METHODOLOGY TO DETECT ILLICIT TRAFFICKING OF NUCLEAR AND OTHER RADIOACTIVE MATERIAL ACROSS BORDERS

DRAFT TECHNICAL GUIDANCE

INTERNATIONAL ATOMIC ENERGY AGENCY
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FOREWORD

[TOT BE PREPARED BY THE SECRETARIAT AT A LATER TIME]
6. CONTROL PROCESS .......................................................................................................................................................... 24

6.1 DETECTION OF ILLICIT TRAFFICKING OF NUCLEAR AND OTHER RADIOACTIVE MATERIAL AS PART OF A SHIPMENT DECLARED AS A RADIOACTIVE MATERIAL SHIPMENT .................................................................................................................................................. 25

6.1.1 Document examination .................................................................................................................................................. 25

6.1.2 Visual and physical assessments .................................................................................................................................. 27

6.1.3 Confirmation techniques .................................................................................................................................................... 29

6.2 DETECTION OF ILLICIT TRAFFICKING OF NUCLEAR AND OTHER RADIOACTIVE MATERIAL AS PART OF A SHIPMENT NOT DECLARED AS A RADIOACTIVE MATERIAL SHIPMENT .................................................................................................................................................. 31

6.2.1 Document examination .................................................................................................................................................. 31

6.2.2 Visual and physical assessments .................................................................................................................................. 32

6.2.3 Confirmation techniques .................................................................................................................................................... 32

6.3 DECISION TO SUSPEND OR RELEASE THE CONSIGNMENT ................................................................................................. 32

APPENDIX I RADIATION MEASUREMENT .................................................................................................................................. 33

APPENDIX II CONFIRMATION TECHNIQUES .................................................................................................................................. 36

REFERENCES ................................................................................................................................................................................. 40

List of Tables

Table 1. Multiplication factor for tanks, freight containers and unpackaged LSA-I and SCO-I

Table 2. The categories of packages and overpacks (from Ref. [10])

Table 3: Typical Performance Characteristics for portable dose rate meters

Table 4: Typical parameters of a gamma-spectrometer

List of Figures

Figure 1: A high-level outline of the methodology to detect illicit trafficking of nuclear and other radioactive material

Figure 2: Methodology for document examination

Figure 3 Position of detector and package
1. INTRODUCTION

1.1 BACKGROUND

Shipments of radioactive material constitute part of everyday movement of goods around the world and are essential to the functioning of economies and health-care systems. Trade security programmes have been set up to provide conditions for securing international trade and also to facilitate and promote international trade. World Customs Organization (WCO) Authorized Economic Operators (AEOs) /Trusted Trader programmes are designed to provide faster processing of goods and reduced examinations by the Customs administration at the borders. As part of these programmes, additional security measures are in place, which significantly limit the potential for illicit trafficking.

Some radioactive material shipments are closely regulated and additional security measures in respect of such shipments are in place, which limit the potential for tampering with the nuclear and other radioactive material. Such tampering may include (a) the introduction of nuclear and other radioactive material into a shipment not declared as such and (b) the removal and/or the substitution of nuclear and other radioactive material from or into a shipment that is declared as such.

The IAEA devotes considerable attention to assist States in combating illicit trafficking of nuclear and other radioactive material; and has been promoting the development of technological means, and the establishment of guidelines for implementation at border crossings. The term ‘illicit trafficking’ as used in this publication covers all instances of nuclear and other radioactive material that is not declared in a shipment, whether declared or not declared as a radioactive material shipment.

The World Customs Organization has defined a Framework of Standards that serves as the basic guidelines in the arrangement of a State’s activities by its Customs officials. One of the roles that Customs officials perform is the checking of qualitative and quantitative aspects of goods being transferred across the border for consistency with information on declared shipments.

This Technical Guidance describes a methodology that may be utilized by national authorities, particularly Customs officials, which incorporates existing Customs procedures using a risk-informed approach (or risk management approach for Customs officials) and a selection process to be applied to all goods being transferred across the border for a graded approach to detecting illicit trafficking.

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1 A ‘border’ in the context of this publication is the boundary of a national jurisdiction.

2 The term ‘risk informed approach’ is equivalent to the term ‘Risk-management approach’ defined in WCO Standards. The IAEA Nuclear Security Fundamentals publication specifies the use of risk-informed approaches as one of the essential elements of the State’s Nuclear Security Regime: “A nuclear security regime uses risk-informed approaches, including in the allocation of resources for nuclear security systems and measures and in the conduct of nuclear security related activities, that are based on a graded approach and defence-in-depth [...].”
This risk-informed approach may be used to identify those shipments where there is a significant potential for the presence of illicitly trafficked radioactive material in a manner that would avoid unnecessary delays to legitimate shipments\(^3\). This risk-informed approach recognizes that a greater level of confidence is provided by existing inter-governmental regulatory frameworks, mandatory security practices, and Customs compliance programmes through controls which mitigate risks.

According to the national legislation of any State, Customs officials are responsible for checking compliance with Customs and other regulatory requirements when goods are moved between national jurisdictions, including nuclear and other radioactive material. A Customs official has the authority to request documentation or information relating to goods/packages that cross the border.

Each State creates its own Customs laws and requirements based on its own needs and increasingly base these laws on the World Customs Organization’s Framework of Standards [3].

Customs laws may operate separately from other laws and regulations, such as those related to transport of nuclear and other radioactive material. The compliance assessments carried out by Customs officials are based on their legislation and may include checking import/export permit and any other authorization/permission/licence (hereinafter referred to as ‘authorization’) and correct Customs declaration. The classification of radioactive material according to other laws such as those governing radiation protection is not dealt with in this Technical Guidance publication.

Technological measures to detect and respond to the trafficking of nuclear and other radioactive material have been developed and new technologies are continually being developed. This Technical Guidance publication fulfils the need for guidance on detecting illicit trafficking within a shipment whether declared or not declared as a radioactive material shipment. Developing and applying a methodology incorporating a risk-informed approach for detecting such illicit trafficking would strengthen both domestic and international control over such material.

To assist Customs officials, when illicit trafficking of nuclear and other radioactive material is suspected, this Technical Guidance addresses the Customs control process. The methodology includes document examination, visual and physical assessments, and confirmation techniques with detection and radiation protection inputs, for assessing the nuclear and other radioactive contents of a shipment, and in the case of high-risk consignments, to address the threat of illicit trafficking.

This Technical Guidance relies on both, World Customs Organization and IAEA, guidance or guidelines: it supports other IAEA Nuclear Security Series publications for prevention, detection and response to criminal\(^4\) and other unauthorized acts involving nuclear and other radioactive material. It

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\(^3\) Legitimate/legal shipments are shipments of nuclear and other radioactive material that comply with all the applicable regulations (e.g. the Regulations for the Safe Transport of Radioactive Material [10]).

\(^4\) The term “criminal acts” is covered by the term “unlawful acts” in WCO Standards.
also applies, in conjunction with the SAFE Framework of Standards[^3] produced and adopted by
WCO, to facilitate global trade and ensure its security.

1.2 OBJECTIVE

The objective of this Technical Guidance publication is to provide national authorities, particularly
Customs officials, with a risk-informed methodology for detecting illicitly trafficked nuclear and other
radioactive material within shipments, whether declared or not declared as radioactive material
shipments.

1.3 SCOPE

The scope of this Technical Guidance publication is the detection of illicit trafficking of nuclear and other
radioactive material within shipments, whether declared as radioactive material shipments (i.e.
shipments including the conveyances that have been declared to Customs officials as containing
radioactive material) or not declared as radioactive material shipments. Such detection would prevent
the completion of the illicit trafficking of the detected material.

For the purposes of this Technical Guidance publication, illicit trafficking of nuclear and other
radioactive material means the unlawful or intentional unauthorized import, export, sale, delivery,
movement, disposal or transfer of nuclear and other radioactive material, or the possession, use or
storage of nuclear and other radioactive material in connection with such unlawful or intentional
unauthorized acts. These acts may occur both within and between national jurisdictions.

For the purposes of this Technical Guidance publication, a shipment declared as a radioactive material
shipment is a shipment, including the conveyance, of nuclear and other radioactive material where
both the activity concentration and the consignment limits as defined in the Transport Regulations [10]
are met or exceeded and has been reported to Customs as containing nuclear or other radioactive
material regardless of classification by Transport Regulations.

For the purposes of this Technical Guidance publication, a shipment not declared as a radioactive
material shipment means a shipment that is exempt from the Transport Regulations [10] because either
the activity concentration or the consignment limit (or both) are below the limits specified in these
Regulations. The term ‘not declared as’ is equivalent to ‘other than declared as’.

While application of this methodology is subject to meeting safety requirements [10], the details of
such compliance with safety requirements are outside the scope of this publication.

1.4 STRUCTURE

Section 2 describes illicit trafficking of nuclear and other radioactive material. Section 3 discusses the international and national legal framework for detection of nuclear and other radioactive material by Customs officials, as well as the key stakeholders including industry and regulatory bodies. Section 4 explains the risk-informed approach that is the foundation for the subsequent sections, dealing with how threats are to be assessed and what mitigation measures may be put in place. Section 5 details the selection process for threat and risk assessments, and the screening and targeting processes for a graded approach to detecting illicit trafficking. Section 6 describes the control process according to the principle of escalation. This includes document examination, visual and physical assessments, and other types of confirmation techniques, on suspicion of illicit trafficking of nuclear and other radioactive material as part of a shipment whether declared or not declared as a radioactive material shipment. The techniques may be applied to confirm the contents of a shipment of nuclear and other radioactive material, taking into account the practical limitations of each technique.

Appendices I and II provide additional information on performing radiation measurements and confirmation techniques.

2. ILLICIT TRAFFICKING OF NUCLEAR AND OTHER RADIOACTIVE MATERIAL ACROSS BORDERS

2.1 POSSIBLE VECTORS FOR ILLICIT TRAFFICKING

2.1.1 Transport of nuclear and other radioactive material in the public domain

Nuclear and other radioactive material are used for many everyday activities - including but not limited to – food preservation; sterilization of single use medical products; diagnosis of diseases; location and treatment of cancers; non-destructive testing of welds and castings; and industrial/commercial vessels; industrial process control; quality control of industrial products; oil well logging; production of nuclear power; and as raw material for the extraction of non-radioactive elements for use in electronic consumer goods, chemical processing equipment, turbine components and drill bits. Radioactive material is also used in new drug development and in research related to the curing of diseases.

The producers of nuclear and other radioactive material include a few specialized companies with production facilities in a small number of States. However, the activities requiring such material are present in nearly every State. This necessitates the global transport of nuclear and other radioactive material of all kinds, whether of low or high activity, or with short or long half-lives. Transport occurs with all modes and often includes trans-shipment through a number of States en route to final destination.
2.1.2 Radioactive material shipments

All shipments of radioactive material are required to comply with the Transport Regulations (mainly derived from [10] or from the previous editions of [10]). Compliance with regulations includes, *inter alia*, classification of the material to be transported, selection of the appropriate package type and the preparation of the package for transport including marking, labelling, shipping documentation, etc.

The Customs declaration and harmonized system (HS) for these shipments (to 6 digits) normally needs to identify the radioactive material so that these shipments are recognizable as being radioactive material shipments. It also normally reflects the generic product description therefore the radioactive characteristics will not always be recognizable.

Moreover the transport of nuclear and other radioactive material is carefully regulated for safety and security. The IAEA has developed recommendations and guidance publications in relation to security measures for nuclear and other radioactive material such as:

- “Nuclear Security Recommendations on Radioactive Material and Associated Facilities” (Nuclear Security Series No. 14 [5]);
- “Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5)” (Nuclear Security Series No. 13 [6]);
- “Security in the Transport of Radioactive Material” (Nuclear Security Series No. 9 [7])
- “Physical Protection of Nuclear Material during Transport” (Nuclear Security Series under preparation) [8]; and
- “Security of Radioactive Sources” (Nuclear Security Series No. 11 [9]);
- The list of competent authorities for transport safety.

These publications highlight the absolute needs for continuous and adequate security during transport to reduce the risk of tampering, sabotage or diversion of the material.

There are certain naturally occurring radioactive material (NORM) which consist primarily of materials containing uranium, thorium, and potassium and their associated decay products and progeny in small quantities but sufficient to cause alarms in modern radiation detection systems, resulting in potential delays. Examples of NORM cargoes include:

- fertilizers, agricultural produce, tobacco products,
- clay-based cat litter, mining ores, tiles, ceramics (including glazed ceramics, porcelain) and granite.

Some legitimate cargoes such as those containing NORM or devices incorporating radioactive material that are exempt from the Transport Regulations [10] (e.g. smoke alarms or dials painted with

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radioactive luminous compounds) may also trigger an alarm in radiation detectors. Hence, if a shipment that is not declared as a radioactive material shipment sets off radiation detectors at a border crossing, it does not necessarily mean that it is suspect. It could well be a legitimate shipment qualifying for exemption.

Non-intentional unauthorized acts [13] may also have nuclear security implications and should not be dismissed.

2.2 ILLICIT TRAFFICKING

2.2.1 Illicit trafficking of nuclear and other radioactive material

Illicit trafficking of nuclear and other radioactive material — as already stated under Scope — may occur within and between national jurisdictions.

This Technical Guidance focuses, in particular, on illicit trafficking during the phase of transport at border crossings where the Customs administration is empowered by national laws to control the movement of goods.

In view of the possible consequences of a successful attempt to use nuclear and other radioactive material for criminal or deliberate unauthorized acts, illicit trafficking of this type of material represents a threat to international peace and security.

2.2.2 Combating illicit trafficking

To combat all forms of illicit trafficking, several international organizations have developed a global response in the field of Customs activities that is applicable to all kinds of illicit trafficking, including nuclear and other radioactive material [20]. A graded approach\(^7\) that allows all States to implement this response, as appropriate, and depending on their available resources is suggested.

This approach enables Customs officials to prioritize and focus on those shipments that have the potential for containing illicitly trafficked nuclear and other radioactive material while facilitating legitimate shipments. This approach needs to take into consideration the mitigation effects of robust regulatory regimes and other security requirements (e.g. security trade programmes\(^8\)). Implementation of this technical guidance may also be a deterrent to illicit trafficking of nuclear and other radioactive material within a shipment whether it is declared or not declared as a radioactive material shipment.

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\(^7\) The term ‘graded approach’ is comparable with the term ‘layered approach’ as defined in WCO standards.

\(^8\) A security trade programme is a programme developed to address all security issues in supply chain. These programmes are complementary to Customs systems. The partners to these programmes volunteer to be committed to compliance with the requirements of these programmes and are audited by the relevant authorities in charge of the development of these programmes. Examples of security trade programmes: United States Customs–Trade Partnership against Terrorism (C-TPAT); Known Shipper; Authorized Economic Operators (AEOs); Partners in Protection (PIP).
Using the graded approach, it may be possible to detect:

— Within a shipment declared as a radioactive material shipment:
  
  • Substitution of material (other material shipped in place of the material declared in the documents);
  
  • Addition of nuclear or other radioactive material;
  
  • Substantially different characteristics (such as significantly different isotopic composition or activity) from those of the declared material as stated in the documents.

— Within a shipment not declared as a radioactive material shipment:

  • Substitution or addition of nuclear or other radioactive material.

2.2.3 International instruments addressing illicit trafficking of nuclear and other radioactive material

States are encouraged to become parties to the legally binding international instruments and to indicate their commitment to non-binding international instruments. To harmonize laws, regulatory frameworks and practices on each side of a border, States are encouraged to implement the obligations and political commitments arising under these instruments.


2.3 SCENARIOS FOR ILlicit TRAFFICKING OF NUCLEAR AND OTHER RADIOACTIVE MATERIAL

Although the transport of nuclear and other radioactive material is carefully regulated for safety and security purposes, there is the potential for the illicit trafficking of nuclear and other radioactive material within a shipment whether declared or not declared as a radioactive material shipment. The different scenarios for illicit trafficking include:

1. Within a shipment not declared as a radioactive material shipment:
   
   o Addition or substitution of radioactive material content(s)/package(s);

   Illicit trafficking may be conducted to the detriment of the shipper⁹. The shipper may not know that the material is radioactive material or nuclear material (e.g. stolen cargo). In some cases, the transport may be operated directly by a trafficker.

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⁹ The ‘shipper’ is equivalent to the consignor as defined in Ref. [10].
2. Within a shipment declared as a radioactive material shipment
   o Within the package:
     Substitution, addition and/or removal of declared nuclear and other radioactive material;
   o Within the conveyance/container:
     The addition or the removal of package(s) containing nuclear and other radioactive material;
     The substitution of package(s) containing nuclear and other radioactive material:
       • Replacement with empty radioactive material package(s), e.g. scams;
       • Replacement with other radioactive material package(s) having different radioactive content(s) (eventually with the same external packaging);
     All these illicit trafficking cases are operated by the trafficker or at the expense of the shipper.
     The shielding in radioactive material packages and/or the presence of declared nuclear and other radioactive material provides a potential risk of nuclear and other radioactive material not declared but concealed in a shipment declared as a radioactive material shipment (in the package or within the conveyance) as it makes the detection of this illicitly trafficked nuclear and other radioactive material challenging.

3. Intentional falsification of documents leading to erroneous declaration (potentially allowing substitution, addition and/or removal of declared nuclear and other radioactive material / package(s) containing nuclear and other radioactive material).
   
   Note: Erroneous declarations addressed in this Technical Guidance essentially relate to the radioactive content (e.g. radionuclides; activity; enrichment for uranium) and not to non-compliance with safety requirements such as labelling and placarding requirements.
   Some common examples of unintentional erroneous declarations are:
   — Radioactive source or contaminated object among bulk material (e.g. the presence of radioactive material incorporated into scrap metal and semi-finished products of the metal recycling industries);
   — Underestimated specific activity of naturally occurring radioactive material (NORM) (e.g. the specific activity in excess of the exemption values specified in the Transport Regulations [10];
   — Minor discrepancies in paper work and declared activities.
Some incidents deal with false representations of nuclear material or radioactive material; although assessed with the same rigour as episodes involving the actual diversion of nuclear and other radioactive material. Many such cases consist of hoaxes or scams that either falsely claim the presence of radionuclides that do not exist or misrepresent the nature or quantity of trafficked material. When reported, these cases require careful investigation to determine their authenticity, which may divert resources away from actual case investigations. Examples are given in the literature [20]. Unlawful scams or hoaxes with nuclear security implications are considered criminal offences (para. 3.6 of [13]).

3. FRAMEWORK FOR A METHODOLOGY FOR DETECTING ILLICIT TRAFFICKING ACROSS BORDERS

3.1 GENERAL FRAMEWORK

Security in the transport of nuclear and other radioactive material is primarily the State’s responsibility but also the responsibility of the supply chain, from suppliers to users. Regulatory bodies, Customs officials and industry play key roles and need to work together to ensure that nuclear and other radioactive material is transported in compliance with the laws of the States through or into which the shipment takes place.

This means there need to be mechanisms for these groups to create frameworks, strategies and share information about how to develop and institute the best practical methodologies and procedures to deter and detect illicit trafficking of nuclear and other radioactive material across borders, and how to deal with such a situation if it occurs.

3.2 LEGAL FRAMEWORK

A legal framework is an important foundation for addressing the risk of illicit trafficking of nuclear and other radioactive material across borders (See Requirement 2 of [14]).

In keeping with the Code of Conduct on the Safety and Security of Radioactive Sources [11], States may enact and enforce laws that control the import and export of certain radioactive material. These laws may address safety requirements as well as security concerns. Customs officials may utilize import and export permits for clearance of nuclear and other radioactive material, at border crossings. This is aimed at dealing with security matters (for example, providing assurance that an importer or exporter is authorized to deal with radioactive material being transported) whereas the Transport Regulations [10] include an emphasis on safety aspects.

Laws and regulations on nuclear safety and security need to complement each other and need to operate together to enable both to be achieved, and not compromise one another.
To be most effective in deterring illicit trafficking of nuclear and other radioactive material, States need to have laws that make it an offence to trade in or possess nuclear and other radioactive material, without obtaining appropriate permission. Such laws would minimize the potential for nuclear and other radioactive material to be traded for use in illicit purposes.

3.3 RESPONSIBILITIES OF PARTIES

3.3.1 Responsibilities of industry stakeholders

Industry stakeholders that obtain, produce or otherwise take custody or ownership of nuclear and other radioactive material need to discharge their national obligations for notification of the regulatory body\textsuperscript{10}, as well as authorizing where required. Industry stakeholders need to observe national regulations for maintaining control of and ensuring security of nuclear and other radioactive material. Relevant international guidance and recommendations [4], [11]-[13] and [9] incorporated in national legislation also requires compliance.

International transport of nuclear and other radioactive material is highly regulated, particularly for shippers. Safety requirements apply to such shipments, including the need for a management system and radiation protection programmes [10]. Industry stakeholders may need to obtain prior authorization/permission for the supply, transport, storage and receipt of radioactive material. The permission may include import or export permits. Where available they may choose to be part of a Customs security trade programme (see para. 2.5) (e.g. United States Customs–Trade Partnership against Terrorism (C-TPAT), Partners in Protection (PIP), WCO Authorized Economic Operators (AEOs)) in order to gain a greater level of trust in their activities and their competence to carry them out.

The complexities of international transport of radioactive material relate to the availability of carriers, the availability of routes, and differing regulatory requirements along segments of the transport route. Industry stakeholders and their qualified supply chain take significant efforts to ensure that shipments of nuclear and other radioactive material are thoroughly planned and that the accompanying documentation is prepared to the highest professional standard. In particular, the varying regulatory requirements that may be encountered on a transport route need to be anticipated and prepared for.

3.3.2 Responsibilities of regulatory body

The responsibilities of the regulatory body are dependent upon the governmental and legal framework for safety ([4], [10] and [14]), for security ([6] and [8]; [5] and [7]), and the related legal international

\textsuperscript{10} A regulatory body is one or more authorities designated by the government of a State as having legal authority for conducting the regulatory process, including issuing authorizations, and thereby regulating nuclear, radiation, radioactive waste and transport safety.
instruments to which each State is a party. The responsibilities are dependent on the national laws and regulations and international obligations.

The objective of regulatory functions performed by a safety regulatory body that has jurisdiction over nuclear and other radioactive material is the verification and assessment of safety, to assure compliance with regulatory requirements. The performance of these regulatory functions is generally commensurate with the radiological risks associated with the product activity and is based on a graded approach. The regulatory process would:

a) provide a high degree of confidence that safety is optimized, the balance between operational benefits and potential consequences for people and the environment being taken into account;

b) assure that an adequate level of safety has been achieved and that the objectives and criteria for safety established by the regulatory body have been met.

The regulatory body may have a variety of responsibilities including the issuing of authorizations to authorized persons for the import, export, transport, manufacture, use, storage and disposal of such material. The regulatory responsibilities may rest with a single national authority or may be assigned to a number of regulatory bodies. For example, in a given State, there could be a regulatory body in each province or for each mode of transport (i.e. rail, road, sea, air, etc.), for safety and/or security, for nuclear and/or other radioactive material. In some States the regulatory body for the safe transport of radioactive material may be different from the one(s) responsible for the safe handling of radioactive material in hospitals, industrial establishments and research institutions and nuclear facilities.

The type of authorization issued by the regulatory body normally relates to the following activities involving nuclear and other radioactive material, for example:

— Import;
— Export;
— Transport;
— Handling.

Generally a graded approach is adopted in issuing authorizations for export, import and transport of nuclear and other radioactive material. Certain nuclear and other radioactive material poses negligible potential risk from the standpoints of safety and security. In the case of material where the associated potential risk is not negligible, import/export permits are required to be obtained from the regulatory bodies concerned. Authorizations are issued after verifying and confirming the genuineness of the transaction and authenticity of the importer and the exporter. This principle is implemented on the basis of a defined threshold value of the quantity of the radioactive and other nuclear material. The shipment is then subject to authorizations for import, export and transport when the threshold value is exceeded. The threshold values are determined by the potential risk that may arise in the event of loss or diversion of the material. These values are recommended in international Basic Safety Standards [4] and required in the Transport Regulations [10] and are adopted by States in accordance with their national regulations.
The responsibilities of the regulatory body, *inter alia*, are as follows:

1. Assessment of the capability of the applicant to carry out the authorized activities involving the nuclear and other radioactive material in a safe manner prior to the issuing of an authorization;
2. Confirmation through an undertaking that the authorized person would be responsible for the safety and security of the nuclear and other radioactive material;
3. Issuing of an authorization or permission to import nuclear and other radioactive material only after confirming the credibility of the shipper and ensuring that the final user of the nuclear and other radioactive material is authorized to handle the material;
4. Assessment of the package design, if applicable, for compliance with the regulatory requirements prior to the issuing of the necessary design approval;
5. Issuing of shipment approvals, where applicable, upon confirmation that the applicant has indeed ensured that regulatory requirements for the safe transport of nuclear and other radioactive material have been duly complied with;
6. Inspection of:
   - facilities where nuclear and other radioactive material are handled, stored and disposed of;
   - conveyances carrying radioactive material consignments.

In the event of any non-compliance, a regulatory body may take enforcement actions as provided under national or local regulations.

The authority for security of nuclear and other radioactive material may be vested either in the regulatory body for safety or in a different regulatory body designated for the purpose. The regulatory body would need to be empowered to ensure that the nuclear material and other radioactive material is handled by authorized persons for the authorized purposes only. The regulatory body would further need to be empowered to ensure that radioactive and other nuclear material is transported only:

a) from and to authorized facilities,
b) between authorized persons and
c) in conformity with the applicable regulations.

### 3.3.3 Roles and responsibilities for Customs

The Customs administration controls the international movement of goods, while enhancing the security and facilitation of international trade.

To do this, the Customs administration has powers and processes in place to allow for the inspection of and intervention on international cargo that is trans-shipped, imported or exported. However, the
focus is to facilitate the movement of cargo that satisfies all trade requirements while identifying the few that may not.

While the collection of revenue and ensuring compliance with import and export requirements remain as high priorities for the Customs administration, many have moved to take a lead or active role in dealing with aspects of national security. Customs officials and law enforcement officers have the skills, knowledge and authority to deal with goods moving into or out of States, and are therefore well placed to support global and national security initiatives and efforts.

With regard to nuclear and other radioactive material, this is treated as any other commodity in that it will be required to meet all normal import and export requirements. Precedence of safety and security needs to be considered by Customs officials.

It is not the role of the Customs administration to verify compliance with the Regulations for the Safe Transport of Radioactive Material. Shipments of nuclear and other radioactive material which are declared as such and are accompanied by documents as required under the applicable regulations have been permitted to be transported by the authorities of the State of origin and of the State of destination of the shipment. As such material may have a limited useful lifetime and may be urgently required by patients waiting for diagnosis and treatment, processing of such shipments by Customs authorities needs to be done in a timely manner.

If, despite compliance by industry stakeholders, a shipment of nuclear material or radioactive material is not able to proceed, then this may be considered to be a case of delay or denial of shipment. All cases of delay or denial of shipment should be notified to a relevant regulatory body for prompt resolution.

An important role for the Customs administration is to prevent, where possible, the supply of substances and materials for illicit purposes. It is recognized that if nuclear and other radioactive material fell into the wrong hands it could result in serious consequences, so the Customs officials may use systems and powers such as detention and seizure to prevent high risk goods from being imported and exported, when there is a lawful basis to do so.

The Customs officials need to use risk management principles (See Section 4.1) to identify potentially high risk trade transactions that might pose a potential risk to security and safety. These systems can be automated and incorporate mechanisms to target trade that might be of concern.
3.4 COORDINATION BETWEEN CUSTOMS OFFICIALS AND REGULATORY BODIES

3.4.1 Sharing information

It is important that the regulatory bodies and Customs officials work closely, at national and international levels, to provide information about any potential high risk supplier or carrier of nuclear and other radioactive material.

For example, if an applicant is known to have affiliations with criminal elements, the authorization application would be unsuccessful and this would be useful information for Customs officials ([13], para. 17). Conversely, if Customs officials identify inconsistencies in trade data relating to radioactive material, then this information could be shared with regulatory body(ies) to ascertain the potential risk.

3.4.2 Technical support

This publication provides guidance on how to ascertain by technical means whether nuclear and other radioactive material is being legitimately imported and exported. It is recognized that not all Customs officials will have access to the same levels of expertise, capability and technology.

The detection and prevention of illicit trafficking of nuclear and other radioactive material is a complex process. In some cases, Customs officials may not have the requisite technical expertise for this purpose. In this type of situation, Customs officials may consider using experts from other technical organizations, including other regulatory bodies, as well as expertise and/or facilities of shippers or authorized recipients. Customs officials may consider having:

- A 24 hour, 7 days a week helpline for assistance;
- A memorandum of understanding or other appropriate arrangements that would be comprehensive and adequate for the purpose of obtaining the required technical support;
- A contract arrangement with providers of technical support for specific services (See Appendix II for some specifications);
- A process whereby a suspect package is shipped under Custom’s bond to the consignor’s or consignee’s premises, where it can be verified safely.

Customs officials may consider including in their budget adequate provisions for obtaining the required technical support, in the interest of safety and security.

In some States, the role of law enforcement at the border is shared across a variety of agencies/organizations. In this case, responsibilities need to be clearly identified.
4. RISK INFORMED APPROACH

4.1 GENERAL CONSIDERATIONS

Risk management is “the systematic application of management procedures and practices which provide the Customs administration with the necessary information to address movements or consignments which present a risk” [3]. The Customs administration uses this approach and these tools to allocate resources to focus its effort on the higher end of the risk continuum.

Customs officials are the primary authority charged with the responsibility of verifying that all import, export, trans-shipment and transit shipments are made in accordance with applicable national laws and regulations.

The on-going increases in cross-border flows and limitations in human and technical resources led the Customs administration to increasingly implement risk-informed approaches in their operations. This has required systematic application of management procedures and practices which provide the Customs officials with the necessary information to conduct analysis and address movements or consignments which present high risk.

When adopting a risk-informed approach, the Customs officials may intentionally move away from random inspections towards targeted controls. This allows the Customs administration to focus resources on detecting non-compliance, whilst at the same time facilitating consignments that conform to the regulatory requirements.

Robust legislation, flexible administrative procedures, deployment of technology and introduction of risk management to decision-making at all levels form the core foundation for a risk-informed approach. These components are critical in enabling a balance between control, facilitation and supply chain security and together determine the way the Customs administration utilizes its resources in ensuring compliance.

The WCO Customs Risk Management Compendium, endorsed by the 177 WCO member states, provides a common methodology for implementing a risk-informed approach. It needs to be read in conjunction with this publication [11] [15].

The WCO Customs Risk Management Compendium [12] [15] provides more information on risk management and makes reference to documents that can be made available to Customs officials, such as:

11 More information on the WCO Customs Risk Management Compendium and its content can be found at http://www.wcoomd.org/learning_customshome_valearningoncustomsvaluation_rmc.htm

12 This document is partially available on-line under these links: http://www.wcoomd.org/files/1.%20Public%20files/PDFandDocuments/Procedures%20and%20Facilitation_2/RMC_en/Common%20part.pdf
http://www.wcoomd.org/files/1.%20Public%20files/PDFandDocuments/Procedures%20and%20Facilitation_2/RMC_en/Volume%201.pdf
— the WCO Risk-Management Guide;
— the WCO Global Information and Intelligence Strategy; and
— the WCO Standardized Risk Assessment and General High-Risk Indicators.

While many WCO member states have adopted the common methodology outlined in the Compendium, it is recognized that varying operating environments exist and that the application of the methodology will not always lead to “one-size-fits-all” outcomes. The required level of control will depend on the level of risk and the rate of intervention may be higher for some commodities and in some States than in others.

4.2 A PROCESS TO DETECT ILLICIT TRAFFICKING OF NUCLEAR AND OTHER RADIOACTIVE MATERIAL

Figure 1 provides a high-level outline of a graded approach to a process to detect illicit trafficking of nuclear and other radioactive material.

![Diagram](image)

**Fig. 1.** A high-level outline of a graded approach to a process to detect illicit trafficking of nuclear and other radioactive material.

The model outlined in Fig. 1 can be broken into two main parts: selection and application of controls. The processes identified in Fig. 1 are closely linked as the evaluation of risk factors at each step results in an accumulation of facts, signifying that the transaction is or is not of concern. If the threshold for
compliance is not satisfied during the screening and targeting process, additional controls are applied often according to the principle of escalation. This process adopts a graded approach moving from less resource intensive controls, such as documentary checks, towards more resource intensive forms until the threshold of compliance is reached or non-compliance detected. The Customs officials need to be aware, when following these processes, that potential delays may have negative consequences and need to be avoided to the fullest extent possible.

5. SELECTION PROCESS

5.1 THREAT ASSESSMENT

A threat assessment [16] provides inputs to the selection process. Threat assessments can be government wide exercises; target a certain sector of the government (e.g. border sector); be agency specific; or may involve some form of assessment at all these levels in a cascading manner. Depending on existing national structures and practices, threat assessments can be on-going or of ad hoc nature. These assessments may follow a periodic planning cycle or may be conducted as required during times of heightened threat.

When the outcomes of the higher level threat assessments cascade down to Customs, Customs further refine the threat picture in its agency specific context and take action to manage the risks that could contribute to the materialization of the threats. For example, if the possibility of a malicious act using nuclear material or radioactive material is identified as a threat at the governmental level, then cross-border illicit trafficking of nuclear and other radioactive material would be a risk that would need to be managed by Customs officials and regulatory bodies.

The threat assessments may also take into account an activity necessitating heightened awareness and the related social disruption factor. For example, this would include situations when States may be holding large, high level, high profile meetings or international conferences such as Asia-Pacific Economic Cooperation meetings or may be hosting major international events such as the Olympic Games [17].

5.2 RISK ASSESSMENT

Through the risk assessment process, Customs make targeted decisions about the allocation of control resources at the operational level. The process includes identification, analysis, and evaluation of risks and forms the basis for risk treatment.

Identification of risks requires gathering and processing of information on potential risks. In the case of illicit trafficking of nuclear and other radioactive material, the risk identification phase could include:
The revised Kyoto Convention (2005);
The SAFE Framework of Standards [3];
the WCO Customs Risk Management Compendium, Volumes 1 and 2 [15];
the WCO Global Information and Intelligence Strategy; and
the WCO Standardized Risk Assessment and General High-Risk Indicators.

Types of information sources that can be used to gather information concerning nuclear and other radioactive material may, among other things, include:

- Customs seizure and other law enforcement databases;
- Customs declarations and other historical data;
- Information in relation to authorizations;
- Transport, commercial and other documents;
- Intelligence;
- News items on illicit trafficking;
- IAEA Illicit Trafficking Data Base, connected to Customs Enforcement Network (CEN));
- Court cases;
- Tests and exercises;
- Models;
- Research and study reports;
- Interviews with stakeholders;
- Internet and other available open sources.

It is important to note that the Customs risk assessment process is not only about high risks. In order to concentrate resources on the high-risk end of the risk continuum, it is critical that the process also focus on identifying low risks — those operators and transactions that require no or minimum scrutiny from Customs at the border.

Participation in well-defined and well-established Customs-Trade Partnership programmes often indicates a reduced risk as members of these programmes have made significant investments in securing the integrity of their supply chains. These programmes are established around agreed standards to ensure confidence that industry stakeholders are complying with these requirements. Further, the responsible government authorities undertake audits and meet with programme participants to provide guidance, educate and share information with them.

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13 Examples of supply chain security programmes include the WCO Authorized Economic Operator (AEO) concept; the United States Customs-Trade Partnership against Terrorism (C-TPAT); the International Civil Aviation Organization (ICAO) Known Shipper scheme; and the Canada Border Service Agency Partners in Protection (PIP) programme.
In addition to different Customs–Trade partnerships schemes, there are also other indicators that can guide Customs officials in deciding a consignment or transaction poses a lesser risk. These can include, but are not limited to, factors such as:

- Regular business from known shippers to known recipients;\(^{14}\)
- High quality supply chain partners;
- Reliability regarding import and/or export permits; and
- Reputable producers.

For example, if the consignee is a known responsible user of nuclear and other radioactive material, the shipper is recognized as reputable and all other risk assessment elements lead to identifying the consignment as compliant and therefore of low risk, then these combined elements may provide sufficient information to allow the goods to be moved across the border unhindered by the Customs.

Following the risk identification phase, risk analysis systematically uses available information to determine how often defined risks may occur and the magnitude of their likely consequences. After analysing and evaluating the information, priorities can be defined and profiles developed to guide operational decision making in relation to individual shipments.

Risk indicators and search parameters are developed following the completion of the risk assessment process. Risk indicators flag potential problems with a particular shipment and can be used individually or be built into profiles that are used when selecting individual transactions for Customs scrutiny. The WCO Customs Risk Management Compendium \([15]\) elaborates more on risk indicators and profiling practices and provides a substantive reference material for these topics.

5.3 SCREENING AND TARGETING

Risk indicators and profiles are put into practice through the screening and targeting process. Customs declarations; manifest information; bills of lading; authorizations; and any other documentation that may be available for Customs include important information against which risk indicators and profiles are screened when determining the level of risk associated with an individual transaction.

By using indicators, profiles and their experience, trained Customs officials are able to spot certain patterns and anomalies in such documents that might imply an elevated risk for illicit trafficking and target such shipments or consignments for further investigative action.

The different data elements found in standard Customs declarations and other shipping documents used in screening and targeting include, but are not limited to, factors such as:

- Goods description;
- Weights;

\(^{14}\) The ‘recipient’ is equivalent to the consignee as defined in Ref. \([10]\).
Value;
— Packaging(s);
— State of origin;
— Destination State;
— Trans-shipment point(s);
— Carrier(s);
— Importer(s) and exporter(s);
— Shipper;
— Forwarder;
— Recipient(s);
— Customs broker(s);
— Type of conveyance.

Customs officials need to develop criteria to guide their screening and targeting practices. The WCO Customs Risk Management Compendium [15] includes useful reference material on the development of such criteria. Screening and targeting criteria are sensitive information and need to be treated as such.

Customs operate automated systems incorporating risk indicators and profiles. Automation facilitates the screening process although risk indicators and profiles can also be implemented without automation.

Illicit trafficking is a rational and deliberate act driven by intent. Traffickers may invest in disguising their acts and provide Customs with false documentation to conceal high risk shipments. Because of this, the screening and targeting process would not rely solely on any individual measure but would follow a graded or layered approach that, where appropriate, combines measures such as:

— information based screening (automated, manual or mix of both);
— intelligence;
— front-line surveillance; and
— use of technology.

6. CONTROL PROCESS

According to the outcome of the selection process, goods may either be released or subjected to additional controls. As outlined in Fig. 1, Customs control techniques can be categorized into three general clusters. These are:

— Document examination;
— Visual and physical assessments; and
— Other types of confirmation techniques.
While applying controls in relation to nuclear and other radioactive material shipments or shipments that are under suspicion to include these types of substances, Customs officials always need to be mindful of relevant safety and security procedures.

The process will differ according to whether or not the shipment is declared as a radioactive material shipment.

6.1 DETECTION OF ILLICIT TRAFFICKING OF NUCLEAR AND OTHER RADIOACTIVE MATERIAL AS PART OF A SHIPMENT DECLARED AS A RADIOACTIVE MATERIAL SHIPMENT

6.1.1 Document examination

Document examination is often the first stage of Customs controls if additional measures to verify compliance are needed. Figure 2 outlines a basic model for the document examination process.

![Methodology for document examination](image)

**Fig. 2. Methodology for document examination**

The review of documentation may be performed as a two-step process: the primary document examination concentrates on reviewing Customs and transport related documentation, whereas the
secondary document examination, if needed, may require requesting additional information and conducting additional analysis if the shipment does not meet the low risk threshold.

6.1.1.1 Initial document examination

Together with the Customs declaration, the following documents may be required (either as hard copies or electronically) to complete Customs clearance:

- Shipping documents
- Export and/or import permits where applicable; which include:
  - Name, nature (physical and/or chemical form) and quantitative characteristics such as activity/mass of the material;
  - Authorization type, whether export from or import to, and authorization expiration date;
  - Legal name and address of the recipient (when applicable);
  - Shipping and receiving States;
  - Legal name and address of a shipper (when applicable);

The Dangerous Goods Declaration may be requested by Customs Officials since it provides some significant details on the declared content including:

- Radionuclide
- Activity
- UN Dangerous Goods number
- Proper shipping name

6.1.1.2 Additional information (available on request)

Further to the normal documentation that relates to the shipment, Customs may request some additional information from the shipper such as:

- Dose rate monitoring records, if available, can contain information on gamma and neutron dose rates in contact with and at a specified distance from the package, contact temperature, etc.:
- Reference number of certificate/permission for handling of nuclear and other radioactive material, the date of issue and the expiration date when applicable;
- Reference number, where applicable, of certificate/permission for safe transport/conveyance of nuclear and other radioactive material, the date of issue and the expiration date;

Most shippers have a permanently attended contact number which can be called to ask questions or to obtain additional information.
Reference number, where applicable, of certificate for the container used to carry the radioactive material.

It needs to be noted that not all these documents are available or issued for all radioactive material transported.

6.1.1.3 Analysis of the content of the documents

The information extracted from the documents may be analyzed in order to detect inconsistencies, anomalies or illogical combinations. For example, the transport index TI of a package containing a pure beta-emitter of small activity cannot be high. Significant discrepancies may trigger further actions as detailed in Section 4.

6.1.2 Visual and physical assessments

Visual and physical assessments or controls often consist of radiation measurement and checking of seals. Radiation measurements described here may not prove legitimacy of a shipment to a high degree of confidence. These checks have to be used in conjunction with other available documents and data as part of an overall assessment.

These measures could include the following:

— Data from radiation portal monitors and any subsequent examination.
— Making radiation dose rate measurements;
— Checking of seals.

Before starting any measurements on a shipment, appropriate radiation protection procedures have to be implemented and followed (in accordance with the requirements for radiation protection as established in the IAEA safety standards [4]). Measurement techniques described in this sub-section require trained and competent personnel, procedures and appropriate equipment for measurement of dose-rate on the exterior of the package without the need for opening a package.

6.1.2.1 Radiation portal monitoring

Some States have implemented radiation detection at borders, usually in the form of portal monitors and some form of additional examination when required. Radiation measurement data may be readily available from such systems and need to be utilized as part of an overall assessment. Data from portals provides count rates that can be used for broad comparison with known shipments. If neutron detectors are present in a portal these are likely to be the most sensitive neutron detector available. A subsequent examination may include the use of hand-held radionuclide identification detectors, the results from which may be useful in the assessment of the shipment.
6.1.2.2 Radiation measurement

Where available and appropriate, dose-rate measurements could be made for broad comparison with the transport documents. The dose-rates on shipments of short-lived nuclides (half-life typically less than 5 days) will be less than the values given in the transport documents. The dose rate measurements made at a border crossing may be at variance from that made at the point of origin due to the limitations on the accuracy of radiation monitors. In addition, in the case of a multi-package shipment, the dose rate measurement of one package may be affected by radiation from other packages. These discrepancies need to be taken into account while making dose-rate measurements. Radioactive material in excepted packages does not require labelling as radioactive but will be marked with the appropriate UN number. Dose-rates on external surfaces of such packages could be up to 5 μSv/h.

All radiation measurement instruments (hand-held, portable, installed monitors, etc.) need to be used and maintained in accordance with manufacturer’s instructions and calibrated and documented in accordance with the national requirements.

The labels affixed on the external surfaces of packages, freight containers and overpacks indicate the TI. The TI is related to the dose-rate measured on the exterior of the packages, freight containers and overpacks. Information on TI limits and package categories is given in Appendix II.

The recommended typical performance characteristics of the equipment used for confirmation of the TIs, category and radiation dose rate of transport packages are discussed in Appendix I.

6.1.2.3 Checking of seals

Types of seals for radioactive and nuclear material can be anything from package security tape for cardboard carton packages to individually numbered breakable seals for large containers. The objective of the use of a seal is to give an indication if a package or a shipment has been tampered with and therefore the inner contents potentially compromised. Procedures for application and confirmation of seals are required by the Transport Regulations.

In addition to seals, there are a wide variety of other types of security devices that can be deployed to promote the integrity of a shipment. Where a security device is deployed on package or a shipment, it needs to be checked to confirm that it has not been tampered with. Customs officials need to be made familiar with the various types of security devices. If the security device of the package is numbered, this needs to be noted in transport documents.

In case of security device failure or a suspicion of package tampering, Customs officers need to inform the regulatory bodies according to the national procedures and take the appropriate actions.

In particular, IAEA seals must not be broken (see privileges and immunities of the Agency (Art. 10 of INFCIRC/153 (Corrected) [18])). The IAEA has to be informed BEFORE Customs break any IAEA
seals so that IAEA can send an inspector to oversee the breaking of the seal. No numbered seals are to be broken without first informing relevant authorities and the shipper.

Nevertheless, if it has happened, the regulatory body and the IAEA have to be promptly informed. If broken or replaced with another seal (numbered or unnumbered) the reference in the shipping documents will be incorrect and the package will appear to have been tampered with, having significant negative consequences. Appropriate changes and verifications would then need to be made to the shipping documents.

*Note:* Packages containing radioactive material are never to be opened en route [10].

### 6.1.3 Confirmation techniques

If required, it may be necessary to determine the package content with greater confidence. Measurement techniques selected need to be commensurate with the need for confirmation. However, measurement techniques may be limited by the availability of technical and human resources. These capabilities may not always exist within the Customs organization. Customs officials need to cooperate with the relevant regulatory bodies, as necessary. Confirmation of the package content is achieved by determining the quality and the quantity of the declared nuclear and other radioactive material (the nature of nuclear and other radioactive material, their isotopic compositions, activity, etc.) for consistency with declared data.

After completing the confirmation techniques recommended in this sub-section, if the shipment is required to be held for further investigation, then Customs need to identify an appropriate secure storage area where the consignment would be kept stored in conformity with the applicable regulations and provide appropriate security arrangements until the investigation is completed and consignment can be moved.

Confirmation techniques should not damage or change the integrity of the package or the quality of the verified nuclear material or radioactive material ([10] para. 582). Confirmation techniques described in this Section require trained and competent personnel, procedures and appropriate equipment for confirmation of package content, without opening a package.

The following additional procedures can be used, where applicable, separately or in combination, in order to assess the declared contents of shipment of nuclear and other radioactive material:

- Weighing (gross mass);
- X-ray examination;
- Neutron measurements; and
- Gamma spectrometry.
6.1.3.1 Weighing of packages

The gross mass of the package is required to be marked on the external surface of the package weighing in excess of 50 kg. In many cases where the gross mass is 50 kg or less, the gross mass of the package may be stated in the transport documents. Weighing of packages and comparing the measured value with the documented value is one of the methods to assess the contents of a package.

The weighing equipment needs to be calibrated, maintained, and documented in accordance with manufacturer’s instructions. Limitations on the accuracy of weight measurements at the point of origin and the error in the user measurements need to be considered when addressing weight discrepancies.

Weighing packages provides limited information due to packages being declared at their maximum weight. The stillage, playing the function of restraint system attached to the conveyance, as applicable, may not be part of the package and therefore would not be included in the declared mass. The stillage must not be removed from the package.

6.1.3.2 X-ray examination

X-ray examination of packages may be useful to confirm the content and geometry of packages containing radioactive material. Standard and special X-ray equipment (radiography equipment) can be used for this purpose. In some cases, the density of the shielding material will make interpretation of a radiography image difficult or impossible. The use of X-ray examination may be more useful for shipments not declared as radioactive material shipments where the presence of shielding material may be an indicator of attempted concealment of radioactive material.

6.1.3.3 Neutron measurements

The detection of neutrons from a package may indicate the presence of illicit nuclear and other radioactive material if the declared nuclear and other radioactive material is not a known neutron emitter. Neutron measurements may also be useful in confirming package contents for known neutron emitters.

The detection of neutrons does not always indicate an illicit activity as there are legitimate consignments that may contain neutron emitting material. Depleted uranium used as shielding for some radioactive material shipments is also a neutron emitter.

If it is suspected that a package contains a fissile material or fissionable material which is not included in the declared nuclear and other radioactive material shipment, a neutron detector can be used for further examination. Neutron dose rate meters may be utilized but, for greater sensitivity, neutron count rate meters, with higher detection efficiency and sensitivity, are more suitable.

If neutron measurements are not consistent with the declared package contents other confirmation techniques are to be utilized.

More information is provided in Appendix II.
6.1.3.4 Gamma spectrometry

Gamma spectrometry is the most appropriate tool to identify the gamma-emitting radionuclides in a closed package.

Hand-held radionuclide identification detectors are commonly available and in use at borders. These instruments are generally low-resolution gamma spectrometers suitable for basic identification of nuclides. Such instruments have technical limitations (low efficiency, low spectral resolution, simplified software for spectrum analysis, etc.) and may not be sufficient for confirmation of a shipment declared as a radioactive material shipment.

For a more complete identification of the radioactive material in a closed package, high-resolution gamma spectrometry is more suitable in order:

- To identify and quantify declared (nuclear material and other) radioactive material using a complete isotopic library and detailed package information;
- To detect in the package (nuclear material and other) radioactive material, which is not included in the declared nuclear material and other radioactive material shipment; and
- To confirm isotopic composition and enrichment of nuclear material.

Knowledge of the package design is essential for qualitative and quantitative measurements of radioactive material. The drawings have to be made available by the regulatory body, if so required by the Customs. More information can be found in Appendix II.

6.2 DETECTION OF ILLICIT TRAFFICKING OF NUCLEAR AND OTHER RADIOACTIVE MATERIAL AS PART OF A SHIPMENT NOT DECLARED AS A RADIOACTIVE MATERIAL SHIPMENT

As part of the selection process, a high-risk shipment for illicit trafficking of nuclear and other radioactive material in a shipment not declared as a radioactive material shipment may be identified. This may trigger further scrutiny to satisfy Customs officials about compliance.

In any shipment not declared as a radioactive material shipment, the guidance provided in sub-section 6.1.3 on measurement techniques and in the Appendices I and II, needs to be applied when determining the characteristics of a radioactive source.

6.2.1 Document examination

Unlike with shipments declared as radioactive material shipments, the documentation for a shipment not declared as a radioactive material shipment may not reveal much about the radioactive content of the shipment.
Naturally occurring radioactive material (NORM) often cause radiation alarms (innocent alarms). In the case of alarm, further examination of all available documentation and questioning of relevant Parties (shipper/consignor, recipient/consignee, carrier, logistics provider or broker) can provide Customs officials with useful information about the source of radiation within the shipment; thereby guiding decisions on further control activities.

6.2.2 Visual and physical assessments

Visual and physical assessments in the case of a shipment not declared as a radioactive material shipment consist of different types of radiation measurements outlined in sub-section 6.1.2. Unlike with shipments declared as radioactive material shipments, these measurements often cannot be used in conjunction with other documents on shipment radiation levels as these documents may not be available.

In the case of radiation detection equipment alarms, the results of measurements can be compared with normal radiation levels of NORM to gain assurance that the naturally emitting substance is the sole source of radiation.

As outlined in sub-section 6.1.2.2, all radiation measurement instruments (hand-held, portable, installed monitors, etc.) have to be used and maintained in accordance with manufacturer’s instructions and calibrated and documented in accordance with the national requirements.

6.2.3 Confirmation techniques

If documentary examination, visual and physical assessment, and any other information possessed by Customs officials do not allay concerns about illicit trafficking, it will be necessary to determine and confirm the package content with greater confidence. Measurements and investigation including consultation with technical support (see para. 3.4.2) when necessary, need to be conducted until the source of radiation is confirmed.

6.3 DECISION TO SUSPEND OR RELEASE THE CONSIGNMENT

When applying controls to radioactive material shipments, the results need to be carefully studied after each stage to determine whether the shipment can be released or whether it needs to be subjected to further controls.

If non-compliance is detected, once all available control measures have been exhausted, the shipment needs to be secured at a suitable location for further investigation under the control of Customs.

If a shipment is not cleared, Customs officials need to be mindful of the safety and security requirements commensurate with the risk.
I.1. METHODOLOGY FOR CONFIRMATION OF TRANSPORT INDEX (TI)

A methodology for confirmation of the TI is given below:

a) Maximum radiation level in mSv/h is measured at 1 m from the external surfaces of the package or freight container or overpacks or unpackaged LSA-I or SCO-I (low specific activity; surface contaminated object); the measured result is multiplied by 100; the resulting number is the TI.

b) Multiplication factors for tanks, freight containers and unpackaged LSA-I and SCO-I, the value determined in step a) are multiplied by the appropriate factor from Table 1.

<table>
<thead>
<tr>
<th>Size of load *</th>
<th>Multiplication factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of load ≤ 1 m²</td>
<td>1</td>
</tr>
<tr>
<td>1 m² &lt; Size of load ≤ 5 m²</td>
<td>2</td>
</tr>
<tr>
<td>5 m² &lt; Size of load ≤ 20 m²</td>
<td>3</td>
</tr>
<tr>
<td>20 m² &lt; Size of load</td>
<td>10</td>
</tr>
</tbody>
</table>

* Largest cross-sectional area of the load being measured.

a) If there are several packages in one overpack, freight container or conveyance, the TI for each overpack, freight container or conveyance is determined as either the sum of the TIs of all the packages contained, or by direct measurement of radiation level, except in the case of non-rigid overpacks, for which the TI is determined only as the sum of the TIs of all the packages;

b) For uranium or thorium ores and their concentrates, the maximum radiation level at any point 1 m from the external surface of the load may be taken as:

- o 0.4 mSv/h for the uranium and thorium ores and their physical concentrates;
- o 0.3 mSv/h for the chemical concentrates of thorium;
- o 0.02 mSv/h for the chemical concentrates of uranium, except uranium hexafluoride.

The Customs officials need to be cautioned that in certain instances, the measured value of the TI of a consignment could be different from the declared value, leading to erroneous suspicions of discrepancies. For example, in the case of radionuclides used in nuclear medicine and short-lived nuclides, the measured and the declared TI values could be significantly different. When packages
shipped in overpack or freight container, the TI calculations are for the overpack or freight container, not the individual packages. Comparison of the TIs in such instances would be erroneous and problematic.

The categories (I-WHITE, II-YELLOW, III-YELLOW) of packages are based on the results of the dose rate (gamma + neutrons) measurement at the external surface of the package and the TI. If the TI satisfies the condition of one category, but the surface radiation level satisfies the condition for a different category, the package or the overpack is assigned to the higher category. In any case, the category “I-WHITE” is considered the lowest category (See Table 2).

**TABLE 2. THE CATEGORIES OF PACKAGES AND OVERPACKS (FROM REF. [10])**

<table>
<thead>
<tr>
<th>Transport index TI</th>
<th>The maximum radiation level at the any point of the external surface</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0(^a)</td>
<td>Not more than 0.005 mSv/h</td>
<td>I - WHITE</td>
</tr>
<tr>
<td>More than 0 but not more than 1 (^a)</td>
<td>More than 0.005 mSv/h but not more than 0.5 mSv/h</td>
<td>II – YELLOW</td>
</tr>
<tr>
<td>More than 1 but not more than 10</td>
<td>More than 0.5 mSv/h but not more than 2 mSv/h</td>
<td>III – YELLOW</td>
</tr>
<tr>
<td>More than 10</td>
<td>More than 2 mSv/h but not more than 10 mSv/h</td>
<td>III -YELLOW(^b)</td>
</tr>
</tbody>
</table>

\(^a\) If the measured TI is not greater than 0.05. The quoted value may be zero.
\(^b\) Only for transport under exclusive use.

**I.2. PARAMETERS OF PORTABLE DOSE RATE METERS**

The typical parameters of the equipment used for confirmation of the TIs, category, and radiation dose rate of packages are shown in Table 3.

**TABLE 3: TYPICAL PERFORMANCE CHARACTERISTICS FOR PORTABLE DOSE RATE METERS**

<table>
<thead>
<tr>
<th>Type of radiation</th>
<th>Measured parameters</th>
<th>Measured range</th>
<th>Energy range of the measured radiation</th>
<th>Max. error, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamma</td>
<td>Dose rate, µSv/h</td>
<td>From 0.1 to 1 × 10^4 µSv/h</td>
<td>From 0.05 to 3 MeV</td>
<td>±20</td>
</tr>
<tr>
<td>Neutron</td>
<td>Dose rate, µSv/h</td>
<td>From 1 to 1 × 10^8 µSv/h</td>
<td>From thermal to 14 MeV</td>
<td>±40</td>
</tr>
</tbody>
</table>

Portable dose rate meters can be used for confirmation of package category and TI. The investigating authorities need to be aware that when using portable dose rate meters of the types in Table 3, there could be large relative errors between dose-rate meters and this needs to be taken into consideration before reaching any judgment.

Some of the operating specifications of typical hand-held radiation detection instruments are:
— Working temperature: from -20°C to +50°C;
— Time of continuous work using the built-in batteries: not less than 8 hours;
— Weight of hand-held instruments: typically less than 5 kg;
— Total measuring time: not more than 300 s.

Typically measurement times could vary from 10 to 100 s.
Appendix II
CONFIRMATION TECHNIQUES

II.1. INSTRUMENTATION FOR THE DETECTION OF NEUTRONS

Neutron dose rate meters can be utilized as a qualitative measurement tool in order to indicate the presence of neutrons. However, when used for this purpose, users must be aware of the sensitivity limitations of the equipment and thus must interpret the readings with caution.

Radiation portal monitors with neutron detection capabilities and hand-held neutron detectors provide a more reliable way of detecting the presence of a neutron source. In this methodology, radiation portal monitors and hand-held neutron detectors may indicate the presence of illicit (nuclear and other radioactive) material if the declared nuclear and other radioactive material is not a known neutron emitter.

II.2. GAMMA SPECTROMETRY

Gamma spectrometers can be utilized to assess a shipment declared as a radioactive material shipment.

II.2.1 Low resolution gamma spectrometry

Handheld radionuclide identifiers can be used for searching and localization of radioactive sources. Furthermore, these instruments can be operated as gamma spectrometers to identify certain user defined radionuclides. For this purpose the gamma radiation spectra are compared with gamma lines or reference spectra of common radionuclides and identified. Relevant particulars are provided in Ref. [1].

The scintillation detectors used in the radionuclide identifiers have relatively low resolution. They are suitable for identification of radioactive material with relatively simple gamma spectra through limited shielding (e.g. $^{60}$Co, $^{137}$Cs, $^{67}$Ga, etc.). They can also be used to confirm the absence of radioactive material in some shielded packages.

II.2.2 High resolution gamma spectrometry

Semiconductor detectors (e.g. germanium, cadmium-telluride) have much better resolution and are preferred for measurements of complex gamma spectra or for accurate quantitative measurements of nuclides (e.g. $^{235}$U enrichment in UF$_6$ cylinders, etc.).

II.2.3 Gamma spectrometric measurements

Gamma spectrometry can be used for establishing the quality and quantity of gamma emitting radionuclides including enrichment of nuclear material. An appropriate set up has to be established for
making the measurements. Suitably qualified and experienced personnel need to be entrusted with the
task of making the measurements.

It is desirable to have a dedicated measurement area separate from other radioactive material to reduce
background radiation and to improve measurement accuracy. In addition, collimators may be used for
the detectors.

It is recommended to check the package design to locate the radiation source position inside the
package. Requirements for disclosure of design characteristics of transport packages are described in
para. 838(j) of Ref. [10]. If the data are not available, it is necessary to verify the radiation source
position by making additional measurements around the package. The maximum count rate or dosemeter reading would correspond to the actual position of the radioactive sources in the package, as
shown in the figure below. The distance from the package surface needs to be selected so that the
count rate is optimized. The spectrometer dead time should not be above the recommended value.

If the declared (nuclear and other radioactive) material is transported in a package for which design
information is not available, the gamma attenuation factor may be calculated in order to verify the
activity of the source. In this case, two or more different gamma energy lines of the same measured
radioactive nuclide with known abundances can be used to calculate attenuation in the shielding
material. This calculation may result in large uncertainties.

The measured gamma spectrum is analysed in order to identify the radionuclides and calculate their
activities. Information on the declared radionuclides, their activities as on a specified date, type of
package and distance from the detector to the surface of the package can be used to confirm the
declared contents. Software, incorporating package design characteristics may be available to assist in
the analysis.
**Fig. 3. Position of detector and package.**

1. $L_1$ is the distance of the detector from the external surface of the container.
2. $L_2$ is the distance of the detector from the source position within the container.
3. $H$ is the distance of the source position within the container from the floor.
4. $h$ is the distance of the source position from the bottom of the containment system within the container.

**TABLE 4. TYPICAL PARAMETERS OF A GAMMA-SPECTROMETER**

<table>
<thead>
<tr>
<th>Quantity name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of measured gamma energies, keV</td>
<td>$50–3 \times 10^3$</td>
</tr>
<tr>
<td>Energy resolution:</td>
<td></td>
</tr>
<tr>
<td>- semi-conductor spectrometer, better than</td>
<td>0.2%</td>
</tr>
<tr>
<td>- scintillation spectrometer, better than</td>
<td>8%</td>
</tr>
<tr>
<td>Efficiency (1332 keV, $^{60}\text{Co}$):</td>
<td></td>
</tr>
<tr>
<td>- semi-conductor spectrometer, better than (%)</td>
<td>15%</td>
</tr>
<tr>
<td>- scintillation spectrometer, better than (%)</td>
<td>40%</td>
</tr>
<tr>
<td>Maximum error in quantitative measurement (point geometry), better than</td>
<td>$\pm 10%$</td>
</tr>
<tr>
<td>Continuous measurement time:</td>
<td></td>
</tr>
<tr>
<td>Main power supply, not less than</td>
<td>24 h</td>
</tr>
<tr>
<td>Batteries, not less than</td>
<td>8 h</td>
</tr>
<tr>
<td>Number of channels in the analyser:</td>
<td></td>
</tr>
<tr>
<td>- semi-conductor spectrometer</td>
<td>8192</td>
</tr>
<tr>
<td>- scintillation spectrometer</td>
<td>1024</td>
</tr>
<tr>
<td>Climatic conditions for stable spectrometer operation Temperature, °C</td>
<td>From -20 to +50</td>
</tr>
<tr>
<td>Relative humidity, (%)</td>
<td>Up to 90</td>
</tr>
</tbody>
</table>
II.2.3.1. Confirmation of uranium isotopic composition

If it is required to confirm a uranium shipment this needs to include the confirmation of the enrichment.

Computer software is available to assist in the confirmation of the declared uranium enrichment, which uses different energy regions of the collected gamma spectra of uranium or a combination of two of them: 89–100 keV, 185 keV and 1001 keV. Owing to high attenuation of low energy gamma rays, the 89–100 keV region is typically used for the packages with a steel wall thickness less than 5 mm. Only approved software is to be used for this purpose.

If similar packages, containing the same or similar uranium products are found in several shipments, one of the packages with known uranium enrichment may be selected as reference. The other packages can be measured in the same geometry as used for the reference package and the results can be compared.

II.2.3.2. Confirmation of plutonium isotopic composition

Computer software is available to assist in the analysis of plutonium isotopic composition. Plutonium isotopic composition can be measured using two regions of the gamma spectrum: 120–210 keV or 630–670 keV. The low energy region is preferable but it can be used only for packages with low attenuation of gamma rays. Only approved software is to be used for this purpose.
REFERENCES


[18] The Structure and Content of Agreements between the IAEA and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/153 (Corrected), Vienna (1972).
