5.5.1]. States are also responsible for arranging, at the request of other States, recovery actions in the event of a loss of an international shipment of nuclear material within their territory [6.2.11.2/6.4.8.2/6.5.5.2]. States party to the Convention on the Physical Protection of Nuclear Material are required to identify and make known their central authority having responsibility for physical protection and for coordinating recovery and response operations in the event of any act, or credible threat, to steal or sabotage nuclear material. The IAEA circulates details of these central authorities on a regular basis.

448. The recommendations in Sections 3 and 6 of INFCIRC/225/Rev.3 are not made in sequence with the steps necessary to plan, approve and execute a shipment of nuclear material. To put these in a more chronological order, the relevant recommendations for a Category I international shipment are summarised in the following paragraphs. Relevant recommendations for Category I domestic shipments and Category II/III domestic and international shipments follow in the same chronological order.

449. Responsibility for planning the shipment rests with the owner of the nuclear material (or his designated agent), acting in conjunction with the shipping facility, any transport company to be used [6.2.6.2], and the receiving facility. In doing so, the owner should take account

of the principles listed in 6.1.2/6.2.3.1 by which the objectives of sound physical protection may be assisted. The plan will need to comply with regulations of the sending State and the requirements of its competent authority, and of the regulations and requirements of the receiving State and of other States which are transited [6.2.3.2].

450. In drawing up contracts or agreements for the shipment, it is important that the point at which responsibility for physical protection is transferred from one transport authority to another is clearly stated [6.2.12.1]. This will not necessarily coincide with the point at which legal ownership of the material is transferred, but it will determine whether the shipper or receiver (or even a third party) and its State has the responsibility for the physical protection of the material, the maintenance of communications, the arrangements for dealing with an emergency and the arrangements for recovery if needed. Under the terms of the Convention on the Physical Protection of Nuclear Material, each State party is required to ensure as far as practicable that nuclear material within its territory, or on board a ship or aircraft under its jurisdiction is protected to prescribed levels. This indicates that the point of handover of responsibility for air and sea shipments will be dictated by the flag of the carrier, as a States will assume or have continuing responsibilities in international waters or airspace for nuclear material carried on its ships or aircraft. Contracts or agreements should contain provisions for the appropriate degree of advance notice to be provided of shipments so that physical protection arrangements may be made by the parties involved [6.2.12.2].

451. Although in cases where physical protection is adequately covered by regulations, advance authorization for routine shipments is not required [6.2.2.1], it would be prudent for the competent authority to require physical protection plans for all shipments (or series of identical shipments) to be submitted for approval in advance. Experience suggests that it is rarely possible for existing regulations to cover every contingency [6.2.2.2] and liaison will be necessary with other State bodies and relevant overseas competent authorities. The competent authority may wish to undertake a security survey on part of the route or the mode of transport to be used. Additionally, the competent authority or relevant State body should consider whether (or, if a State party to the Convention on the Physical Protection of Nuclear Material, will require assurances that) the material will be adequately protected during international nuclear transportation, perhaps before granting an import or export licence. Paragraph 3.2.1.4 of INFCIRC/225/Rev.3 provides examples of satisfactory assurances that this will be the case.

452. In reviewing plans for proposed shipments, the competent authority should consider whether the package to be used requires to be assessed for its resistant to acts of sabotage (4.3.2). The competent authority should also consider the implications of the proposed point of handover of physical protection responsibility from it's State to that of the recipient (or third party) State [6.2.11.1/6.2.11.2/6.2.11.4]. For road and rail movements, this may involve reaching agreement with the State whose border is to be crossed concerning the exact point at which handover will take place, e.g. at which State's border control post. For air movements, advance arrangements may need to be made with States en route in whose territory emergency diversion airports have been identified for cooperation in protecting the nuclear material if the diversion airport is required. For sea shipments through international waters, the competent authority will require to be satisfied that adequate arrangements have been made regarding maintenance of communications throughout voyage and that response forces have been designated for both international and foreign territorial waters. Close liaison will be necessary therefore with relevant overseas competent authorities before the shipment, and relevant communication links established for use immediately prior to and during the shipment.

453. In granting consent to the proposed shipment, the competent authority may lay down specific limitations and conditions related to the particular circumstances [6.2.2.2]. It is the responsibility of the licensee/operator to whom approval or a licence for the shipment has been given by the competent authority to issue written instructions in advance to those persons responsible for physical protection during the shipment [6.2.6.1]. The competent authority should coordinate the issue of satisfactory written instructions by other external bodies involved in protecting the nuclear material in transit (such as police escorts).

454. Shortly prior to commencing the shipment, the shipper should confirm details and timings of the proposed shipment with the receiving facility and obtain prior confirmation of its readiness to accept delivery at the designated point of handover [6.2.1.1/6.2.1.2]. The competent authorities of the States involved and designated response forces should also be informed of the timetable of the shipment by the shipper directly or through the competent authority. (The Convention on the Physical Protection of Nuclear Material requires the responsible State party to inform States in advance if nuclear material is expected to transit through their territory other than through their territorial waters or airspace).

455. Physical protection of the shipment should be undertaken in accordance with the approved shipment plan and associated written instructions, taking into account the regulations and any specific conditions stipulated by the State competent authorities through whose territory the shipment is transported. Competent authorities are encouraged to carry out periodic security audits of shipments in order to confirm that physical protection arrangements conform to applicable requirements [3.2.1.3/3.5.1].

456. If road movements cannot be completed without overnight stops, or if there is a requirement to place nuclear material in temporary storage en route (for instance at a transfer point), then the material should be protected in a manner consistent with that employed to protect it in use and storage at a facility. For Category I shipments, this involves the establishment of a temporary protected area (or the use of an existing protected area at a nuclear facility) to which access is restricted and which is under surveillance by guards who are in close communication with off-site response forces. If the material is to remain on the load vehicle, then the vehicle should immobilised in order to deter or delay any unauthorised movement. Temporary storage arrangements should be approved in advance by the competent authority as part of the shipment plan [6.1.2(c)/6.3.2.5].

457. Finally the receiver should check the integrity of the packages at the point of handover and notify the shipper/owner immediately of their safe arrival. At the same time the escort should notify the communications centre of the handover of the packages to the receiver [6.2.7.1]. If there have been any incidents or unscheduled delays during transit, a review of physical protection arrangements should be carried out in order to evaluate their effectiveness and identify any necessary improvements which may be made to optimize their effectiveness during future shipments.

Appendix

THE PHYSICAL PROTECTION OF NUCLEAR MATERIAL

INFCIRC/225/Rev.3

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INTERNATIONAL ATOMIC ENERGY AGENCY

PREFACE

Physical protection against the theft or unauthorized diversion of nuclear materials and against the sabotage of nuclear facilities by individuals or groups has long been a matter of national and international concern. Although responsibility for establishing and operating a comprehensive physical protection system for nuclear materials and facilities within a State rests entirely with the Government of that State, it is not a matter of indifference to other States whether and to what extent that responsibility is fulfilled. Physical protection has therefore become a matter of international concern and co-operation. The need for international co-operation becomes evident in situations where the effectiveness of physical protection in one State depends on the taking by other States also of adequate measures to deter or defeat hostile actions against nuclear facilities and materials, particularly when such materials are transported across national frontiers.

The IAEA recognized early on that it might be called upon to play a role in the area of the physical protection of nuclear materials and facilities. Its first effort resulted in the publication, in 1972, of "Recommendations for the Physical Protection of Nuclear Material", which was prepared by a panel of experts convened by the Director General. These recommendations were revised by a group of experts in co-operation with the IAEA Secretariat, and the revised version was published in 1975 in the INFCIRC series.[1] This was modified by an Advisory Group in 1977. The modified document[2] was favorably received by Member States and has since become a standard reference document. The document was later updated in 1989 and published as Revision 2.

The Convention on the Physical Protection of Nuclear Material[3], which came into force on 8 February 1987, constitutes an important framework for international co-operation in the physical protection of "nuclear material used for peaceful purposes while in international nuclear transport". A Review Conference of the Physical Protection Convention was held in September 1992. The final statement of the Review Conference called on the IAEA to organize a meeting to examine INFCIRC/225/Rev.2, primarily to consider the need for consistency of the Categorization Table contained in that document with the Convention, and to consider the incorporation of further guidance on such issues as irradiated fuel, nuclear material contained in waste and other matters.

As a result of that recommendation, a Technical Committee met 21 - 25 June 1993[4] to consider changes to INFCIRC/225/Rev.2. The revised document, INFCIRC/225/Rev.3, reflects the Technical Committee recommendations for changes to the text as well as other modifications determined necessary to advance the consistency of the Categorization Table in INFCIRC/225/Rev.2 with the categorization table contained in The Convention on the Physical Protection of Nuclear Material and to reflect additional improvements presented by the experts. The recommendations presented in this IAEA document reflect a broad consensus among Member States on the requirements which should be met by systems for the physical protection of nuclear materials and facilities. It is hoped that they will provide helpful guidance for Member States.

Hans Blix
Director General

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1 INFCIRC/225/(Corrected).

2 INFCIRC/225/Rev.1.

3 INFCIRC/274/Rev.1.

4 Participants and observers from the following countries attended the meeting of the Technical Committee on Physical Protection of Nuclear Material in Vienna from 21 to 25 June 1993: Australia, Austria, Belgium, Canada, China, the Republic of Croatia, the Czech Republic, Denmark, the Federal Republic of Germany, France, Hungary, Italy, Japan, Luxembourg, Morocco, Netherlands, the Russian Federation, Spain, Sweden, Switzerland, the United Kingdom of Great Britain and Northern Ireland and the United States of America. An observer from the International Maritime Organization also attended.

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1. INTRODUCTION

1.1. Principles of physical protection are realized through administrative and technical measures. The measures for the physical protection of nuclear material in use, transit and storage and of nuclear facilities presented herein are recommended for use by States as required in their physical protection systems. These measures are based on the state of the art in physical protection hardware and systems and on the types of nuclear materials and nuclear facilities.

1.2 The State's physical protection system should be based on the State's assessment 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. The recommended physical protection measures are intended for all nuclear facilities and shipments.

1.3 The recommended measures are in all cases additional to, and not a substitute for, other measures established for safety purposes for nuclear material in use, transit and storage and for nuclear facilities.

1.4 It is essential that the recommended measures be reviewed and updated from time to time to reflect advances made in the state of the art in physical protection hardware and systems or introduction of new types of facilities. Further, the design of a physical protection system for a specific facility is expected to vary from these recommendations when prevailing circumstances indicate a need for a different level of physical protection.

1.5 In implementing these recommendations, States are encouraged to co-operate and consult, and to exchange information on physical protection techniques and practices, either directly or through international organizations.

1.6 The Convention on the Physical Protection of Nuclear Material (INFCIRC/274) obligates parties to:

- make specific arrangements and meet defined standards of physical protection for international shipments of nuclear material;
- co-operate in the recovery and protection of stolen nuclear material;
- make as criminal offences specified acts to misuse or threats to misuse nuclear materials to harm the public; and
- extradite or prosecute those accused of committing such acts.

The Convention also promotes international co-operation in the exchange of physical protection information.

2. OBJECTIVES

2.1 The objectives of the State's physical protection system should be:

(a) To establish conditions which would minimize the possibilities for unauthorized removal of nuclear material or for *sabotage*[1], and

(b) To provide information and technical assistance in support of rapid and comprehensive measures by the State to locate and recover missing nuclear material and to minimize the effects of *sabotage*[2].

2.2 The objective of the Agency are:

(a) To provide a set of recommendations on requirements for the physical protection of nuclear material in use, transit and storage and of nuclear facilities. The recommendations are provided for consideration by the competent authorities in the States. Such recommendations provide guidance but are not mandatory upon a State and do not infringe the sovereign rights of States; and

(b) To be in a position to give advice to State's authorities in respect of their physical protection systems at the request of the State. The intensity and the form of assistance required are, however, matters to be agreed upon between the State and the Agency.

It should be noted that the Agency has no responsibility either for the provision of a State's physical protection system or for the supervision, control or implementation of such a system. Assistance by the Agency will be provided only when so requested by the State.

3. ELEMENTS OF A STATE'S SYSTEM OF PHYSICAL PROTECTION OF NUCLEAR MATERIAL AND NUCLEAR FACILITIES

3.1. GENERAL

3.1.1. A State's system of physical protection of nuclear material and nuclear facilities should include the elements described in Sections 3.2. - 3.6. below.

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[1] Terms in italics are defined in Section 7 below.

[2] See also the Convention on Early Notification of a Nuclear Accident (INFCIRC/335) and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (INFCIRC/336).

3.1.2. An assessment by the State of the threat of unauthorized removal of nuclear material and of *sabotage* is an essential element of a State's system of physical protection. The State should continuously review the threat, and evaluate the implications of any changes in that threat for the levels and the methods of physical protection.

3.2 REGULATIONS

3.2.1. Responsibility, authority and sanctions

3.2.1.1 The responsibility for the establishment, implementation and maintenance of a physical protection system within a State rests entirely with that State.

3.2.1.2. The State should promulgate and review regularly its comprehensive regulations for the physical protection of nuclear material and nuclear facilities whether in State or private possession.

3.2.1.3 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. A State can delegate the administration of physical protection measures either to a national body, or to duly authorized persons. It will be implicit in case of delegation that the State has satisfied itself that the physical protection arrangements conform to the requirements laid down by the State. The duly authorized persons should be fully responsible for the continuing confirmation of complete compliance with the physical protection measures.

3.2.1.4 In the case of international transfer of nuclear material the responsibility for physical protection measures should be the subject of agreement between the States concerned. The sending State should consider, before allowing the international transfer, if the States involved in the transfer, including the transit States:

- are Parties to the Convention on the Physical Protection of Nuclear Material (INFCIRC/274); or
- have concluded with it a formal agreement which ensures that physical protection arrangements are implemented; or
- formally declare that their physical protection arrangements are implemented according to internationally accepted guidelines; or
- have issued licenses which contain appropriate physical protection provisions for the transport of the nuclear material.

3.2.1.5 Sanctions to enforce standards of physical protection are not in themselves a necessary part of a State's physical protection system; they can, however, provide support to it. Sanctions against the unauthorized removal of nuclear material and against *sabotage* are important to an effective State system of physical protection.

3.2.2. Licensing

3.2.2.1. The State should license activities only when they comply with its physical protection regulations. It should be noted that other regulations such as those relating to radiological safety may also apply.

3.2.3. Categorization of nuclear material

3.2.3.1. The State should regulate the categorization of nuclear material in order to ensure an appropriate relationship between the material concerned and the protective measures. This categorization should be based on the potential hazard of the material, which itself depends on: the type of material, i.e. plutonium, uranium, thorium; isotopic composition, i.e. content of fissile isotopes; physical and chemical form; degree of dilution; radiation level; and quantity. For example, nuclear material with a radiation level that exceeds 1 Gy/hr (100 rads/hr) at one meter unshielded may be protected in accordance with the requirements of a lower category than that determined by the fissile content of the material. Additionally, nuclear material that is in a form that is no longer usable for any nuclear activity, minimizes environmental dispersal and is practicably irrecoverable, may be protected in accordance with prudent management practices.

3.2.4. Physical protection requirements for nuclear material in use, transit and storage

3.2.4.1. The State should define requirements for the physical protection of nuclear material in use, transit and storage. They should take into account the category of nuclear material, its location (use, transit, storage) and the particular circumstances prevailing either in the State or along the transportation route. When considering the measures required for the physical protection of irradiated fuel against unauthorized removal or sabotage, the State should take into account the attractiveness and self-protecting nature of the material and the containment measures used for safety reasons.

3.2.5. Physical protection requirements for nuclear facilities

3.2.5.1. The State should define requirements for the physical protection of nuclear facilities against *sabotage*. They should take into account possible releases of radioactivity, the location of the nuclear facility, and the particular circumstances prevailing in the State.

3.2.5.2. Adequate physical protection measures should be implemented for nuclear facilities which may be subject to *sabotage* regardless of the categorization of nuclear materials therein contained.

3.2.5.3. Several types of nuclear facilities pose a hazard to the environment in case of *sabotage* because of the potential for release of radioactivity. The categorization of nuclear material may not reflect this hazard in an adequate way. Therefore, it is important that the protection of the facility take also this hazard into consideration.

3.2.6. System of information

3.2.6.1. The State's system of physical protection should include an information system which enables the State to be informed of any change at nuclear sites or transportation of nuclear material which may affect implementation of physical protection measures.

3.2.6.2. In addition, the State's physical protection system should have access to information from the State's system of accounting for and control of nuclear material.

3.2.7. Protection of detailed physical protection information

3.2.7.1. The State should take steps to ensure appropriate protection of specific or detailed information concerning the physical protection of nuclear materials in use, storage, or transport, and or nuclear facilities at which there is a potential for *sabotage*.

3.3. IMPLEMENTATION OF THE PHYSICAL PROTECTION MEASURES PRESCRIBED BY THE REGULATIONS

3.3.1. Physical protection measures can be implemented by the State itself, the operator or any other entity duly authorized by the State.

3.4. CONTROL OF COMPLIANCE WITH THE PRESCRIBED PHYSICAL PROTECTION MEASURES

3.4.1. The State's system of physical protection should make provisions for periodic review of the licensed activities, and whenever a significant change takes place, to ensure continuous compliance with physical protection regulations.

3.5. QUALITY ASSURANCE IN IMPLEMENTING PHYSICAL PROTECTION

3.5.1. To ensure that physical protection measures are maintained in a condition capable of effectively responding to potential threats, the State physical protection authority should ensure that quality assurance programmes are implemented at facilities and for transportation. Such programmes should include periodic testing of detection, *alarm* and communications systems and periodic audits of security procedure implementation. Such programmes should also include exercises to test the training and readiness of *escorts, guards* and off-site response forces.

3.6. STATE'S CONTACT POINTS FOR PHYSICAL PROTECTION MATTERS

3.6.1. States should inform each other, either directly or through the Agency, of appropriate points of contact for matters related to the physical protection of nuclear materials and facilities.

4. ASSIGNMENT OF NUCLEAR ACTIVITIES TO PHYSICAL PROTECTION CATEGORIES

4.1. BASIS FOR CONCERN

4.1.1. The possibility exists that the theft of plutonium, highly enriched uranium or uranium-233 could lead to the construction of a nuclear explosive device by a technically competent group. The theft of these materials could lead to their use as radiological contaminants. An act of *sabotage* against a nuclear facility or against a shipment of nuclear material could create a radiological hazard to the public.

4.2. CATEGORIZATION OF NUCLEAR MATERIAL

4.2.1. The primary factor for determining the physical protection measures against unauthorized removal of nuclear material is the nuclear material itself, categorized in accordance with the considerations given in Section 3.2.3.1 above.

4.2.2. In determining the levels of physical protection in a facility, which may consist of several buildings, it is possible that the State's physical protection authority may identify part of the facility which contains material of a different category and which is therefore protected at a different level than the rest of the facility.

4.2.3. The following table gives a categorization of the different types of nuclear material taking into account the above considerations. This categorization has been used throughout this document.

NOTE: This table is not to be used or interpreted independently of the text of the entire document.

TABLE: CATEGORIZATION OF NUCLEAR MATERIAL

Material	Form	Category I	Category II	Category III[c]
1.Plutonium [a]	Unirradiated [b]	2 kg or more	Less than 2 kg but more than 500 g	500 g or less but more than 15 g
2.Uranium-235	Unirradiated[b] - uranium enriched to 20% ^{235}U or more	5 kg or more	Less than 5 kg but more than 1 kg	1 kg or less but more than 15g
	- uranium enriched to 10% ^{235}U but less than 20 % ^{235}U		10 kg or more	Less than 10kg but more than 1 kg
	- uranium enriched above natural, but less than 10 % ^{235}U			10 kg or more
3. Uranium-233	Unirradiated[b]	2 kg or more	Less than 2 kg but more than 500 g	500 g or less but more than 15 g
4. Irradiated Fuel (The categorization of irradiated fuel in the table is based on international transport considerations. The State may assign a different category for domestic use, storage, and transport taking all relevant factors into account.)			Depleted or natural uranium, thorium or low-enriched fuel(less than 10% fissile content)[d/e]	

[a] All plutonium except that with isotopic concentration exceeding 80 % in plutonium-238.

[b] Material not irradiated in a reactor or material irradiated in a reactor but with a radiation level equal to or less than 1 Gy/hr (100 rads/hr) at one meter unshielded.

[c] Quantities not falling in Category III and natural uranium, depleted uranium and thorium should be protected at least in accordance with prudent management practice.

[d] Although this level of protection is recommended, it would be open to States, upon evaluation of the specific circumstances, to assign a different category of physical protection.

[e] Other fuel which by virtue of its original fissile material content is classified as Category I or II before irradiation may be reduced one category level while the radiation level from the fuel exceeds 1 Gy/hr (100 rads/hr) at one meter unshielded.

4.3. POTENTIAL FOR *SABOTAGE*

4.3.1. The physical protection measures to be implemented at a nuclear facility and for nuclear materials in transit should take into account not only the attractiveness of nuclear material for unauthorized removal, but also whether there exists a potential for *sabotage.*

4.3.1.1. At nuclear reactors, a potential for *sabotage* exists because of the inventory of radioactive material and the potential for release.

4.3.1.2. At separate irradiated fuel storage facilities, a potential for *sabotage* exists because of the inventory of radioactive material and the potential for release.

4.3.1.3 At reprocessing plants, a potential for *sabotage* exits because of the inventory of irradiated fuel, separated plutonium, and other radioactive material and the potential for release.

4.3.1.4. At fuel fabrication plants utilizing plutonium, a potential for *sabotage* exists in the areas where plutonium is used or stored.

4.3.1.5. At other nuclear facilities, a potential for *sabotage* exists if there is an inventory of radioactive material.

4.3.1.6. For nuclear material in transit, a potential for *sabotage* exists if the load contains plutonium and/or other radioactive material.

4.3.2. Radiological hazards are strongly dependent on the threat to be considered, on the design of the facility or package and on its safety features. Consequently, a plant-specific or package design assessment of the potential for *sabotage* and associated radiological consequences should be made in close consultation between safety and physical protection specialists.

4.3.3. The State's competent authority should determine if there is a credible threat to disperse plutonium malevolently. The State should then apply physical protection requirements for Category I, II or III nuclear material, as it deems appropriate and without regard to the plutonium quantity specified under each category, to the plutonium isotopes in those quantities and forms determined by the State to fall within the scope of the credible dispersal threat.

5. REQUIREMENTS FOR PHYSICAL PROTECTION OF NUCLEAR MATERIAL IN USE AND STORAGE AND OF NUCLEAR FACILITIES

5.1. GENERAL

5.1.1 The concept of physical protection is 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 physical protection system is designed specifically for each facility after taking into account the geographical location and the State's assessment of the threat. Emergency procedures should be prepared to handle effectively any possible threat.

5.1.2. Achievement of the objectives of the physical protection system should be assisted by:

(a) Limiting access to nuclear material or facilities to a minimum number of individuals. To accomplish this aim the State's physical protection authority can designate *protected areas, inner areas* and *vital areas.* In designating such areas, consideration should be given to the plant safety design, the location of the plant and the threat circumstances. Access to these areas should be limited and controlled; and

(b) Requiring predetermination of the trustworthiness of all individuals regularly permitted access to nuclear material or facilities.

5.1.3. Some types of nuclear facilities may pose a hazard to the public and to the environment because of the potential for *sabotage.* Safety specialists should evaluate the consequences of malevolent acts, considered in the context of the State's threat assessment, to identify equipment, systems or devices the failure of which could directly or indirectly endanger the public health and safety by exposure to radiation. Equipment, systems or devices identified as vital should be protected by designation of *vital areas.* It is important that physical protection issues are considered early in the design of the nuclear facility. Close co-operation between physical protection and nuclear safety specialists is important to ensure that the physical protection system takes into account measures that have been designed into the facility for safety purposes. Physical protection measures should not jeopardize nuclear safety during emergency conditions.

5.2. REQUIREMENTS FOR CATEGORY I MATERIAL IN USE AND STORAGE

5.2.1. Category I material should be used or stored only within an *inner area* or *inner areas*.

5.2.2. All persons entering the *protected area* should be issued either with special passes or with badges, appropriately registered, and access to the *protected area* should be kept to the minimum necessary.

5.2.3. Access to *inner areas* should be limited to persons whose trustworthiness has been predetermined and to persons in their *escort*. Access to *inner areas* should be kept to the minimum necessary.

5.2.4. Badging of persons entering *protected* or *inner areas* should follow the general outline below:

Type I: Employees whose duties permit or require continual access to *inner areas*.

Type II: Other employees who are permitted access to the *protected area*.

Type III: Temporary repair, service or construction workmen should be escorted by a Type I badged employee at all times when they may have access to *inner areas*, and by a Type II badged employee when they have access to *protected areas*.

Type IV: Visitors should be escorted by a Type II badged employee at all times in the *protected area*, and by a Type I badged employee when they have access to the *inner areas*.

Visitor-*escort* ratios should be limited. Passes and badges should be designed so as to make counterfeiting extremely difficult.

5.2.5. All persons and packages entering or leaving *inner areas* should be subject to search to prevent the introduction of articles of *sabotage* or the unauthorized removal of nuclear material. Instruments for the detection of nuclear material and metals can be used for such searches.

5.2.6. Entry of private motor vehicles into *protected areas* should be minimized and limited to authorized parking areas. Private motor vehicles should be prohibited access to *inner areas*.

5.2.7. Whenever persons are present in *inner areas*, those areas should be under constant *surveillance*. The *surveillance* can be effected by mutual observation between two or more co-workers (e.g. two-man rule).

5.2.8. All employees should be frequently (about annually) informed of the importance of effective physical protection measures and be trained in their implementation. Notices on the subject should be conspicuously posted throughout the facility.

5.2.9. Every nuclear material handler should be required to conform to procedures for transferring custody of the nuclear material to the succeeding handler. Additionally, nuclear material handlers should endeavor to ascertain on reporting for duty that no interference with or unauthorized removal of nuclear material has taken place, and report to a senior authority whenever they have reason to suspect the a discrepancy exists.

5.2.10. A record should be kept of all persons having access to or possession of keys or key-cards concerned with the containment or storage of nuclear material. Arrangements should be made for:

(a) The checking and custody of keys or key-cards, particularly to minimize the possibility of duplication; and

(b) The changing of combination settings at suitable intervals.

Locks should be changed if compromised.

5.2.11. Movements of nuclear material within the *inner area* and the *protected area* should be the responsibility of the operator who should apply all prudent and necessary physical protection measures. Movements out of or between two *protected areas* should be treated in full compliance with the requirements for nuclear material in transit, after taking account of prevailing conditions.

5.2.12. The perimeter of the *protected area* should normally consist of a *physical barrier* in addition to and outside of the building walls. However, where the walls of a building are of such solid construction as to be designated, as a result of a *security survey*, as being the perimeter of a *protected area*, a supplementary *surveillance* system should be provided outside the building walls. Clear areas should be provided at the perimeter of the *protected area* with illumination sufficient for observation. Intrusion detection and assessment should be performed at the *protected area* perimeter.

5.2.13. *Inner areas* should be so arranged that the number of entries and exits is minimized (ideally only one). All emergency exits should be fitted with *alarms*. All external windows should be permanently locked, alarmed and covered with firmly embedded bars. *Inner areas* should not be sited close to public thoroughfares.

5.2.14. Storage areas should be of the "strong room" type in design and should be located within an *inner area*. They should be provided with *alarms* and adequate locks and the issue of keys or key-cards should be closely controlled. Access to storage should be strictly limited to assigned persons and to others only when under their *escort*. Where nuclear material is stored overnight in work areas, or in sub-storage structure within a work area, specially authorized procedures should be used to protect the area. *Alarms, patrols* or TV monitors can satisfy this requirement.

5.2.15. A 24-hour guarding service should be provided. The *guard* should report at scheduled intervals to local police or other public security forces during non-working hours. States are encouraged to use armed *guards* to the extent that laws and regulations permit. If *guards* are not armed, compensating measures should be applied. The objective should be the arrival of adequately armed response forces rapidly enough to counter armed attacks and prevent the unauthorized removal of nuclear material or *sabotage*.

5.2.16. An external and an internal *patrol* should be provided.

5.2.17. Independent, duplicated transmission systems for two-way voice communication should be provided for activities involving detection, assessment and response. This should include links between *guards*, their headquarters and response forces.

5.2.18. Independent, duplicated transmission systems, including independent power supplies, should be provided between the sensors and display areas (audible and/or visual) of *alarms*.

5.2.19. Emergency plans of action should be prepared to counter effectively any possible threats, including attempted unauthorized removal of nuclear material or *sabotage*. Such plans should provide for the training of facility personnel in their actions in case of *alarm* or emergency. In addition, personnel trained in the facility should be prepared to meet all necessary demands of physical protection and recovery of nuclear material and should act in full co-ordination with response forces and safety response teams, who should also be appropriately trained.

5.2.20. Arrangements should be made to ensure that during emergency evacuation conditions (including drills) nuclear material is not removed in an unauthorized manner. Such unauthorized removal can be prevented by, for example, keeping persons under continuous *surveillance* and searching them. Instruments for the detection of nuclear material and metals can be used for such searches.

5.2.21. A *security survey* should be made at least annually (or whenever a significant change in the facility, or its function, takes place) by the State's designated physical protection authority to evaluate the effectiveness of the physical protection measures, and to identify necessary changes in measures so as to optimize their effectiveness in particular situations at the facility. Furthermore, plant operators should maintain checks on the efficient functioning of physical protection measures.

5.3. REQUIREMENTS FOR CATEGORY II MATERIAL IN USE AND STORAGE

5.3.1. Category II material should be used, or stored, within a *protected area* or *protected areas*.

5.3.2. All persons entering the *protected area* should be issued either with special passes or with badges, appropriately registered, and access to the *protected area* should be kept to the minimum necessary.

5.3.3. Access to the *protected area* should be limited to persons whose trustworthiness has been predetermined and to persons in their *escort*.

5.3.4. Badging should follow the general outline below:

Type I: Employees whose duties permit continual access to the *protected area*.

Type II: Temporary repair, service or construction workmen and visitors: these should be escorted by a Type I badged employee at all times when they may have access to the *protected area* (except where their trustworthiness has been predetermined).

Visitor-*escort* ratios should be limited. Passes and badges should be designed so as to make counterfeiting extremely difficult.

5.3.5. From time to time persons and packages entering or leaving the *protected area* should be searched.

5.3.6. Vehicles and all large objects entering the *protected area* should be checked to ensure that no unauthorized persons and articles of *sabotage* are introduced.

5.3.7. Entry of private motor vehicles into the *protected area* should be minimized and limited to authorized parking areas.

5.3.8. All employees should be frequently (about annually) informed of the importance of effective physical protection measures and be trained in their implementation. Notices on the subject should be conspicuously posted throughout the facility.

5.3.9. Every nuclear material handler should be required to conform to procedures for transferring custody of the nuclear material to the succeeding handler. Additionally, nuclear material handlers should endeavor to ascertain on reporting for duty that no interference with or unauthorized removal of nuclear material has taken place, and report to a senior authority whenever they have reason to suspect that a discrepancy exists.

5.3.10. A record should be kept of all persons having access to or possession of keys or key-cards concerned with the containment or storage of nuclear material. Arrangements should be made for:

(a) The checking and custody of keys or key-cards, particularly to minimize the possibility of duplication; and

(b) The changing of combination settings at suitable intervals.

Locks should be changed if compromised.

5.3.11. Movements of nuclear material within a *protected area* should be the responsibility of the operator who should apply all prudent and necessary physical protection measures. Movements out of or between two *protected areas* should be treated in full compliance with the requirements for nuclear material in transit, after taking account of prevailing conditions.

5.3.12. The perimeter of the *protected area* should normally consist of a *physical barrier* in addition to and outside of the building walls. However, where the walls of a building are of such solid construction as to be designated, as a result of a *security survey*,
as being the perimeter of a *protected area*, a supplementary *surveillance* system should be provided outside the building walls. Clear areas should be provided at the perimeter of the *protected area* with illumination sufficient for observation. Intrusion detection and assessment should be performed at the *protected area* perimeter.

5.3.13. Emergency plans of action should be prepared to counter effectively any possible threats, including attempted unauthorized removal of nuclear material or *sabotage*. Such plans should provide for the training of facility personnel in their actions in case of *alarm* or emergency. They should also provide for appropriate response by *guards* or off-site response forces to attempted intrusion into the *protected area*. In addition, personnel trained in the facility should be prepared to meet all necessary demands of physical protection and recovery of nuclear material and should act in full co-ordination with external response forces and safety response teams, who should also be appropriately trained.

5.3.14. Arrangements should be made to ensure that during emergency evacuation conditions (including drills) nuclear material is not removed in an unauthorized manner. Such unauthorized removal may be prevented by, for example, keeping persons under continuous *surveillance* and searching them. Instruments for the detection of nuclear material and metals can be used for such searches.

5.3.15. A *security survey* should be made at least annually (or whenever a significant change in the facility or its function takes place) by the State's designated physical protection authority to evaluate the effectiveness of the physical protection measures, and to identify necessary changes in measures so as to optimize their effectiveness in particular situations at the facility. Furthermore, plant operators should maintain checks on the efficient functioning of the physical protection measures.

5.4 REQUIREMENTS FOR CATEGORY III MATERIAL IN USE AND STORAGE

5.4.1. Category III material should be used or stored within an area to which access is controlled.

5.4.2. All employees should be frequently (about annually) informed of the importance of effective physical protection measures and be trained in their implementation. Notices on the subject should be conspicuously posted throughout the facility.

5.4.3. Movements of nuclear material should be the responsibility of the operator, who should apply all prudent and necessary physical protection measures.

5.4.4. Provision should be made for detecting unauthorized intrusion and for appropriate action by *guards* or off-site response forces to attempted intrusions.

5.4.5. Emergency plans of action should be prepared to counter effectively any possible threats, including attempted unauthorized removal of nuclear material or *sabotage*. Such plans should provide for the training of facility personnel in their actions is case of *alarm* or emergency. They should also provide for appropriate response by *guards* or off-site response forces to attempted intrusion.

5.4.6. A *security survey* should be made initially and whenever a significant change in the facility or its function takes place by the State's designated physical protection authority to evaluate the effectiveness of the physical protection measures, and to identify necessary changes in measures so as to optimize their effectiveness in particular situations at the facility. Furthermore, plant operators should maintain checks on the efficient functioning of the physical protection measures.

6. REQUIREMENTS FOR PHYSICAL PROTECTION OF NUCLEAR MATERIAL IN TRANSIT

6.1. GENERAL

6.1.1. The transport of nuclear material is probably the operation most vulnerable to an attempted act of unauthorized removal of nuclear material or *sabotage*. Therefore it is important that the protection provided should be "in depth" and that particular attention should be given to the recovery system. Emergency procedures should be prepared to handle effectively any possible threat.

6.1.2. Achievement of the objectives of physical protection should be assisted by:

(a) Minimizing the total time during which the nuclear material remains in transit;

(b) Minimizing the number and duration of nuclear material transfers, i.e. transfer from one conveyance to another, transfer to and from temporary storage and temporary storage while awaiting the arrival of a vehicle, etc.;

(c) Protecting nuclear material in temporary storage in a manner consistent with the category of that material;

(d) Avoiding the use of regular movement schedules;

(e) Requiring predetermination of the trustworthiness of all individuals involved in transport of nuclear material; and

(f) Limiting advance knowledge of transport information to the minimum number of persons necessary.

6.1.3. Appropriate measures, consistent with national requirements, should be taken to protect the confidentiality of information relating to transport operations, including detailed information on the schedule and route, and particular consideration should be given to those operations involving Category I and II material. This requires great restraint in the use of any special markings on vehicles, and also in the use of open channels for transmission of messages concerning shipments of nuclear material. When a message is required by safeguards or radiological safety regulations, consideration should be given to measures such a coding and appropriate routing to the extent practicable; care should be exercised in the handling of such information. These considerations should apply also to any subsequent communications.

6.2. REQUIREMENTS FOR CATEGORY I MATERIAL IN TRANSIT

6.2.1. Advance notification to receiver

6.2.1.1. The shipper should give the receiver advance notification of the planned shipment specifying the mode of transport (road/rail/sea/air), the estimated time of arrival of the shipment and the exact point of hand-over if this is to be done at some intermediate point before the ultimate destination.

6.2.1.2. The receiver should confirm his readiness to accept delivery immediately (and hand-over, if applicable) at the expected time, prior to commencement of the shipment.

6.2.2. Advance authorization

6.2.2.1. In cases where physical protection is adequately covered by regulations, advance authorization for routine shipments is not required.

6.2.2.2 In all cases not covered by existing regulations, or going beyond limits specified in such regulations, the consent of a state control authority to a transport operation should be sought in advance. This implies the performance of a *security survey* in advance. The consent to a transport operation can include specific limitations and conditions related to the particular circumstances and to whatever emergency plans have been prepared.

6.2.3. Selection of transportation and routing

6.2.3.1. In choosing the route, consideration should be given to the security of passage, in particular, arranging the route in such a way as to avoid areas of natural disasters or civil disorders. The mode of transport for any given consignment should be such as to keep to a minimum the number of cargo transfers and the length of time the cargo remains in transit. The co-operation of the carrier concerning the implementation of physical protection measures should be ensured in advance.

6.2.3.2. Before shipment the shipper should ensure that the arrangements are in accordance with the physical protection regulations of the receiving State and of other States which are transited.

6.2.4. Provision of locks and seals

6.2.4.1. Unless there are overriding safety considerations, the packages containing nuclear material should be carried in closed, locked vehicles, compartments or freight containers. However, carriage of packages weighing more than 2000 kg that are locked or sealed should be allowed in open vehicles. Subject to safety considerations, the package should be tied down or attached to the vehicle or freight container.

6.2.4.2. Checks should be made before dispatch to confirm the integrity of the locks and seals on the package, vehicle, compartment or freight container.

6.2.5. Search of load vehicle

6.2.5.1. There should be a detailed search of the load vehicle prior to loading and shipment, to ensure that *sabotage* devices have not been implanted or that *sabotage* has not been initiated.

6.2.6. Written instructions

6.2.6.1. Transport authorities with physical protection responsibilities in transit should be given written instructions detailing their responsibilities and should be provided with a standard form of written authority.

6.2.6.2. Transport authorities should be consulted on the route, approved stopping places, destination hand-over arrangements, identification of persons authorized to take delivery, accident procedures, and reporting procedures, both routine and emergency.

6.2.7. Measures after shipment

6.2.7.1. The receiver should check the integrity of the packages, locks and seals and accept the shipment immediately upon arrival. He should notify the shipper of the arrival of the shipment immediately or of non-arrival within a reasonable interval after the estimated time of arrival at its destination. In addition, the *escort* or *guard* should be instructed to report by radio or telephone to the shipper or shipper/receiver designee his arrival at his destination and each overnight stopping place and place of hand-over of the shipment.

6.2.8. Communication

6.2.8.1. Domestic physical protection measures should include provision of continuous two-way radio communication or frequent telephone communication between the vehicle and the shipper, receiver and/or shipper/receiver/State designee.

6.2.9. *Escorts* or *guards*

6.2.9.1. *Escorts* or *guards* should accompany each shipment to protect the material against hostile acts. The *escorts* or *guards* should ensure continuous *surveillance* in the case of road transport. If the packages, vehicle, cargo hold or compartment are locked and sealed, frequent and periodic examination of seals together with continuous *surveillance* of the cargo hold when the vehicle is not in motion should be allowed in place of package *surveillance*. States are encouraged to use armed *escorts* or *guards* to the extent that laws and regulations permit. When armed *escorts* or *guards* are not used, compensating measures should be applied.

6.2.10. Emergency action

6.2.10.1. Arrangements should be made to provide an adequately sized and trained team to deal with domestic emergencies. The response forces should reach the scene of an incident in transit while the act of unauthorized removal of nuclear material or *sabotage* is in process so that they can prevent its successful completion. The objective should be the arrival of the armed response force rapidly enough to prevent the unauthorized removal of nuclear material or *sabotage* and to counter an armed attack.

6.2.11. Advance agreement on responsibilities for international shipments

6.2.11.1 In the case of transit between two States sharing a common frontier, the State's responsibility for physical protection and the point at which physical protection responsibilities are transferred from one State to another should be the subject of an agreement between the States. However, with respect to the maintenance of communication regarding the continuing integrity of the shipment and with respect to the responsibility for carrying out physical protection measures and the recovery actions in the event that a shipment becomes lost, the agreement between the States should provide that this responsibility will rest with the shipping State up to the frontier and will then be transferred to the receiving State.

6.2.11.2. When international shipments transit the territory of States other than the sending State and the receiving State, the arrangements between the sending and receiving States should identify the other States involved in such transit with a view to securing in advance their co-operation and assistance for adequate physical protection measures and for the recovery actions on the territory of such States in case of loss of an international shipment thereon.

6.2.11.3. States should aid each other in physical protection, and particularly in the recovery of nuclear material, in cases where such aid is needed.

6.2.11.4. In the case of an international shipment transitting international waters or air space, the shipping and receiving States should establish specific measures to ensure the maintenance of communication regarding the continued integrity of the shipment and to ensure that responsibility for response planning and capabilities is defined and fulfilled.

6.2.12. Arrangements for international transit

6.2.12.1. In addition to the international agreements mentioned above, in contracts or agreements between shippers and receivers involving international transit of material, the point at which responsibility for physical protection is transferred from the shipper to the receiver should be clearly stated.

6.2.12.2. When the contract or agreement involving international transit provides for delivery to a destination in the receiving State in the vehicle of the shipping State, this contract or agreement should provide that information be supplied in time to enable the receiver to make adequate physical protection arrangements.

6.2.12.3 The use of coded information on the exact dates and places of shipments should be considered between the involved States and international organizations.

6.3. REQUIREMENTS FOR CATEGORY I MATERIAL RELATED TO THE MODE OF TRANSPORT

6.3.1. General

6.3.1.1. In addition to the requirements mentioned above, there should be further detailed requirements for Category I material related to the mode of transport as set out below.

6.3.2. Shipment by road

6.3.2.1. The load vehicle should preferably be specially designed to resist attack, prevent unauthorized removal of the nuclear material, and also preferably be equipped with a vehicle disabling system.

6.3.2.2. A single designated vehicle should be used exclusively for each consignment (i.e. full load concept). The load vehicle should carry a second man to act as *escort* or *guard* for that vehicle.

6.3.2.3. The load vehicle should be accompanied by a vehicle manned by one or more *guards*.

6.3.2.4. The *guards* should maintain continuous *surveillance* and check the seals and locks at each stop.

6.3.2.5. If the journey cannot be completed in one day, prior arrangements should be made for overnight stay at an approved stopping place. During such overnight stays the load vehicle should be immobilized or parked in a locked and guarded building or compound.

6.3.2.6. There should be two-way radio communication between the load vehicle and the *escort* vehicle in addition to communication between these vehicles and the shipper, receiver and/or shipper/receiver/State designee.

6.3.2.7. Alternative routing should be planned in advance, so that any decision to change routes can be implemented at short notice.

6.3.3. Shipment by rail

6.3.3.1. Shipment should be in a goods train or in a separate wagon attached to a passenger train.

6.3.3.2. Shipment should be accompanied by one or more *escorts* or *guards*, who should travel in the carriage nearest to the shipment wagon and keep it under *surveillance* and check locks and seals at stopping places. The *escort* or *guard* should maintain communication by two-way radio or by telephone at scheduled stopping places.

6.3.4. Shipment by sea

6.3.4.1. Each shipment should be accompanied by one or more *escorts* or *guards*.

6.3.4.2. The shipment should be placed in a secure compartment or container which is locked and sealed. Locks and seals should be periodically inspected in transit.

6.3.5. Shipment by air

6.3.5.1. Shipment should be by designated charter cargo aircraft or designated scheduled cargo aircraft and should be accompanied by one or more *escorts* or *guards*.

6.4. REQUIREMENTS FOR CATEGORY II MATERIAL IN TRANSIT

6.4.1. Advance notification to receiver

6.4.1.1. The shipper should give the receiver advance notification of the planned shipment specifying the mode of transport (road/rail/sea/air), estimated time of arrival of the shipment and the exact point of hand-over if this is to be done at some intermediate point before the ultimate destination.

6.4.1.2. The receiver should confirm his readiness to accept delivery immediately (and hand-over, if applicable) at the expected time, prior to commencement of shipment.

6.4.2. Selection of transportation and routing

6.4.2.1. In choosing the route, consideration should be given to the security of passage, in particular, arranging the route in such a way as to avoid areas of natural disasters or civil disorders. The transport method for any given consignment should be such as to keep to a minimum the number of cargo transfers and the length of time the cargo remains in transit. The co-operation of the carrier concerning the implementation of physical protection measures should be ensured in advance.

6.4.3. Provision of locks and seals

6.4.3.1. Unless there are overriding safety considerations, the packages containing material should be carried in closed, locked vehicles, compartments or freight containers. However, carriage of packages weighing more than 2000 kg that are locked or sealed shall be allowed in open vehicles. Subject to safety considerations, the package should be tied down or attached to the vehicle or freight container.

6.4.3.2. Checks should be made before dispatch to confirm the integrity of the locks and seals on the package, vehicle, compartment or freight container.

6.4.4. Search of load vehicle

6.4.4.1. There should be a detailed search of the load vehicle prior to loading and shipment to ensure that *sabotage* devices have not been implanted or that *sabotage* has not been initiated.

6.4.5. Written instructions

6.4.5.1. Transport authorities with physical protection responsibilities in transit should be given written instructions detailing their responsibilities and should be provided with a standard form of written authority.

6.4.5.2. Transport authorities should be consulted on the route, approved stopping places, destination hand-over arrangements, identification of persons authorized to take delivery, accident procedures, and reporting procedures, both routine and emergency.

6.4.6. Measures after shipment

6.4.6.1. The receiver should check the integrity of the packages, locks and seals and accept the shipment immediately upon arrival. He should notify the shipper of the arrival of the shipment immediately or of non-arrival within a reasonable interval after the estimated time of arrival at its destination.

6.4.7. Communication

6.4.7.1. Domestic physical protection measures should include provision of frequent communication between the vehicle and the shipper, receiver and/or shipper/receiver/State designee.

6.4.8. Advance agreement on responsibilities for international shipments

6.4.8.1. In the case of transit between two States sharing a common frontier, the State's responsibility for physical protection and the point at which physical protection responsibilities are transferred from one State to another should be the subject of an agreement between the States. However, with respect to the maintenance of communication regarding the continuing integrity of the shipment and with respect to the responsibility for carrying out physical protection measures and the recovery actions in the event that a shipment becomes lost, the agreement between the States should provide that this responsibility will rest with the shipping State up to the frontier and will then be transferred to the receiving State.

6.4.8.2. When international shipments transit the territory of States other than the sending State and the receiving State, the arrangements between the sending and receiving States should identify the other States involved in such transit with a view to securing in advance their co-operation and assistance for adequate physical protection measures and for the recovery actions on the territory of such States in case of loss of an international shipment thereon.

6.4.8.3. States should aid each other in physical protection, and particularly in the recovery of nuclear material, in cases where such aid is needed.

6.4.9. Arrangements for international transit

6.4.9.1. In addition to the international agreement mentioned above, in contracts or agreements between shippers and receivers involving international transit of material, the point at which responsibility for physical protection is transferred from the shipper to the receiver should be clearly stated.

6.4.9.2. When the contract or agreement involving international transit provides for delivery to a destination in the receiving State in a vehicle of the shipping State, this contract or agreement should provide that information be supplied in time to enable the receiver to make adequate physical protection arrangements.

6.5. REQUIREMENTS FOR CATEGORY III MATERIAL IN TRANSIT

6.5.1. Advance notification to receiver

6.5.1.1. The shipper should give the receiver advance notification of the planned shipment specifying the mode of transport (road/rail/sea/air), the estimated time of arrival of the shipment and the exact point of hand-over if this is to be done at some intermediate point before the ultimate destination.

6.5.1.2. The receiver should confirm his readiness immediately to accept delivery (and hand-over, if applicable) at the expected time, prior to commencement of the shipment.

6.5.2. Provision of locks and seals

6.5.2.1. Where practicable, locks and seals should be applied to vehicles or freight containers.

6.5.3. Search of load vehicle

6.5.3.1. There should be a detailed search of the load vehicle prior to loading and shipment, to ensure that *sabotage* devices have not been implanted or that *sabotage* has not been initiated.

6.5.4. Measures after shipment

6.5.4.1. The receiver should notify the shipper of the arrival of the shipment immediately or of non-arrival within a reasonable interval after the estimated time of arrival at the destination.

6.5.5. Advance agreement on responsibilities for international shipments

6.5.5.1. In the case of transit between two States sharing a common frontier, the State's responsibility for physical protection and the point at which physical protection responsibilities are transferred from one State to another should be the subject of an agreement between the States. However, with respect to the maintenance of communication regarding the continuing integrity of the shipment and with respect to the responsibility for carrying out physical protection measures and the recovery actions in the event that a shipment becomes lost, the agreement between the States should provide that this responsibility will rest with the shipping State up to the frontier and will then be transferred to the receiving State.

6.5.5.2. When international shipments transit the territory of States other than the sending State and the receiving State, the arrangements between the sending and receiving States should identify the other States involved in such transit with a view to securing in advance their co-operation and assistance for adequate physical protection measures and for the recovery actions on the territory of such States in case of loss of an international shipment thereon.

6.5.5.3. States should aid each other in physical protection and in particular in the recovery of nuclear material in cases where such aid were needed.

7. DEFINITIONS

7.1. ***ALARM:*** A technical device for the purpose of sensing intrusion or interference. Such a device should be independent of any power supply failure. It should signal any interference with its function.

7.2. ***ESCORT OR GUARD:*** A person for whom a prior trustworthiness determination has been made entrusted with *surveillance* or access control. His duties should be specified by the *security survey*.

7.3. ***INNER AREA*:** An area inside a *protected area* in which Category I nuclear material is used or stored.

7.4. ***PATROL*:** A person or persons (who may be *guards*) scheduled to inspect barriers,seals or other features at regular or irregular intervals.

7.5. ***PHYSICAL BARRIER*:** A fence or wall or a similar impediment approved by a *security survey*.

7.6. ***PROTECTED AREA*:** An area under constant *surveillance* (by a *guard* or by electronic means) surrounded by a *physical barrier* and having a limited number of controlled admittance points and approved by a *security survey*. Where the wall(s) of a building serves as part (or all) of the perimeter of a *protected area*, all emergency exists on the perimeter wall should be alarmed. All perimeter wall windows should be permanently locked, alarmed and covered with firmly embedded bars.

7.7. ***SABOTAGE*:** Any deliberate act directed against a plant, facility, nuclear material transport vehicle or nuclear material which could directly or indirectly endanger the public health and safety by exposure to radiation.

7.8. ***SECURITY SURVEY*:** A critical examination made by competent officers, in order to evaluate, approve and specify physical protection measures.

7.9. ***SURVEILLANCE*:** Close *surveillance* to be achieved by observers, and/or photo electric, closed-circuit television, sonic detectors, electronic, photographic or other means.

7.10. ***VITAL AREA*:** An area containing equipment, systems or devices which are, alone or in combination, determined vulnerable to *sabotage*.

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