IAEA
International Atomic Energy Agency

Safeguards Implementation Practices Guide on Facilitating IAEA Verification Activities

Vienna, December 2014

Services Series 30

SAFEGUARDS IMPLEMENTATION PRACTICES GUIDE ON FACILITATING IAEA VERIFICATION ACTIVITIES

The following States are Members of the International Atomic Energy Agency:

AFGHANISTAN
ALBANIA
ALGERIA
ANGOLA
ARGENTINA
ARMENIA
AUSTRALIA
AUSTRIA
AZERBAIJAN
BAHAMAS
BAHRAIN
BANGLADESH
BELARUS
BELGIUM
BELIZE
BENIN
BOLIVIA
BOSNIA AND HERZEGOVINA
BOTSWANA
BRAZIL
BRUNEI DARUSSALAM
BULGARIA
BURKINA FASO
BURUNDI
CAMBODIA
CAMEROON
CANADA
CENTRAL AFRICAN REPUBLIC
CHAD
CHILE
CHINA
COLOMBIA
CONGO
COSTA RICA
CÔTE D'IVOIRE
CROATIA
CUBA
CYPRUS
CZECH REPUBLIC
DEMOCRATIC REPUBLIC OF THE CONGO
DENMARK
DOMINICA
DOMINICAN REPUBLIC
ECUADOR
EGYPT
EL SALVADOR
ERITREA
ESTONIA
ETHIOPIA
FIJI
FINLAND
FRANCE
GABON
GEORGIA
GERMANY
GHANA
GREECE
GUATEMALA
HAITI
HOLY SEE
HONDURAS
HUNGARY
ICELAND
INDIA
INDONESIA
IRAN, ISLAMIC REPUBLIC OF
IRAQ
IRELAND
ISRAEL
ITALY
JAMAICA
JAPAN
JORDAN
KAZAKHSTAN
KENYA
KOREA, REPUBLIC OF
KUWAIT
KYRGYZSTAN
LAO PEOPLE'S DEMOCRATIC REPUBLIC
LATVIA
LEBANON
LESOTHO
LIBERIA
LIBYA
LIECHTENSTEIN
LITHUANIA
LUXEMBOURG
MADAGASCAR
MALAWI
MALAYSIA
MALI
MALTA
MARSHALL ISLANDS
MAURITANIA, ISLAMIC REPUBLIC OF
MAURITIUS
MEXICO
MONACO
MONGOLIA
MONTENEGRO
MOROCCO
MOZAMBIQUE
MYANMAR
NAMIBIA
NEPAL
NETHERLANDS
NEW ZEALAND
NICARAGUA
NIGER
NIGERIA
NORWAY
OMAN
PAKISTAN
PALAU
PANAMA
PAPUA NEW GUINEA
PARAGUAY
PERU
PHILIPPINES
POLAND
PORTUGAL
QATAR
REPUBLIC OF MOLDOVA
ROMANIA
RUSSIAN FEDERATION
RWANDA
SAN MARINO
SAUDI ARABIA
SENEGAL
SERBIA
SEYCHELLES
SIERRA LEONE
SINGAPORE
SLOVAKIA
SLOVENIA
SOUTH AFRICA
SPAIN
SRI LANKA
SUDAN
SWAZILAND
SWEDEN
SWITZERLAND
SYRIAN ARAB REPUBLIC
TAJIKISTAN
THAILAND
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
TOGO
TRINIDAD AND TOBAGO
TUNISIA
TURKEY
UGANDA
UKRAINE
UNITED ARAB EMIRATES
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
UNITED REPUBLIC OF TANZANIA
UNITED STATES OF AMERICA
URUGUAY
UZBEKISTAN
VENEZUELA, BOLIVARIAN REPUBLIC OF
VIET NAM
YEMEN
ZAMBIA
ZIMBABWE

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world''.

IAEA SERVICES SERIES No. 30

SAFEGUARDS IMPLEMENTATION PRACTICES GUIDE ON FACILITATING IAEA VERIFICATION ACTIVITIES

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2014

Marketing and Sales Unit, Publishing Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna, Austria
fax: +43 1 2600 29302
tel.: +43 1 2600 22417
email: sales.publications@iaea.org
http://www.iaea.org/books

For further information on this publication, please contact:

Strategic Planning and External Coordinaton Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna, Austria
Email: Official.Mail@iaea.org

SAFEGUARDS IMPLEMENTATION PRACTICES GUIDE ON FACILITATING IAEA VERIFICATION ACTIVITIES
IAEA, VIENNA, 2014
IAEA-SVS-30
ISSN 1816–9309

Printed by the IAEA in Austria
December 2014

FOREWORD

The IAEA implements safeguards pursuant to agreements concluded with States. It is in the interests of both States and the IAEA to cooperate to facilitate the practical implementation of safeguards. Such cooperation is explicitly required under all types of safeguards agreement.

Effective cooperation depends upon States and the IAEA sharing a common understanding of their respective rights and obligations. To address this, in 2012 the IAEA published Services Series 21, Guidance for States Implementing Comprehensive Safeguards Agreements and Additional Protocols, which aimed at enhancing understanding of the safeguards obligations of both States and the IAEA and at improving their cooperation in safeguards implementation. States may establish different processes and procedures at the national level, and set up different systems as required to meet their safeguards obligations. Indeed, a variety of approaches are to be expected, owing to such differences as the size and complexity of States' nuclear programmes and their regulatory framework.

The purpose of this Safeguards Implementation Practices (SIP) Guide is to share the experiences and good practices as well as the lessons learned by both States and the IAEA, acquired over the many decades of safeguards implementation. The information contained in the SIP Guides is provided for explanatory purposes and use of the Guides is not mandatory. The descriptions in the SIP Guides have no legal status and are not intended to add to, subtract from, amend or derogate from, in any way, the rights and obligations of the IAEA and the States set forth in The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons (issued as INFCIRC/153 (Corrected)) and Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards (issued as INFCIRC/540 (Corrected)). This SIP Guide provides information which States may find useful in implementing their safeguards agreements with the IAEA.

The IAEA wishes to acknowledge the many safeguards practitioners from Member States who have contributed to the creation of this SIP Guide. The IAEA appreciates the Member State Support Programmes that participated in Task JNT C01959: Member State Contributions to IAEA Topical Guidance on Safeguards Implementation, which facilitated the participation of external experts in providing input to the SIP Guides. The IAEA officer responsible for this publication was C. Mathews of the Division of Concepts and Planning.

TABLE OF CONTENTS

1. INTRODUCTION 1

1.1. Purpose, scope and structure 1

1.2. The SRA and the State/regional system of accounting for and control of nuclear material (SSAC/RSAC) 2

1.3. Overview 3

2. ESTABLISHING THE FRAMEWORK TO FACILITATE IAEA ACCESS 4

2.1. Communication, roles and responsibilities 4

2.2. Inspector designation 5

2.3. Subsidiary Arrangements 5

2.4. Receiving and responding to IAEA notifications 6

2.5. Planning for IAEA in-field verification activities 7

3. IAEA ACTIVITIES IN STATES – DESIGN INFORMATION EXAMINATION AND VERIFICATION 7

3.1. Introduction 7

3.2. Objectives of design information examination 8

3.3. Objectives of design information verification 9

3.4. IAEA activities carried out during DIV 10

3.5. Essential Equipment List (EEL) 12

3.6. Example of DIV at facilities under construction or modification 13

3.7. Scheduling of DIVs 15

3.8. State support to DIV activities 16

3.9. Benefits of effective State-IAEA cooperation during facility construction 17

4. IAEA ACTIVITIES IN STATES - INSPECTIONS 17

4.1. Ad hoc inspections 17

4.2. Routine inspections 17

4.2.1. Unannounced routine inspections 18

4.2.2. Short-notice routine inspections (SNRIs) 20

4.3. IAEA activities conducted during inspections 20

4.3.1. Review of nuclear material accounting reports and records 22

4.3.2. Evaluation of an operator’s measurement system 23

4.3.3. Use of containment and surveillance (C/S) measures 24

4.3.4. IAEA use of secure electronic mailbox systems 25

4.3.5. IAEA measurements of nuclear material 26

4.3.6. Destructive analysis 27
4.3.7. Environmental sampling 28
4.4. Specific provisions for inventory taking and verification 28
5. IAEA ACTIVITIES IN STATES – COMPLEMENTARY ACCESS 30
5.1. IAEA activities during complementary access 30
5.2. Notification 31
5.3. Managed access 31
5.4. Considerations for CA with twenty-four hour access 32
5.5. Considerations for complementary access with advance notice of two hours or less 33
6. STATE ACTIVITIES TO PREPARE FOR IN-FIELD VERIFICATION 34
6.1. General considerations in preparing for any type of IAEA in-field verification 34
6.2. Operational programmes 37
6.3. Facility-specific health and safety information including radiation protection 37
6.4. Facility-specific procedures 37
6.5. Basic essentials for IAEA inspectors 38
6.6. Operational support to inspectors 39
6.7. Accompanying inspectors 39
6.8. Facility-specific training for IAEA inspectors 40
6.9. Customs clearance of IAEA equipment and samples 42
6.10. Use and storage of IAEA equipment at facilities 42
6.11. Opening meeting 43
6.12. Resolving difficulties during in-field activities 44
6.13. Closing meeting 46
6.14. Action tracking and follow up 46
6.15. Considerations regarding IAEA inspections at LOFs 47
7. IAEA USE OF EQUIPMENT 48
7.1. Introduction 48
7.2. Portable equipment 48
7.3. Unattended and remote monitoring systems 49
7.4. Non-destructive assay measurement equipment 50
7.5. Sensors 51
7.6. Sealing systems 52
7.7. Tamper indicating enclosures 53
7.8. Data generators 54

7.9. Operational aspects of IAEA equipment ... 55
7.10. Facility infrastructure needed to support the use of IAEA equipment ... 55
7.11. IAEA review of data ... 56
7.12. IAEA equipment maintenance ... 58
7.13. Joint-use equipment ... 58
7.14. IAEA authorization of equipment for safeguards use ... 59
7.15. Technology evolution ... 60
8. SAFEGUARDS IMPLEMENTATION AT LOCATIONS OUTSIDE FACILITIES ... 60
8.1. Introduction ... 60
8.2. Submitting information on LOFs ... 60
8.3. Nuclear material at LOFs ... 60
8.4. Facilitating access to LOFs ... 61
8.5. Carrying out in-field activities at LOFs ... 62
9. RESOURCES AVAILABLE TO STATES RELATED TO FACILIATING IAEA VERIFICATION ACTIVITIES ... 62
BIBLIOGRAPHY ... 63
ABBREVIATIONS ... 65
ANNEX 1 – TABLE OF CONTENTS OF MODEL SUBSIDIARY ARRANGEMENTS (GENERAL PART) ... 67
ANNEX 2 – FACILITY LIFECYCLE STAGES AND ASSOCIATED SAFEGUARDS ACTIVITIES ... 69
ANNEX 3 - CASE STUDY ON DESTRUCTIVE ASSAY SAMPLING AND ANALYSIS ... 73
ANNEX 4 – EXAMPLE FACILITY PROCEDURES TO SUPPORT A PIV AT A BULK HANDLING FACILITY ... 75
ANNEX 5 – CASE STUDY IN FACILITATING COMPLEMENTARY ACCESS WITH 24 HOUR ADVANCE NOTIFICATION ... 77
ANNEX 6 – EXAMPLE PROCEDURE FOR FACILITATING IAEA COMPLEMENTARY ACCESS ... 81
ANNEX 7 - CASE STUDY ON ROLES AND RESPONSIBILITIES IN PREPARING FOR IAEA ACCESS ... 85
ANNEX 8 – EXAMPLES OF IDENTIFICATION AND RESOLUTION OF A POSSIBLE INCONSISTENCY OR DISCREPANCY ... 89
ANNEX 9 – REMOTE MONITORING SYSTEMS ... 91
CONTRIBUTORS TO DRAFTING AND REVIEW ... 95

1. INTRODUCTION

1.1. Purpose, scope and structure

The purpose of Safeguards Implementation Practices (SIP) Guides is to share information about effective safeguards implementation practices for the benefit of all States, particularly with the aim of enhancing their capacity and capabilities in the area of safeguards implementation. States with Small Quantities Protocols are advised to refer to the Safeguards Implementation Guide for States with Small Quantities Protocols (IAEA Services Series 22) found on the IAEA Resources and Assistance for States webpage[1].

This SIP Guide addresses the activities undertaken by States and operators/licensees to **effectively facilitate IAEA verification activities** that are carried out both in the State and at IAEA headquarters, to meet safeguards objectives.

The Guide primarily addresses the activities undertaken by the IAEA and States pursuant to a comprehensive safeguards agreement (CSA) based on INFCIRC/153 (Corr.) and an additional protocol based on INFCIRC/540 (Corr.). However, States that have concluded a voluntary offer safeguards agreement (VOA) and States that have concluded item-specific safeguards agreements based on INFCIRC/66/Rev.2 could also use this Guide to facilitate the implementation of IAEA activities under their safeguards agreements.

SIP Guides belong to a series of guidance prepared by the IAEA with the assistance of experts from Member States and are focused on facilitating safeguards implementation in States with CSAs. The Guides that have been published as well as those that are planned for this series are shown in Figure 1. The SIP Guides further elaborate on the content of the *Guidance for States Implementing Comprehensive Safeguards Agreements and Additional Protocols* (IAEA Services Series 21). This SIP Guide describes the communication channels, roles, responsibilities and specific arrangements that support the verification activities conducted by the IAEA. Design information examination and verification, inspections, and complementary access are explained, as well as the specific support the SRA and operators may provide to each of these IAEA activities. The different kinds of IAEA equipment are also described in some detail. Finally, the general support by States and operators to IAEA verification activities is addressed. Several annexes included in this SIP Guide provide case studies and examples of such support and good practices.

Key points are provided in coloured text boxes such as this one.

Implementation practices and examples are contained in ***white text boxes with italicized text.***

The diagram shown in Figure 1 indicates the subjects of each of the four SIP Guides, and their relationship with the higher level Guidance for States Implementing CSAs and APs (IAEA Services Series 21). IAEA Services Series 11 and 15 are also shown, which provide guidance on additional protocol declarations and nuclear material accountancy, respectively.

[1] www.iaea.org/safeguards/resources-for-states/guidance-documents.html

Guidance documents and many other resources can be found at www.iaea.org/safeguards under the ‘Resources and Assistance for States’ tab.

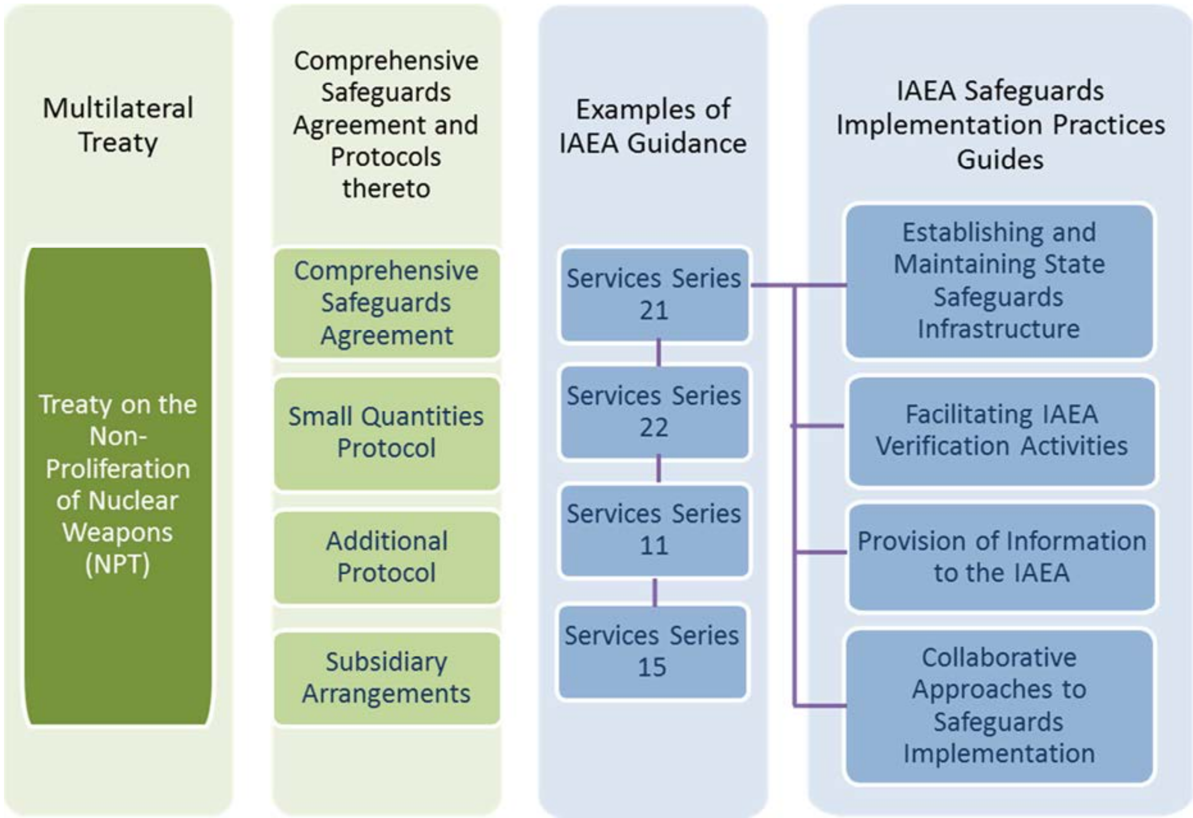

FIG 1. IAEA safeguards guidance related to comprehensive safeguards agreements

1.2. The SRA and the State/regional system of accounting for and control of nuclear material (SSAC/RSAC)

The IAEA and the State must cooperate to implement safeguards, as specified in the State’s CSA. CSAs also provide for the establishment and maintenance of a State (or regional) system of accounting for and control of nuclear material (SSAC/RSAC).

The SSAC and the State[2] authority responsible for safeguards implementation, or SRA, are described below.

The **State authority responsible for safeguards implementation (SRA)** is the authority established at the national level to ensure and facilitate the implementation of safeguards. In addition to its safeguards functions, the SRA (if established within a broader nuclear authority) may have additional responsibilities associated with nuclear safety, security, radiation protection and export/import controls. One of the primary responsibilities of an SRA is to establish (initially) and maintain (continuously) a State system of accounting for and control of nuclear material (SSAC).

[2] Here and in the rest of this document, the word ‘State’ is used in relation to either a single State or, as applicable, a group of States which have agreed to establish a regional organization with nuclear material accounting and control responsibilities or other responsibilities relating to the implementation of safeguards.

An **SSAC as a system** is comprised of all of the elements that enable the SRA to carry out its nuclear material accounting and reporting responsibilities. These elements include information systems (computerized or paper-based); nuclear material accounting systems that produce the accounting data at facilities and other locations; various processes, procedures and administrative controls (such as license requirements including import and export; collection and submittal of design information); quality checks; and oversight activities conducted by the SRA to ensure all requirements are satisfactorily met.

It is recommended that all safeguards responsibilities in a State (pursuant to a CSA as well as an additional protocol) be assigned to the same State authority. However, sometimes a State may assign some safeguards responsibilities to one authority (such as nuclear material accounting and reporting) and some to another authority (such as preparing and submitting AP declarations). This could be based on legal or practical reasons related to the scope or competencies of certain authorities. In such a case, the responsibilities of an SRA are fulfilled by two or more authorities, and those authorities should coordinate with one another as necessary to ensure effective safeguards implementation.

1.3. Overview

The IAEA and the State must cooperate to implement safeguards. The IAEA's verification activities are carried out in States (at facilities and other locations) and at IAEA headquarters in Vienna.

INFCIRC/153 (Corr.) Paragraph 3
The Agreement should provide that the Agency and the State shall co-operate to facilitate the implementation of the safeguards provided for therein.

In order for IAEA inspectors to conduct verification activities in States, they need the support and cooperation of the SRA and the facility operators. Effective support and cooperation require adequate State infrastructure.

States need to develop a safeguards infrastructure addressing three fundamental areas:

1) Establishment of laws, regulations and a system of accounting for and control of nuclear material at the national level (and regional level, if applicable) which ensure that the requirements of the safeguards agreement and associated protocols and Subsidiary Arrangements are fully met;

2) Provision of timely, correct and complete reports and declarations to the IAEA; and

3) Provision of timely and adequate access and support for IAEA inspectors to locations and information necessary to meet States' obligations under the safeguards agreements.

This SIP Guide focuses on the third of these three areas. Effective planning, coordination and preparation are needed to provide timely access and adequate support to IAEA inspectors.

For example, advance planning is often needed to provide inspectors with information and support necessary to carry out their activities at facilities and other locations, including escorts, radiation protection personnel and equipment, technical and operational staff, and training.

INFCIRC/153 Paragraph 9
The Agreement should provide that the State shall take the necessary steps to ensure that Agency inspectors can effectively discharge their functions under the Agreement. The Agency shall secure the consent of the State to the designation of Agency inspectors to that State. If the State, either upon proposal of a designation or at any other time after a designation has been made, objects to the designation, the Agency shall propose to the State an alternative designation or designations. The repeated refusal of a State to accept the designation of Agency inspectors which would impede the inspections conducted under the Agreement would be considered by the Board upon referral by the Director General with a view to appropriate action. The visits and activities of Agency inspectors shall be so arranged as to reduce to a minimum the possible inconvenience and disturbance to the State and to the peaceful nuclear activities inspected, as well as to ensure protection of industrial secrets or any other confidential information coming to the inspectors' knowledge.

As described in Sections 9 and 10 of IAEA Services Series 21, IAEA activities in the field are carried out during design information verification; inspections; and complementary access. The activities that inspectors may carry out are explained in detail in subsequent sections of this Guide. The efforts undertaken by SRAs and facility operators to facilitate the effective performance of such activities are also described. Examples of activities carried out by inspectors include: reviewing documents and records, using containment and surveillance (C/S) devices and measurement equipment, collecting samples, reviewing surveillance, checking seals, verifying inventory items and visual observation.

Facilitating IAEA verification activities requires effective **coordination, communication and planning** at facilities and other locations in the State. Each State’s obligation to provide access and support to IAEA verification activities should be addressed in its infrastructure.

This SIP Guide shares information about State practices that have been helpful in this respect.

2. ESTABLISHING THE FRAMEWORK TO FACILITATE IAEA ACCESS

2.1. Communication, roles and responsibilities

Communication is a two-way process: safeguards information is exchanged between the IAEA and the SRA and/or operators. When a State submits information to the IAEA, the IAEA acknowledges its receipt and responds with questions or requests for clarifications/amplifications of such information as needed. When the IAEA sends correspondence to a State, the SRA should acknowledge its receipt and respond accordingly and within the requested timeframe.

Some important steps need to be taken to facilitate communication. First, the name, address, email and phone/fax number of the key point(s) of contact in the SRA need to be provided to the IAEA. Formal contact information and communication protocols are exchanged following the provisions of the General Part of the Subsidiary Arrangements. The SRA plays a key role in transmitting relevant information regarding safeguards to operators of facilities and locations outside facility where nuclear material is customarily used (LOFs).

To facilitate IAEA activities in the State, the **roles and responsibilities** of the various stakeholders (e.g. SRA and operators) need to be clearly defined.

The management and staff of the SRA, the operators of facilities and LOFs, the staff of other government agencies in the State, and the staff of a State's Mission or Embassy may all have some responsibilities associated with safeguards implementation. Their roles and responsibilities should be clearly understood by all of them and by the IAEA.

2.2. Inspector designation

In order for IAEA safeguards inspectors to carry out verification activities in a State, they must be designated for that State. The IAEA is responsible to request that specific IAEA staff members be designated for a State. The State is required to respond to the IAEA's request. Most States accept tacitly the proposed designations; the State communicates only in cases where the State decides not to accept a designated inspector. In such cases, no response equates to acceptance of a designated inspector.

Having a **sufficient number of inspectors designated** for a State helps the IAEA significantly to efficiently plan verification activities and in discharging its functions under the agreement. It is a good practice for States to accept the inspectors that are requested by the IAEA to be designated.

2.3. Subsidiary Arrangements

Subsidiary Arrangements to a safeguards agreement are concluded between the IAEA and the State to specify the detailed procedures for implementing the provisions specified in a safeguards agreement or an additional protocol. They specify, for example, what information is to be provided by a State to the IAEA, in what format, and at what frequency.

INFCIRC/153 (Corr.) Paragraph 39
The Agreement should provide that the Agency and the State shall make Subsidiary Arrangements which shall specify in detail, to the extent necessary to permit the Agency to fulfil its responsibilities under the Agreement in an effective and efficient manner, how the procedures laid down in the Agreement are to be applied. Provision should be made for the possibility of an extension or change of the Subsidiary Arrangements by agreement between the Agency and the State without amendment of the Agreement.

Subsidiary Arrangements to a CSA consist of a General Part that is applicable to all nuclear activities in the State, and separate Facility/LOF Attachments that are applicable to individual facilities or LOFs in the State. The General Part is typically divided into ten parts and a code is assigned to each part. Annex 1 provides the table of contents of the General Part of Model Subsidiary Arrangements to a CSA.

Facility Attachments form part of the Subsidiary Arrangements and specify important details about how IAEA activities are carried out in a particular facility or LOF.

Subsidiary Arrangements are negotiated with the SRA on the basis of model text designed to enable the IAEA to fulfil its responsibilities under the CSA in an effective and efficient manner, although the details of such Arrangements will vary according to the State. The Subsidiary Arrangements, General Part are negotiated between the IAEA and the SRA during or soon after the entry into force of a CSA or the rescission of a small quantities protocol[3] (SQP) and do not require approval of the Board of Governors. Technical and administrative procedures related to the implementation of an additional protocol may also be specified in the Subsidiary Arrangements, General Part, if deemed necessary by the State or the IAEA.

The reporting formats and timing for submission of, for example, nuclear material accounting reports, are based on Code 10 of the Subsidiary Arrangements, General Part[4] and are an important consideration in setting up the accounting structure at a facility, to ensure that the accounting codes and database fields are consistent with those established by the IAEA, and the procedures are defined and effective. Facility/LOF Attachments contain information about, for example, submission of reports (including special reports)[5], installation of C/S devices, number and mode of routine inspections, safeguards activities during routine inspections, costs associated with safeguards activities, and provision of statements on IAEA's verification activities.

The IAEA has developed Model Facility Attachments for different types of facilities such as research reactors, power reactors, fuel fabrication plants, or storage locations. The IAEA negotiates with the relevant SRA to develop and finalize a Facility/LOF Attachment. An example Model Facility Attachment for a nuclear power plant can be found on the Resources and Assistance for States webpage.[6]

2.4. Receiving and responding to IAEA notifications

The IAEA typically faxes or emails a notification letter informing the SRA of an upcoming verification activity. The IAEA expects to receive a response from the SRA indicating that the correspondence was received (within the time frame specified in the notification letter), and that arrangements will be made to facilitate the access, within the timeframe and at the location specified in its notification. The SRA response should be sent by the State contact point specified in the Subsidiary Arrangements, with copies to other relevant organizations such as the Ministry of Foreign Affairs and the relevant operator(s).

---

[3] For more information about SQPs, please see the *Guide for States with Small Quantities Protocols*, IAEA Services Series 22.

[4] Model Code 10 can be found at the Resources and Assistance for States webpage at www.iaea.org/safeguards.

[5] A special report is a report submitted by the State following an unusual incident, such as a situation where integrity of containment of nuclear material may have changed, or nuclear material is or may have been lost. See paragraph 68 of INFCIRC/153 (Corr.).

[6] See http://www.iaea.org/safeguards/resources-for-states/overview.html

Communication can be improved by the IAEA following up on its email/fax notification with a phone call to the SRA to confirm that the notification has been received. The SRA may use this opportunity to inform the IAEA of specific details regarding the access, including any circumstances that could potentially impact the objective of the access (e.g. health and safety conditions at the facility, construction work or equipment failure). This discussion can be used to identify possible solutions to ensure that the planned verification activities can be carried out and the associated objectives can be achieved.

2.5. Planning for IAEA in-field verification activities

IAEA access to locations and information is essential for carrying out verification activities. Each in-field verification activity involves various tasks undertaken to achieve specific objectives. They may involve access to a variety of buildings or places within a facility, site or other location in a State. Many activities involve the use of equipment – for example to make measurements, apply C/S devices, monitor nuclear material movements and take samples. The use of equipment often requires the support of the State and/or operator, as well as infrastructure such as electricity, liquid nitrogen cooling, calibration standards, lifting equipment, protective gear and other support. The use of IAEA equipment and the associated support are addressed in Section 7.

3. IAEA ACTIVITIES IN STATES – DESIGN INFORMATION EXAMINATION AND VERIFICATION

3.1. Introduction

The IAEA needs to understand a facility and its operations and processes in sufficient detail to design an effective safeguards approach for that facility. Information about a facility and its characteristics and processes is referred to as design information, and it is provided using a form called a Design Information Questionnaire (DIQ). The *SIP Guide on Provision of Information* includes a completed DIQ for a research reactor.

Preliminary design information is provided when a State has taken the decision to construct or to authorize the construction of a facility with further information on designs provided at the **earliest stages of construction**, when the site is being prepared and utilities, roads and other infrastructure are being developed. Such information includes, for example, plans, design drawings, process maps and equipment specifications.

Design information examination (DIE) refers to the IAEA’s analysis of information provided by a State about a facility. DIE begins for a new facility long before concrete is poured, so that inspectors can verify features of the facility that will no longer be accessible after the walls, floors, ceilings and other structures are complete. Early dialogue between the IAEA and the SRA and facility operators is important for creating a shared understanding amongst all parties about all aspects of the safeguards approach, the equipment the IAEA will be using, the placement of cameras and conduits for wiring. This dialogue helps to avoid costly retrofitting after a building has been constructed.

INFCIRC/153 Paragraph 48
The Agreement should provide that the Agency, in co-operation with the State, may send inspectors to *facilities* to verify the design information provided to the Agency pursuant to paragraphs 42—45 above for the purposes stated in paragraph 46.

Design information verification (DIV) is performed at a facility during all of its lifecycle stages, from construction, commissioning, operation, modification, shutdown and closure to decommissioning. Figure 2 depicts an IAEA inspector verifying storage capacity of a location at a facility. Of course, many other safeguards activities are carried out through the lifecycle stages of a facility; a summary of the activities carried out by the IAEA and by the SRA during each lifecycle stage is provided in Annex 2. It is the State's responsibility to facilitate inspectors' access in order that the objectives of the DIV can be met.

The access needed by inspectors to perform DIV **extends beyond the strategic points** at which the IAEA has access during a routine inspection.

FIG. 2. IAEA inspectors verify the storage capacity for nuclear material items during DIV

3.2. Objectives of design information examination

Design information is examined by the IAEA for several purposes, including, for example, to:

- Identify the features of facilities, equipment and nuclear material relevant to the application of safeguards in sufficient detail as to facilitate verification of their design (see Figure 3);
- Establish the facility safeguards approach and draft the Facility Attachment;
- Determine material balance areas (MBAs);

- Select strategic points that will be key measurement points (KMPs) and other strategic points that may provide information necessary to support the KMPs and that may include containment and/or surveillance (C/S) measures;
- Establish the nominal timing and procedures for the operator's physical inventory taking (PIT) for accounting purposes;
- Establish the records and reports requirements and examination procedures;
- Establish requirements and procedures for verification of the quantity and location of nuclear material;
- Select appropriate combinations of C/S methods and techniques and their location;
- Establish indicators that could be used to confirm the operational status of the facility; and
- Establish a facility-specific list of items (e.g. equipment, systems, structures) essential for the declared operation of the facility (called an essential equipment list or EEL). EEL is covered in more detail below.

The primary objective of DIE is to develop a **safeguards approach** for the facility, and to plan for design information verification (DIV).

FIG.3. Verifying facility layout

3.3. Objectives of design information verification

An initial DIV[7] is performed in order to achieve several objectives, including:

- Confirming the correctness and completeness of the information provided in the DIQ;
- Obtaining additional information about the facility through visual observation (which may include the taking of photographs) and discussions with the SRA and operator;
- Confirming and documenting the design features of the facility that are relevant to IAEA safeguards;
- Contributing to the development of the safeguards approach for the facility;

[7] An initial DIV is the first DIV at a new facility, and this is conducted early in the construction process, long before nuclear material is introduced into the facility.

- Providing assurance that the facility has been designed and used according to its declared purpose, and identifying possible diversion or misuse scenarios; and
- Identifying sensitive design-related information, documents, records and diagrams or photos that must be kept on site under C/S for future re-examination and verification of design information.

DIV is performed periodically at a facility throughout all of its lifecycle stages, to confirm that design information upon which the safeguards approach is based remains correct and complete, to provide assurance that no undeclared modifications to the facility or the processes have occurred, to confirm the operational status of the facility, to resolve any outstanding anomalies or discrepancies, and to evaluate the safeguards approach and current IAEA resource expenditures.

DIV is also performed as a result of revisions to design information to reflect planned changes to the facility, its processes or other safeguards-relevant features. These DIVs need to be carried out in advance of changes being made, during the process of changes being made, and/or immediately following the changes that were made, depending on the nature of the modifications. These DIVs are performed to assess if the safeguards approach and measures continue to be appropriate or require modifications, such as application of a new sealing system or containment measures, additional surveillance cameras or NDA detectors.

3.4. IAEA activities carried out during DIV

Activities that are undertaken during DIV include, for example:

- Examination of documentation regarding the facility, such as
  - the site, plant and building design;
  - the process and containment design;
  - the utility and support systems;
  - characteristics, flows and locations of nuclear material;
  - integrity of the containment (including a review of penetrations such as vents, piping and ports);
  - nuclear material and process measurement systems;
  - operating procedures and records; and
  - nuclear material accounting procedures and records;
- walking through the facility and comparing DIQ drawings with the actual layout of the plant;
- assessing the nuclear material accounting system, including operator measurement system (measurement control programme information, calibration standards, frequency of measurements, procedures, expected uncertainties);
- examining operational parameters and records (reading parameter values in the control room);
- performing environmental sampling (such as in a hot cell, as shown in Figure 4), NDA and photography to confirm that the facility is used as declared (sensitive photos may be kept at the facility under IAEA seals);

- taking physical dimension measurements (may use laser range finder, or make a 3-D image of a room);
- assessing the declared capacity of the facility and the declared throughput (volume of vessels, shipping containers, piping connections);
- assessing access routes and flows of nuclear material (large ventilation system, ducts, maintenance hatchways);
- sealing limited access areas (rooms that may not be accessible at a later time due to high radiation levels); and
- verifying the facility layout (e.g. to confirm the GPS coordinates for the facility).

FIG.4. Verifying hot cell configuration

It is not always possible to notify the SRA in advance of the exact location in a facility that the inspectors will need to visit during a DIV. During the construction phase, the DIV and construction plans need to proceed in a coordinated way, so that DIV takes place while access is available to areas that will be inaccessible at later phases. The primary objectives might be different from one DIV to another; the focus may shift from, for example, equipment and processes to general plant layout to accounting and measurement systems, or a particular aspect of the process. The facility should ensure that the necessary technical experts are available to answer questions as needed.

To achieve the objectives of any DIV, inspectors need to verify safeguards-relevant aspects of the facility and its operations, which often requires access to locations where there is no nuclear material, and to locations where there is nuclear material but which are typically not accessible when the facility is operating (e.g., due to prohibitively high radiation levels). Locations that inspectors visit during DIVs include, for example, multi-purpose rooms, storage rooms and control rooms. DIV is often conducted in conjunction with physical inventory verification (PIV).

DIV activities also include the verification of the facility design information submitted by the SRA and efforts to confirm, for example, that the facility is not being (or could not be without being detected) misused to produce undeclared nuclear material. The IAEA also verifies the design and capacity of important equipment such as fuel handling equipment and processing tanks at a facility.

During an initial (or early) DIV, IAEA inspectors may be on site to inspect and photograph the concrete forms before concrete is poured into them. In later DIVs, the IAEA inspectors may walk through the facility with detailed building plans to confirm the as-built design and to look for design features not shown on the drawings.

Example: The design information for a geological repository has to be verified frequently since the shape and capacity of the facility changes continuously. Casting, construction and backfilling of parts of the facility will take place during the operational phase of the disposal facility.

New types of instruments may be needed to support DIV at new kinds of facilities. For example, 3D laser scanners may be used by inspectors to create a map of the configuration of piping. It is helpful for the operator to understand the equipment and its uses, as this may assist the operator to avoid situations that would impede the equipment's function (doors, locks, etc.) and to ensure compliance with facility safety requirements (e.g. the power of the laser).

Example: During DIV, an inspector might observe an abnormal situation and ask questions. For example, a flask may be located in an unexpected place. The inspector is required to follow up with the SRA and/or operator to determine why the situation has occurred. This follow up may happen during the DIV (preferred) but also could be reported and followed up later.

Example: During a DIV at a research reactor site in a State, the IAEA inspectors collected swipe samples from inside of hot cells located in an auxiliary building.

3.5. Essential Equipment List (EEL)

The IAEA prepares a list of the equipment and systems at the facility that are essential to its function and/or influence its operational status, throughput, capabilities and/or inventory of nuclear material. This list is called an '**essential equipment list'** (EEL).

Changes to the equipment and systems on the EEL may impact the safeguards approach so any changes need to be communicated to the IAEA in advance of such changes being made. The EEL plays an important role in determining the operational status of a facility; its primary purpose is to support the evaluation of the decommissioned status of a facility. Before a facility can be considered by the IAEA to be decommissioned, all items on the EEL must be removed or rendered inoperable and all nuclear material must also be removed from the facility. The following criteria are used in establishing the EEL:

- Whether the equipment, system or structure is essential with respect to the main process[8];
- Whether the equipment is commercially available and easily acquired;
- Whether the equipment is complex to modify, re-install or repair;

[8] The main process is facility-specific and comprises all steps and unit operations necessary to generate or manufacture the product for which the plant is operating.

- Whether such modification, re-installation or repair is easily detectable;
- Whether the equipment has high significance from the safeguards point of view; and
- Whether the equipment is especially designed or prepared for the processing, use or production of nuclear material (the equipment listed in Annex II of the additional protocol or in the trigger list annexed to the Nuclear Suppliers Group Guidelines (reproduced in INFCIRC/254/Part 1).

In addition to the essential equipment which is selected because of its direct contribution to the facility's main process, there are often other items with less direct contributions but which are essential due to their role in nuclear material flow pathways, handling and transportation (e.g. the fuel handling items, the spent fuel storage pond, the fuel transport containers, the fresh fuel storage racks, etc.).

3.6. Example of DIV at facilities under construction or modification

DIV for a new, complex facility that will process nuclear material in bulk form requires technical expertise in both the IAEA and the State and may continue for several years. The analysis of the design information requires expertise in facility design and nuclear material processing. The IAEA will require detailed information from the operator in order to develop its safeguards approach. Meetings are held with the SRA and operator to clarify the information received. Such meetings can be made more productive by preparing a detailed agenda in advance that helps the operator to ensure the right people are available at the meetings to answer questions.

Example: In one case, a large bulk processing facility was being constructed. To support development of the safeguards approach, experts at the IAEA analysed process documents to understand the facility processes and design, produced engineering and process diagrams at a level of detail useful to understand nuclear material flows and characteristics. Facility layouts were analysed using drawings provided by the operator to the IAEA. Nuclear material flows and accountancy systems were analysed to identify locations for installation of IAEA measurement and monitoring equipment, and to design the MBAs and key measurement points for the facility. To support the IAEA's efforts, DIE meetings were held in the field involving the relevant IAEA staff (e.g. IAEA facility officer, the IAEA facility safeguards design project manager), the SRA, the operator, process engineers and the nuclear material accountancy manager. Design experts were also available upon request (e.g., when discussing blending of the nuclear material, the blending engineer was invited to participate in the meeting).

During meetings with the SRA and operator, the IAEA will review drawings, answer questions regarding anticipated equipment and installed systems, and the SRA may have questions regarding compatibility of IAEA equipment with national or international certification standards. It is helpful to document the version number of the documentation provided to the IAEA. Examples of drawings that will need to be reviewed by the IAEA include:

- Floor layouts, for the entire facility including process and utilities;
- Process flow diagrams;

- Process descriptions (block diagrams); and
- Equipment and containers that indicate the material type and quantity/capacity.

Other information that needs to be provided to the IAEA includes regular schedule updates for the construction, engineering and manufacturing design work, and equipment development schedules. This allows for planning of DIV activities. There may be situations when the IAEA will need to perform technical visits to supplier sites if equipment needs to be viewed prior to installation in an inaccessible location.

The IAEA will also need to evaluate information regarding the nuclear material accounting procedures, detailed descriptions of all nuclear material flows, including solid/liquid waste, sampling, recycled material, analytical laboratory, production regimes, storage, estimated residence times and process capabilities. This will help in determining relevant safeguards measures.

Example: A spent fuel storage facility at a nuclear power plant was being constructed. In this facility, DIE involved the review of design and operating information contained in the DIQ and all other information provided to the IAEA, such as design drawings, electronic copies of relevant design documents and accounting information, sketches, photographs and publications (such as marketing brochures or technical reports). These activities were performed from the beginning of the development of the design, continued during the operation of this facility and will continue during all future phases of the facility's lifecycle. One of the main objectives of these activities during construction was to ensure that diversion of nuclear material through the concrete containment body of the facility was not possible.

DIV at facilities where modifications are planned are equally important, and can be complicated by the presence of nuclear material which must continue to be verified during the modification process.

Example: A spent fuel storage facility was modified to increase the storage capacity by constructing additional storage ponds. This project was complex due to the presence of subcontractors, the continued storage of nuclear material in existing ponds, and the on-going construction at the site.

The SRA submitted advance information to the IAEA on the operator's plan to expand the spent fuel store. The DIQ was updated with the preliminary information such as drawings for the completed storage with the new ponds, a project timeline and the estimated new storage capacity. As a result of the IAEA's examination of the design information, a question was raised regarding how the integrity of the existing C/S system could be maintained during the expansion work and how the IAEA could verify that no new penetrations were added to the spent fuel storage facility.

The modification work involved site preparation, pouring of a foundation, construction of additional ponds and construction of the building enclosing the ponds. The DIV was performed inside and outside the facility to confirm that the progress was consistent with the design information provided. In the course of performing DIVs, the operator was requested to instruct subcontractors about the importance of safeguards measures in place at the facility and the connections between the work schedule and the verification activities.

One of the verification challenges was the need to cover one of the ponds in the existing building while the construction work was underway. (Figure 5 shows the temporary cover on the ponds.) A temporary wall was built to maintain the integrity of the C/S measures.

During the DIV at the beginning of the project, the absence of spent fuel in the pond was confirmed. During the construction of the temporary wall, the surveillance system was used to confirm that no nuclear material was moved into or out of the facility. Some of the construction activities interfered with the C/S system. For example, the ventilation system inside the building was upgraded and the old ventilation tubing was removed to allow installation of a new ventilation system designed for the entire capacity of the modified store. During this work, a lift crane that was placed close to the temporary wall obstructed the view of the surveillance system. The challenge for DIV was to confirm that the access routes for nuclear material were not modified. This was accomplished through visual observation of the dimensions of the storage and comparison with the design information.

After the new building was in place and the additional ponds built, the temporary wall between the old part of the storage and the new part was removed. The C/S system was re-evaluated for the entire spent fuel storage building. The adequacy of the camera views was assessed, the integrity of the new walls was confirmed during a walk-through and the absence of new penetrations was also confirmed.

During the entire expansion work, regular DIVs were conducted and the status of the expansion of the storage ponds was assessed. Camera views were made suitable for the expanded spent fuel storage by applying a wider-view lens.

FIG. 5. Temporary cover over storage pond. (Courtesy of TVO, Finland)

3.7. Scheduling of DIVs

IAEA access for DIV is provided for under paragraph 48 of INFCIRC/153 (Corr.), and continues until the IAEA verifies and confirms that the facility has been decommissioned for safeguards purposes. Under an additional protocol, the IAEA may carry out complementary access to a decommissioned facility to confirm that status; this may include access to facilities that were decommissioned before a State's CSA entered into force. The IAEA may carry out both DIV and complementary access to a facility during its decommissioning process.

DIVs are typically performed annually, and are often scheduled in conjunction with a routine inspection (e.g. during a physical inventory verification or PIV). The IAEA requires a good understanding of the operator’s schedule, because some activities carried out at the facility may need IAEA presence or monitoring, such as shipments of large empty containers (e.g. empty shipping casks) to verify that they do not contain nuclear material. The IAEA will send a notification for a planned DIV to the SRA, and the SRA then should notify the operator. There may be a case where an operator might inform the SRA that a situation at the facility might prevent the IAEA from carrying out the planned DIV. For example, during a modification to a spent fuel storage facility, the ponds are covered to ensure nothing accidentally falls into the pond. In such a case, the IAEA would be unable to verify the capacity of the ponds. The IAEA, SRA and operator can work together to determine how best to respond to such a situation.

The IAEA’s notification describes the scope of the DIV. A pre-meeting on the first day of the DIV provides an opportunity to discuss the planned activities, establish a shared understanding, and identify the support needed to facilitate the IAEA’s work. When detailed, relevant information is provided in the DIQ, the IAEA can effectively and more specifically define the activities it plans to carry out and the associated locations. When the IAEA can specify the activities clearly, the operator has an easier task to support the IAEA.

3.8. State support to DIV activities

The cooperation and support of the SRA and operators are very important during DIV. Some support that is particularly important to ensuring smooth implementation of planned activities includes:

- Providing the requested information at an adequate level of detail and in a timely manner;
- Providing experts that are needed to meet the objectives;
- Working in a cooperative spirit, recognizing that everyone is learning;
- During particularly busy times in the construction process (such as cold testing or preparing for commissioning), identifying people that are available to work with and assist the IAEA inspectors;
- Providing timely updated schedule information to facilitate verification or examination activities; and
- Identifying key milestones (also called hold points) in the schedule where a comprehensive review by the SRA and IAEA will be important to ensure safeguards objectives have been adequately addressed.

The operator plays an essential role in supporting DIV by providing information such as an updated facility layout, floor plans and site plan, and by assisting the IAEA inspectors in gaining access to meet the objectives of the DIV. The IAEA may use some equipment during a DIV that is not typically used during inspections.

3.9. Benefits of effective State-IAEA cooperation during facility construction

Effective IAEA-State cooperation during DIE and DIV for a facility under construction results in an **optimized safeguards approach** that facilitates installation of IAEA equipment at locations most suited to the process specifics, and facilitates the cost efficient implementation of safeguards.

The importance of addressing safeguards early in the facility design process is a fundamental tenet of systems engineering[9], and is encouraged in the *Nuclear Power Plant Exporters' Principles of Conduct*, which is an industry code of conduct aimed at enhancing national and international governance and oversight, and incorporating best practices.[10]

4. IAEA ACTIVITIES IN STATES - INSPECTIONS

The IAEA may conduct three types of inspections pursuant to comprehensive safeguards agreements – ad hoc, routine and special inspections.

4.1. Ad hoc inspections

Ad hoc inspections are carried out to verify information in connection with the initial report on nuclear material, or to verify nuclear material before it is exported out of the State or upon receipt in an importing State. Such inspections may be carried out before and after Subsidiary Arrangements have been concluded between the IAEA and the State. During ad hoc inspections the IAEA has the right of access to any location where nuclear material is present in order to confirm the initial report of nuclear material and identify and verify changes in the situation which have occurred since the date of the initial report.

4.2. Routine inspections

Routine inspections are conducted after the Subsidiary Arrangements have been concluded and specific provisions for MBA structure, KMPs, strategic points and other specifics are established. Access for routine inspections is limited to strategic points specified in the Subsidiary Arrangements (Facility/LOF Attachments) and to accounting and operating records. Routine inspections may be announced or unannounced. Announced inspections are notified to the State pursuant to paragraph 83 of INFCIRC/153 (Corr.).

The IAEA periodically communicates to the State its **general programme of inspections** to help minimize impacts on the facilities.

[9] INCOSE, 2007, Systems Engineering Handbook – A Guide for System Life Cycle Processes and Activities, Version 3.1. See http://www.incose.org/ProductsPubs/incosestore.aspx.
[10] The Nuclear Power Plant Exporters' Principles of Conduct are available online at www.nuclearprinciples.org.

Advance notification is transmitted to the SRA in most cases one week before the inspection, but it can be from a month to 24 hours in advance or less, or unannounced, depending on the facility type and what has been agreed for that facility.

Example: For an announced inspection at one State's research reactor that uses low enriched uranium fuel, a fax and email are sent by the IAEA through the official channel at least one week before the inspection. Announced inspections at this reactor usually occur more than a year apart from one another. When the notification is received, the SRA contacts the operator of the research reactor immediately and because the inspections occur so infrequently, the SRA discusses the expected activities with the safeguards manager at the reactor and answers any questions in advance.

4.2.1. Unannounced routine inspections

Unannounced routine inspections may be carried out as provided for in paragraph 84 of INFCIRC/153 (Corr.). The relevant provisions are typically specified in a Facility Attachment. Sometimes facility-specific procedures will need to be developed to support the conduct of unannounced routine inspections, because providing access for IAEA inspectors without advance notification will often require a non-routine entry process.

Example: For some facilities, the IAEA inspectors arrive at the facility gate with a notification that is presented to the facility operator. Access is then provided according to procedures that had been previously approved by the SRA. This process required prior agreement to be reached with the operator that allows for the SRA's functions to be delegated to a representative at the facility until the SRA representative arrives.

In order for the IAEA to plan and conduct unannounced routine inspections, initial discussions between the IAEA, SRA and operator are needed to agree on practical arrangements to implement them. Procedures need to be established to support the implementation of unannounced inspections, to ensure that all parties are aware of their roles and obligations. Discussions with the operator help the IAEA to identify potential obstacles and determine how unannounced inspections can be conducted at that facility.

A State may need to modify its laws to enable the implementation of unannounced inspections. Although presence of a SRA during IAEA safeguards inspections is not required, some States' laws require that a SRA representative be present during all inspections. In such a situation, unannounced inspections would be difficult if the SRA representative is not located close to the facility or has not designated a point of contact at the facility (e.g. a resident representative) that could accompany IAEA inspectors during unannounced inspections. The law may need to be amended to allow the facility operator to act as the SRA representative until the SRA representative reaches the facility. Initial discussions between the IAEA and the SRA regarding implementation of unannounced inspections will include a review of any legal constraints; in several cases, States have modified their legislation to facilitate the implementation of unannounced inspections at certain facilities.

Once procedures are in place, a transition period for the implementation of unannounced inspections is beneficial and may include field trials. In some cases, surveillance equipment may need to be installed at the facility, in which case the IAEA, operator and SRA can discuss a practical timeline for starting the implementation of such inspections in a routine manner. The operator's ability to provide timely information, access and technical support are all critical to the successful implementation of unannounced inspections.

During the transition period for unannounced inspections, **field trials** have been used to test the process, to help ensure that when inspectors arrive at the facility without advance notice, the operator is able to facilitate access within the agreed timeframes. During field trials, the operator can assess its ability to provide timely access and support the implementation of unannounced inspections.

Field trials also serve as a **mechanism to identify issues** that need to be resolved. Once there is confidence in the outcome of field trials, the transition can be made to full implementation.

Implementing unannounced inspections in a State could result in an overall reduction in the frequency of routine inspections and a reduced impact on facility operations.

Example: Prior to the implementation of unannounced inspections in a facility, considerable IAEA effort was spent in verifying the transfer of spent fuel to dry storage at reactor sites. Prior to implementing unannounced inspections, all transfer activities at reactor and dry storage sites required the continuous presence of IAEA inspectors. Resources were further strained in the event of unforeseen breakdown of facility transfer equipment. Without knowing when equipment could come back on line, the IAEA inspectors either returned to the office or remained on "stand-by" for the duration of the equipment repair which could take many days or even weeks. With the implementation of unannounced inspections, considerable resource savings were realized for both the IAEA and the SRA/operator while maintaining the effectiveness of safeguards implementation.

To ensure the successful implementation of unannounced inspections, it is important to have the following elements in place:

- Agreed procedures (practical arrangements) are established and adhered to by the SRA, operator and IAEA and are exercised periodically (especially in cases when a long period of time may pass between IAEA inspections);
- Necessary surveillance equipment is installed properly and an electronic mailbox reporting system is used (or equivalent form of information transfer); and
- Entrance procedures and internal communications facilitate access and support short notice access.

Example: Major benefits to the State in the case of the example described above are listed below. Considerable cost savings were realized for the SRA, the operator and the IAEA, while maintaining the effectiveness of safeguards implementation, including:

1. *The replacement of the continuous presence of IAEA inspectors during transfer campaigns by a combination of measures including surveillance, remote monitoring and unannounced inspections;*
2. *With a reduced inspector presence on site, the operator's resources were otherwise spent providing access, escorting and supporting IAEA on site activities were allocated to other priorities;*

3. *The operator no longer had to wait for IAEA inspectors to arrive to perform routine transfer activities; transfer activities were instead communicated in advance using an electronic mailbox reporting system; and*
4. *Last minute changes to the transfer schedule and equipment maintenance were communicated in near-real-time using an electronic mailbox reporting system, thereby ensuring the IAEA was aware of on-going activities without having to be present in the field.*

4.2.2. Short-notice routine inspections (SNRIs)

SNRIs are routine inspections that are scheduled by the IAEA using randomization methods, and with short notice to the SRA/facility (typically less than 48 or 24 hours, but as agreed between the IAEA and the SRA in advance). SNRIs are extensively used at fuel fabrication plants, to enable the IAEA to verify nuclear material transfers in and out of the facility (inventory changes) efficiently and effectively. The implementation of SNRIs requires the facility operator to provide declarations to the IAEA at an agreed frequency (normally on a daily basis or as agreed with the IAEA) and to retain and make available for verification the nuclear material at the facility for a period of time agreed in advance with the IAEA (normally between 1 and 3 working days). Often these declarations are made using a secure electronic mailbox system. The operator retains items that have been received or are planned for shipment and are subject to verification (typically UF6 cylinders, UO2 powder, and produced fuel assemblies or rods) for an agreed period of time after they are reported. More information is provided in section 4.2.4 on the use of electronic mailboxes.

4.3. IAEA activities conducted during inspections

IAEA inspectors carry out verification activities during inspections in order to achieve specific technical objectives, for example, to verify that there was no misuse of the facility and no diversion of declared nuclear material. Inspectors typically verify the nuclear material inventory by reviewing the facility nuclear material accounting documentation (reports and records); selecting items for verification using statistical random sampling techniques; and performing activities to confirm that there was no misuse of the facility. The following kinds of activities are carried out during inspections:

- Checking consistency between facility records and submitted reports;
- Verifying nuclear material in the facility, identifying items and their location (see Figure 6), performing NDA measurements, collecting samples for analysis;
- Confirming the calibration of operator measurement systems;
- Servicing containment and surveillance (C/S) systems and unattended monitoring systems, and verifying the sealing systems;
- Taking environmental samples (see Figure 7) and samples for destructive analysis; and
- Checking the operational status of the facility.

FIG.6. Identifying items and their location

FIG.7. Taking an environmental swipe sample

It is helpful for operators to be familiar with the IAEA's **safeguards requirements** for their facility type. The IAEA 'safeguards by design' guidance series explains some of the safeguards measures that might be applied at various facility types. These documents can be found at http://www.iaea.org/safeguards/resources-for-states/additional-documents.html.

The verification measures during unannounced and announced inspections are generally the same but some activities may differ depending on the facility type and the technical objectives of the inspection. Inspection activities conducted at a research reactor could include, for example:

- Examining the accounting reports (general ledger, list of itemized inventory, material balance report, physical inventory listing, inventory change reports and the related source documentation);
- Checking the operating logbook of the reactor which indicates the power, duration of operation, and the fuel core map and the spent fuel pond;
- Checking the target irradiation records (to show where targets had been placed, how long they had been irradiated, when they were removed);
- Performing measurements using Cerenkov viewing device in the core or spent fuel pond or selecting some fuel elements for performing NDA measurements (using equipment such as is shown in Figure 8);
- Servicing cameras (see Figure 9) and checking or replacing seals;
- Carrying out criticality tests;
- Verifying fresh fuel elements;
- Checking seals placed by the IAEA on fresh fuel that remain in storage.

FIG.8. Portable gamma NDA device

FIG.9. Inspectors servicing a camera

4.3.1. Review of nuclear material accounting reports and records

During inspections, IAEA inspectors will review facility records regarding the nuclear material inventory for each MBA. Facility operators will need to produce up to date documentation in a timely manner. The manner in which documentation is provided (e.g. accuracy, timing, content, format, structure) can have a significant impact on the duration of the inspection.

Documentation that needs to be provided to inspectors includes the general ledger (this is required irrespective of whether or not any inventory changes occurred in the material balance period under review); the list of inventory items or LII (also called an itemized inventory list or IIL), which is provided immediately upon arrival of inspectors or in advance, to enable inventory stratification for sampling and measurements; and the source documents that provide the basis for inventory records (such as shipping manifests and measurement results).

The *Nuclear Material Accounting Handbook* (IAEA Services Series 15) provides detailed guidance regarding accounting, and information is also provided in the *SIP Guide on Provision of Information to the IAEA*.

When providing documentation to inspectors, the facility operator should clarify which inventory changes are reflected in the reports and records and which have yet to be updated in the facility's system of accounting for and control of nuclear material. In many cases, the inventory changes that have occurred one day prior to the inspection may not be reflected until the system is updated (which could occur overnight with a 24 hour delay, for example).

It is useful for IAEA inspectors to receive inventory data in an electronic format, to facilitate the development of a sampling plan. For lists with a variety of items, it is particularly helpful if the electronic data can be provided in advance (e.g. a day before the inspection) so the inspector can stratify the inventory to create a sample plan. It is useful if the facility or SRA provides the list of inventory items (LII) to the inspectors with the items that belong to a particular stratum grouped together. A map of the facility showing the locations of items on the LII is also needed to help the inspectors organize their measurement activities, and can be provided when the inspectors arrive on site.

Depending on nuclear material items and storage characteristics, inventory lists may have multiple levels. For example, a list might initially be provided at the level of boxes, where each box contains several fuel bundles, and each bundle contains several fuel rods. The list of items in a particular box would be requested by the inspector if that box was selected for verification. Some reports generated by the operator contain hundreds of pages of records, and may take a considerable amount of time to generate.

Some reports depend on calculations such as determining the burn-up of spent fuel discharged from a reactor in order to account for its plutonium and uranium content. The operator may need to provide the results of these calculations to the IAEA as soon as they are completed. Other data that is readily available should be provided immediately.

The operator needs to supply a range of supporting documentation for evaluation of information contained in the accountancy reports. For bulk handling facilities there can be many different methods for determining nuclear material amounts, including sampling and destructive analysis, non-destructive assay, weighing and volume measurements. A range of documentation must be supplied to aid verification activities. Appropriate quality checks on the accountancy calculations and the documents supplied should be carried out before transmittal to ensure completeness and consistency.

Operators may benefit from establishing an information-sharing mechanism with the SRA and/or IAEA, such as an electronic mailbox or shared virtual network. Information, such as that listed below, can then be securely and quickly transmitted to inspectors prior to, or during, the inspection:

- Site plans and building layouts;
- List of inventory items (LII);
- Accounting records and book balances;
- Pond maps and visual representations of areas;
- Scale (weight measurement) printouts;
- Calibration curves;
- Lab sampling records;
- Flow sheets calculation;
- Non-destructive analysis results;
- Calibration certificates;
- Measurement control programmes;
- Plant estimation calculations;
- Quality control information; and
- Technical papers.

4.3.2. Evaluation of an operator's measurement system

Nuclear material accounting involves accurate and precise measurements of nuclear material quantity, isotopic and elemental composition, volume, and other characteristics. Paragraph 32(a) of INFCIRC/153 (Corr.) requires States to establish a measurement system for the determination of the quantities of nuclear material received, produced, shipped, lost or removed from inventory, and quantities on inventory. The measurement quality should meet current international quality standards[11]. During IAEA verification activities, the performance of the operator's accounting and nuclear material measurement systems is evaluated.

All facilities where measurements of nuclear material are made should have a **measurement quality control programme** in place.

[11] Zhao, K. et al, International Target Values 2010 for Measurement Uncertainties in Safeguarding Nuclear Materials, STR-368, IAEA, Vienna (2010).

The measurement control programme needs to be established and audited before the facility starts operating or before a piece of measurement equipment is used operationally. The system needs to undergo comprehensive testing using certified reference materials in order to determine the actual measurement uncertainties associated with the methods used at the facility. Procedures for calibration should be prepared and provided to the IAEA for evaluation. The technical documentation that explains the derivation of the declared uncertainties should be maintained.

Through the facility's operations, the measurement systems must be maintained and calibrated. The SRA might establish a license requirement for the nuclear material measurement control programme to comply with relevant ISO quality standards or more specific standards, such as the ANSI N15 series[12]. The DIQ is used for reporting to the IAEA the measurement uncertainties and approaches for each measurement method used.

Facilities should strive to achieve appropriate measurement performance, as specified in the relevant international standards and target values. The procedures and activities should be documented and maintained, to ensure that measurement processes generate results of sufficient quality for their intended purpose.

A measurement control programme should include descriptions of processes, roles and responsibilities, training and qualifications, development and use of models, calibration methods, statistical analyses, records and reports, inventory calculations and quality control. Additional details can be considered for understanding the system, calibration, routine operation measurements, verification, control charts, non-conformance and physical inventory measurements. It is recommended that all measurement control programme documentation is technically defensible, peer reviewed and traceable to international standards.

4.3.3. Use of containment and surveillance (C/S) measures

The IAEA makes extensive use of C/S systems in implementing safeguards. The use of C/S systems reduces the amount of verification activities in the field by maintaining continuity of knowledge on previously measured nuclear material. C/S systems are used to freeze the nuclear material and/or monitor an operational situation in a facility in order to detect possible misuse of the facility. C/S measures and the use of seals are discussed in detail in Chapter 7.

Example: Some operators maintain a schematic diagram of where IAEA seals are applied in the facility, so that it is easy to see where seals are removed, attached and replaced.

It is sometimes necessary to adapt containers or facility fixed[13] elements to allow for the application of seals (that may require drilling holes for example). Such activities require the support of the SRA and facility operator and may impact container certification. This takes a

[12] The primary standards related to nuclear material measurement control include ANSI N15.41 and N15.51.
[13] For the application of seals, the IAEA prefers large fixed structural elements of the facility, which are difficult or impossible to modify or move.

long time, and should be avoided, by considering sealing requirements when designing or selecting a container.

4.3.4. IAEA use of secure electronic mailbox systems

In some facilities, to enable the use of less frequent, randomized, unannounced or short-notice routine inspections, the IAEA and the State work together to implement a ‘mailbox reporting scheme’. This involves the use of an electronic secure information repository (called a mailbox), used by the operator to submit to the IAEA near-real-time data such as inventory changes, operating records, schedules and other information. (A mailbox system can also use a secure physical mailbox where paper printouts are deposited, although this is not preferred by the IAEA.) While not obligatory, use of an electronic mailbox is necessary to facilitate the implementation of SNRIs, which may allow efficiencies to be realized by conducting fewer, and shorter, inspections. This system enables the IAEA inspectors to retrieve information from the mailbox upon arrival (or in advance of arrival if the information is securely transmitted to the IAEA) to support their verification activities.

The use of mailbox reporting is particularly helpful to achieve efficiencies at facilities where **inventory changes are frequent**, such as a fuel fabrication plant, on-load reactor or spent fuel storage facility.

Encryption, time stamps and digital signatures are used by the IAEA to authenticate the information submitted to the mailbox. In addition to inventory information, any data agreed between the IAEA, the SRA and the operator may be submitted to the mailbox. Mailbox data can be transmitted by the operator from the mailbox directly to the IAEA, or from the mailbox to the SRA who then forwards it to the IAEA, or the data may be sent simultaneously by the operator to the IAEA and to the SRA.

Secure electronic data transmission (e.g. encrypted and digitally signed emails or attachments) **protects sensitive information**.

For supporting unannounced inspections or short notice random inspections (SNRIs), an agreed ‘retention period’ is assigned to nuclear material in the facility. In such a case, the material is held by the operator for a specific period of time prior to being moved to another location. This creates a window of time in which the IAEA has the opportunity to send an inspector to the facility to verify the nuclear material and that the activities being performed are consistent with the latest mailbox submission.

The information submitted to a **secure electronic mailbox** should be near-real-time and include up-to-date production schedules, shipping dates and transfers. This ensures that the IAEA has an accurate understanding of the operating conditions of the facility at all times.

The scope and level of detail of mailbox submissions should also be agreed between all parties ahead of time and documented in facility procedures to ensure smooth and consistent implementation. The volume of information submitted through the mailbox can result in information management difficulties for both the operator and the IAEA, so discussions are useful to agree on the information required and the documents to be submitted.

Mailbox data transmission relies on a functioning network, so when a network outage occurs, all parties should have contact information for technical support to resolve the issue as quickly as possible. Traditional means of communication (telephone, fax) should be maintained as a backup for situations where submission to the mailbox is not possible.

4.3.5. IAEA measurements of nuclear material

IAEA verification activities include the performance of independent measurements of nuclear material in item and bulk form. The IAEA inspectors weigh items using scales, perform non-destructive assay measurements (such as gamma spectroscopy and neutron coincidence counting) and carry out destructive assay measurements using analytical chemistry techniques in a laboratory.

The nuclear material items, the stratification approach and the batches at a facility, as well as the associated measurement methods and units, are specified in the Facility Attachment. The results of IAEA measurements are not typically shared with the SRA or operator unless there appears to be an issue which requires resolution. Notwithstanding, the State is informed by the IAEA of the results of inspections and the conclusions it has drawn from its verification activities through paragraph 90 (a) and (b) of INFCIRC/153 (Corr.) statements.

INFCIRC/153 (Corr.) Paragraph 7

… The Agency's verification shall include, inter alia, independent measurements and observations conducted by the Agency in accordance with the procedures specified in Part II below.

Like facility measurement programmes, the IAEA measurement methods also require quality control, calibration and determination of associated uncertainties which requires the procurement of certified reference standards. To calibrate NDA instruments, the IAEA sometimes uses fuel pellets or well characterized items at the facility as reference standards. The IAEA may also bring its own reference standards (weight standards as well as certified NDA standards) which may be stored at the facility under IAEA seal.

To use statistical sampling, which allows the IAEA to measure a randomly selected subset of items from a larger set with similar characteristics, the IAEA must stratify the inventory[14]. The IAEA defines the strata of a facility’s nuclear material inventory as part of the DIE process. The facility should notify the IAEA whether any operational process issues may have occurred which could result in the production of nuclear material in a form that is not within the defined strata for the facility. Operating records that explain and document the operational issue should also be provided.

[14] Inventory stratification is explained in IAEA Services Series 15 in section 4.5.6.

Example: A facility operator helps the IAEA inspectors to prepare sample plans in advance of the inspection by providing an electronic inventory listing that groups the items and batches by the IAEA's defined strata. This allows the verification activities to begin immediately when inspectors arrive at the facility. To reduce the time spent generating reports, the documentation includes only the data necessary to support the IAEA during that particular inspection. Other documentation is produced upon request or submitted at a later date after the inspection.

Section 4.3 provides additional information regarding preparing an inventory for IAEA verification. The *SIP Guide on Provision of Information to the IAEA* provides more detailed guidance regarding operating records, nuclear material accounting data and related topics.

4.3.6. Destructive analysis

To verify nuclear material, the IAEA measures a representative sample of the inventory of material in each stratum. The samples must be homogenous; representative of the stratum from which they are taken; collected in accordance with the approved procedure; packaged; labelled; and shipped. Figure 10 shows samples stored at the IAEA's analytical laboratories. Uncertainties in the measurement results can stem from each of these steps so controlling them carefully is important to the IAEA's ability to achieve its measurement objectives.

IAEA inspectors do not take samples themselves; rather, they request that the samples are taken by the facility operator and observe the sampling process to ensure it is carried out in accordance with procedures. The results of measurement of each sample are applied to the total quantity of nuclear material in the stratum from which the sample was taken, for the purposes of verifying the operator's declaration.

FIG.10. Samples stored at the IAEA laboratories ©IAEA; Dean Calma

Samples are often subdivided, with part of the sample retained at the facility as an archive under IAEA seal. When the measurement results are satisfactory for the measured sample, and the IAEA notifies the operator, the archive sample can be returned to the process.

Example: Each facility should establish a system for logging and archiving samples. Samples should be retained as necessary to meet the IAEA's needs while also minimizing the inventory of material in archived samples by alerting the facility when the retention period has expired.

The IAEA may provide information to the SRA or operator about the performance requirements for the scale used at the facility to weigh the sample and the item from which it was taken. The scale used at the facility to weigh the sample when it is collected should be capable of a similar level of performance as the scale used by the IAEA's laboratory, to avoid substantial differences due to scale uncertainties.

Sometimes an SRA takes a sample from the same stratum as the IAEA (when national inspections are carried out in parallel with IAEA inspections.) The SRA may then measure the sample for its own purposes, or retain it for future analysis. In case there is a problem with the IAEA's results, the SRA's results may be helpful in resolving the issue. Annex 3 provides an example of a case where SRA sample analysis was helpful in resolving such an issue. Chapter 7 provides additional information about shipping IAEA samples.

4.3.7. Environmental sampling

The IAEA may collect environmental samples during inspections, DIVs or complementary access. Environmental samples are typically collected on a square of cotton material, by wiping the material over various surfaces. They may be collected from any surface, such as a vent grate, the top of a filing cabinet, or the walls of a hot cell. Figure 11 shows a typical swipe sample protected inside a clear plastic bag.

Some swipe samples may have radioactivity that exceeds the threshold for routine transport and therefore require special packaging, handling and shipping by the operator (and may require the involvement of a licensed contracted shipper). Other samples will not have detectable activity and may be carried back with inspectors to Vienna for analysis.

FIG.11. Swipe sample kits are received, logged and analysed at one of the IAEA's Network of Analytical Laboratories. © IAEA, Dean Calma.

All swipe samples will need to be surveyed to determine how they will be handled. The survey instrument needs to be accurate enough to ensure the samples are correctly characterized. Multiple replicate swipe samples are typically collected from one location and a sample is left for storage or archiving at the facility. Some SRAs also retain a sample to assist in resolving any issues that might occur in the future.

4.4. Specific provisions for inventory taking and verification

IAEA physical inventory verification follows the physical inventory taking by the facility operator. All nuclear material present in a facility must be made available and accessible for verification. To achieve this, all nuclear material needs to be located in accessible areas, plant hold-up reduced to acceptable levels and appropriate measurement capability made available. All operating records must be available upon request to verify any nuclear material that remains in the process equipment, lines, filters or other locations. The operator should maintain these records and be able to produce them upon request from the SRA or IAEA. Quantifying the material in process may involve activities such as grouping similar containers together, emptying vessels, sampling, measurements and performing quality controls.

Annex 4 provides example procedures used by a State in preparing for a PIV at a bulk handling facility. Some recommendations regarding PIT are provided below.

Example: An operator establishes a PIT plan that includes measurement quality targets (i.e. targets for precision and accuracy) for each key measurement point. The plant is required to meet those targets during the inventory. The quality targets are determined by the person responsible for safeguards at the facility (safeguards officer) and approved by senior management. The PIT plan is communicated to all relevant teams including production programmers, outage coordinators, material controllers, and accountancy and transport teams. These teams work in a coordinated way to ensure that the nuclear material is controlled to create optimal conditions for measurements. If the targets cannot be met, a senior facility manager provides the IAEA and SRA with an explanation prior to the PIV and supplies information regarding the measurement performance achieved.

The following example contains general recommendations regarding inventory preparations for bulk facilities. A subset of these recommendations may be applicable for item facilities.

1. All nuclear material storage locations shall be clearly marked (or shall be easily derivable from a physical data point).

2. All storage containers holding nuclear material shall be segregated from those that are empty and shall be uniquely identified.

3. Where items containing nuclear material are stored, there shall be a storage density and configuration which allows access to all items for verification.

4. Nuclear material movement shall be minimized as possible for the duration of the PIT and the presence of all nuclear material recorded accurately.

5. The stock position at the time of PIT shall be maintained until the PIV is complete. Any deviation from this practice will be justified and documented.

6. Nuclear material contained in every item on the list of inventory items (LII) must be justified through a complete, correct and accurate documentation that will contain all information needed for verifications and will be made available in a timely manner.

7. All instruments used for nuclear material measurement at KMPs shall be calibrated and records of recent calibrations and derived measurement uncertainties must be available. Quality control records shall exist for all KMPs to assure nuclear material measurement integrity.

8. A measurement control programme shall be in place covering all KMPs within each accountancy area.

9. The amount of nuclear material held in any process area (tanks, etc.) will be minimized. Here are some examples:

- Nuclear material in the process area shall be converted to a measurable form and/or transferred to a suitable measurement location.

- If the process lines cannot be emptied, then the estimated nuclear material amount remaining including, e.g. operating records of tank filling (volumes, concentrations), should be provided to the inspectors to evaluate the amount of nuclear material remaining in process.

- Where nuclear material inventory is stored in vessels, the best calibrated tanks shall be used where

practicable. A good practice is to transfer nuclear materials from process tanks to the instrumented tanks with the best measurement quality before the PIT.

- Nuclear material for which accounting values have not been established shall be homogenised, sampled and analysed if technically feasible.

- Sample results to be used in the LII shall be obtained and managed in a timely manner such that quality assured values are used for the PIT.

- Where the above is not practicable, or nominal values are declared on an LII, then a technically justified reason shall be provided and a technically justified estimate shall be used with supporting information provided.

- Confirmation shall be sought that vessels without a sample point are suitably washed out to ensure that nuclear material holdings are as low as possible at inventory.

- Considerations for minimizing in-process inventory include: unexpected maintenance requirements; radiation dose limits for staff; start-up requirements of the plant; and the upstream/downstream availability of plants.

- In the event there is a problem with inventory preparation, IAEA will be informed in a timely manner and appropriate measures to resolve the difficulty and to allow the fulfilment of the safeguards requirements will be discussed and agreed.

10. When these plant conditions are not met a written justification and explanation will be provided by the operator's senior management in advance of PIV.

5. IAEA ACTIVITIES IN STATES – COMPLEMENTARY ACCESS

Complementary access may be carried out by IAEA inspectors pursuant to an additional protocol as provided for in INFCIRC/540 (Corr.). When complementary access is performed IAEA inspectors may carry out the activities set out in Article 6 of the additional protocol to achieve the objectives set out in Article 4 of the additional protocol. To facilitate complementary access, it is helpful for the SRA to understand the objectives of the IAEA request for access and the locations to be accessed in order to meet the objectives. The IAEA may send requests for clarification of a question or inconsistency, which may be followed later by a request for complementary access.

5.1. IAEA activities during complementary access

The IAEA uses a variety of tools and techniques in order to meet the objectives of complementary access. Inspectors may, for example:

- need to take photographs as part of visual observation;[15]
- collect environmental samples;
- collect other samples;
- use radiation detection and NDA measurement devices;
- determine the characteristics of non-nuclear material (using other objective measures such as X-ray fluorescence or Raman spectroscopy);

[15] During the negotiation of the Model Additional Protocol, in response to comments made by Member States as to what was covered by "visual observation", the Secretariat informed the Member States that it "might involve the taking of photographs". (See GOV/COM.24/OR.32, paragraph 106).

- examine records related to quantities or origin or description of material;
- interview operators; and
- apply seals or other tamper indicating devices.

Example: When the IAEA takes photographs during complementary access, a copy of the image file may be retained by the SRA and the operator while the IAEA takes the original back to Vienna or keeps it at the location under IAEA seal. This practice helps to ensure that the security office of the facility is able to retain information about what photographs have been taken by the IAEA while also helping the IAEA to meet its objectives.

5.2. Notification

Normally, complementary access will be requested with an advance notification of at least 24 hours. However, in case the IAEA is conducting a DIV or an inspection at a facility (ad hoc or routine), the IAEA may request complementary access to any place on that same site and the period of advance notice will be at least 2 hours, but, in exceptional circumstances, it may be less than 2 hours. In all cases the advance notice will be in writing and will specify the reason for access and the activities to be carried out during such access.

Example: a complementary access took place for the first time at the site of a research reactor with a two hours advance notification, in conjunction with a DIV at that location. The buildings that had been subject to the CA included waste treatment and storage buildings located on that site. The notification was provided to the SRA by the IAEA inspector and to the site representative simultaneously during a meeting held on the second day of the DIV, during that day's opening meeting. The notification was a letter signed by the Director of Operations Division. The notification listed the purpose of the CA (to assure the absence of undeclared nuclear material and activities) and the activities the IAEA planned to carry out (visual observation, including taking photographs; and interviewing staff).

The purpose of complementary access at facilities that have been decommissioned before a CSA entered into force is to confirm, for safeguards purposes, the decommissioned status of the facility.

5.3. Managed access

Article 7 of INFCIRC/540 (Corr.) provides for managed access. States are required to notify the IAEA in advance when the use of managed access is anticipated. The IAEA requests that the reason for managed access be explained in the relevant AP declaration(s).

Managed access should be used to prevent the dissemination of proliferation sensitive information, to meet safety or physical protection requirements, or to protect proprietary or commercially sensitive information.[16] An example of managed access is the designation by the operator, based on arrangements made with IAEA, of the routes to be followed on a site to prevent the exposure of inspectors to high levels of radiation, or to protect proprietary sensitive information associated with certain equipment.

---

[16] See AP, Article 7.a.

Example: In some cases, the operator may have internal policies concerning the taking of photographs by the IAEA during complementary access. IAEA inspectors and facility representatives may consult on the way photographs can be taken to fulfil the objectives of the complementary access without compromising internal security requirements. At one location, a procedure was established whereby security personnel escorted the IAEA inspectors during the complementary access, and helped to ensure the requested photographs were taken in a way that met the IAEA's needs while avoiding objects or areas that would pose a security risk. The security personnel and the IAEA then reviewed the photographs so that the security personnel could confirm that the pictures did not adversely impact security.

Constructive dialog between the SRA, operator and IAEA helps to ensure that the objectives of the access can be met while respecting security and health and safety requirements of the operator.

Managed access **should not hinder IAEA inspectors** or prevent them from fulfilling the purposes of the complementary access.

5.4. Considerations for CA with twenty-four hour access

For complementary access that is not in conjunction with an inspection or DIV, the notification will typically be provided with an advance notification of at least 24 hours. This time period would normally be sufficient for the SRA to notify the operator of the associated location and make the necessary travel and logistical arrangements. However, some locations may pose logistical complexities. These include remote locations (such as uranium mines), commercial locations with no government funding/regulation, and decommissioned facilities that have been converted and used for non-nuclear purposes.

Example: To reach a uranium mine in one State, the notification time is typically longer than 24 hours to accommodate the chartering of a flight, arranging for four-wheel drive transportation to cope with unpaved roads, and arranging for accommodation in the nearest town centre (which is more than 100 km from the mine). Another complication is winter conditions that make driving dangerous, and a constant risk of collisions with wildlife during other seasons. The IAEA and SRA in this State worked out logistical approaches to facilitate access. Chartered flights are used to fly to and from the mine from the town centre so that the access is carried out in one day.

For commercial locations that are not government funded, which may include some research and development activities that are declared under Article 2.b.(i) of the additional protocol, it may be necessary to explain complementary access (purpose, scope, expectations of the proprietor) in advance to alleviate concerns about release of sensitive information and to make arrangements for access. In exceptional cases, the SRA may need to request the assistance of local police to facilitate the access. The SRA should anticipate the need for arranging access and ensure the regulatory authority is sufficient.

Complementary access to the site of a decommissioned nuclear facility may require some logistical planning and forethought. The facility may have been converted to an entirely non-nuclear-related enterprise, such as an electronics manufacturer. The new occupants may not be acquainted with radiation detection equipment, cameras and IAEA inspectors.

Example: In one State with a shutdown nuclear power plant, the IAEA requested complementary access with 24 hour advance notice. The notice was provided toward the end of a working day and all of the staff at this location had gone home. The SRA arranged for transportation, informed the facility's office in the capital and arrived at the facility to assist the IAEA. To prevent this situation from happening again, the SRA and IAEA agreed that notification for this kind of location would be made early in the day to increase the probability that staff would be available to assist.

The SRA can help alleviate concerns by informing the organization about the purpose of complementary access, the nature and mission of the IAEA, and the objectives of the access. The ability to carry out successfully a complementary access at remote locations requires cooperation between the IAEA, operator and SRA. By planning ahead and discussing possible issues, the SRA and the IAEA can work out practical arrangements that meet the needs of both organisations. A case study describing one State's efforts to facilitate complementary access with 24 hour advance notification is provided in Annex 5. Annex 6 provides an example of the processes and procedures used by one State in facilitating complementary access.

5.5. Considerations for complementary access with advance notice of two hours or less

Two hours advance notice is provided for complementary access to sites where ad hoc/routine inspections or DIV is taking place. In exceptional circumstances where the objective of the access could be jeopardized if two hours have passed (such as a shipment of some items would occur), the period of advance notice might be less than 2 hours. Access may be requested to any place on that site. Occasionally, a large nuclear facility may have buildings on its site that are not necessarily readily accessible by the operator. Access to some buildings may be controlled by a third party company, so the site representative (the individual identified by the SRA as responsible for all safeguards-related matters at the site) should work out arrangements for access. Sometimes a security department has keys for all buildings and may be helpful in this respect. It may also be necessary for the site representative to brief the third-party contractors about IAEA safeguards and the purpose of, and potential for, a complementary access.

Two hours advance notice requests for access are not predictable, but in certain cases the operator might anticipate the possibility of a 2 hours access request. For example, a request may be anticipated in cases where the operator recently declared important changes in its additional protocol Article 2.a.(iii) declaration, or recently received requests for clarification under additional protocol Articles 2.c. or 4.d. Once the IAEA has made the request for 2 hours access, the operator and inspectors will need to immediately discuss the logistics of achieving the objectives of the complementary access. The IAEA will not provide any results or conclusions after the access; analysis is required to evaluate the information gathered during the access before any results can be reached.

Table 2 summarizes the kinds of activities carried out during complementary access.

Example: Mock access (carrying out a complementary access exercise) has been useful for both the IAEA and the SRAs in several States, to test the notification procedures, the follow-up of the notification, the access process for all buildings on the site (including those controlled by third parties), to familiarize facilities and other locations with the process and purpose of complementary access, and to walk through the kinds of activities that can be conducted. These mock access activities can also be used to share the experiences gained in conducting complementary access at other locations in the State. Complementary access exercises have been conducted as table top exercises and as field exercises. Sometimes a table top exercise is followed by a limited in-field exercise.

6. STATE ACTIVITIES TO PREPARE FOR IN-FIELD VERIFICATION

6.1. General considerations in preparing for any type of IAEA in-field verification

IAEA inspectors must be able to access necessary locations to accomplish the objectives of the in-field verification (i.e. inspections, DIV, CA). The inspectors' access should not be denied, delayed or disrupted. SRAs and operators should coordinate with facility security, operational and radiation safety staff to establish entry procedures that enable inspectors' unfettered access to all necessary locations.

It may be helpful for the SRA to carry out a **mock inspection or field trial** to test new or revised procedures in advance of an actual IAEA access.

There may be situations in which personnel in charge of granting access are absent due to meetings or business trips. Access will need to be granted in a timely manner in such situations, so a facility may wish to designate alternate personnel or establish procedures to define what preparations should be taken. If the requirements of the verification notification are unclear, the SRA or operator should proactively seek additional information from the IAEA. The goals of the inspection or other access, as well as the rights and duties of the IAEA inspectors, the SRA and the operator staff, should be clear and unambiguous for everyone involved. A case study on the roles and responsibilities of various individuals involved in preparing for in-field verification activities is found in Annex 7.

Example: A facility operator has prepared a form and provided it to the IAEA to provide the needed information to quickly grant access. Information requested includes: Name, Laissez-Passer number, gender, laptop number, list of other equipment or items to be brought into the facility, height and weight of the inspector, shoe size, head size, medical certificate and training. Providing information in advance on equipment brought by the IAEA not only speeds up clearing the equipment for access but also facilitates removal at the end of the visit. Requesting the gender of inspectors helps the facility to identify escorts.

Some facilities provide a badge that is valid for as long as an inspector is designated. Random alcohol and drug testing on a random basis may be required for inspectors. If inspector access through a security gate might be delayed by a line of other contractors or visitors, a 'fast lane' approach for IAEA inspectors would be helpful.

Table 2. Summary of Complementary Access Activities

Location (where)	**Declarations (what)**	**Purpose (why)**	**Advance notice (when)**	**Allowed activities**	**Statement**
5.a.(i): Any place on a site	2.a.(iii): Description of buildings on site and site map.	4.a.(i): To assure the absence of undeclared nuclear material and activities	4.b.(i): at least 24 hours 4.b.(ii): at least 2 hours in conjunction with DIV/ ad hoc or routine inspection	See article 6.a.: • Visual observation • Environmental sampling • Use of radiation detection & measurement devices • Application of seals & other identifying & tamper-indicating devices • Other objective measures	10.a.
5.a.(ii): Location specified in 2.a.(v)-2.a.(viii)	2.a.(v): Uranium mine and concentration Plant 2.a.(vi): Source material 2.a.(vii): Exempted material 2.a.(viii): Change of location or further processing of intermediate or high-level waste	4.a.(i): To assure the absence of undeclared nuclear material and activities	4.b.(i): at least 24 hours	See article 6.b.: • Visual observation • Item counting • NDA & DA sampling • Use of radiation detection and measurement devices • Examination of records relevant to quantities, origin & placement • Environmental sampling • Other objective measures	10.a.
5.a.(iii): Decommissioned facility/LOF	Design information or other State declaration	4.a.(iii): To confirm the State's declaration of the decommissioned status	4.b.(i): at least 24 hours	See article 6.a.: • Visual observation • Environmental sampling • Use of radiation detection and measurement devices • Application of seals & other identifying & tamper-indicating devices • Other objective measures	10.a.

5.b: Location specified in 2.a.(i), 2.a.(iv), 2.a.(xi)(b), 2.b. (except those referred to in 5.a)	2.a.(i): Government funded fuel cycle R&D not involving nuclear material 2.a.(iv): Annex I (manufacturer) 2.a.(vi): Exempted material 2.a.(ix).(b): Annex II (import) 2.b.: Privately funded R&D not including nuclear material (enrichment, reprocessing, waste processing)	4.a.(ii): To resolve a question/ inconsistency	4.b.(i): at least 24 hours	See article 6.c.: • Visual observation • Environmental sampling • Use of radiation detection and measurement devices • Examination of production and shipping records • Other objective measures	10.a., 10.b.
5.c: Any location other than those referred to in 5.a and 5.b.	Location specified by IAEA	4.a.(ii): To resolve a question/ inconsistency	4.b.(i): at least 24 hours	See article 6.d.: • Environmental sampling In the event that environmental sampling analysis results do not resolve the question or inconsistency: • Visual observation • Use of radiation detection and measurement devices • Examination of production and shipping records • Other objective measures	10.a., 10.b.
8.: Additional location(s)	Specified by State (State offer pursuant to Article 8)	As appropriate	Upon offer by State (without delay)	Activities as agreed with the State	10.a.

6.2. Operational programmes

To the extent possible, the IAEA plans its verification activities to minimize disruption to facility operations. Therefore, the IAEA needs detailed, accurate and timely information about a facility's operating and processing schedules, planned outages, maintenance activities (particularly important for key equipment such as cranes or fuel handling machines), dates of physical inventory taking, holidays and other key activities. Some information is provided at a general level in the DIQ (e.g. length and times of work shifts, days of operation per week, holidays observed, frequency of physical inventories, etc.), but specifics are provided annually or more frequently as required.

The format and timing for providing and updating this information is discussed and agreed between the IAEA and the SRA in the Subsidiary Arrangements. Depending on the facility type and process characteristics, the information might be sent annually, monthly, weekly or even daily, to support SNRIs or unannounced inspections. When an inspection takes place, specific information about operations scheduled for that day is provided to the inspectors.

Example: An annual operational schedule is provided by the SRA followed by quarterly updates submitted by the operator to the IAEA and SRA concurrently via an electronic mailbox system. The format might be text, a specialized calendar or a project management 'Gantt chart', for example.

6.3. Facility-specific health and safety information including radiation protection

Information on facility-specific health and safety requirements and radiation protection programme must be provided pursuant to the Subsidiary Arrangements, Section 3.2 of the model Subsidiary Arrangements. States can expect inspectors to adhere to the rules and restrictions, but it is the State's responsibility to ensure the inspectors are aware of these in advance of the inspection. This topic should be included in the pre-verification briefing and provided in the DIQ.

The IAEA may bring radiation monitoring equipment to meet its own requirements, for example to check its equipment for contamination prior to removing it from the facility. The operator is required to ensure a safe working environment that is suitable for these activities to be carried out.

Where new hazards or safety concerns may have recently developed, and there is a foreseeable **impact on routine safeguards work**, the operator/SRA should advise the IAEA at the earliest opportunity, to allow all parties to work out an acceptable solution.

6.4. Facility-specific procedures

Safeguards approaches and activities vary from one facility type to another (due to factors such as nuclear material forms, type, chemical composition and complexity of processes) and in some cases, facility-specific safeguards procedures are prepared. The development of facility-specific safeguards procedures benefits from early consultation of both the SRA and the operator. The SRA, with input from the operator, can cooperate with the IAEA to help in the conceptualization and development of the safeguards procedures for different facility types. Operators are most familiar with the design and operation of an operating facility so they may have useful suggestions on the feasibility of conceptual safeguards measures as they may be applied in the field. For new facilities, the vendor will be helpful in discussing safeguards approaches, as they are most familiar with the facility design. Such interactions can be accomplished by holding meetings involving the IAEA, SRA, operator and vendor throughout the development process.

Facility specific arrangements, procedures, and Facility Attachments contain information about possible instances in which the State may not be able to fulfil its responsibilities due to acts in the State outside of its control, such as an uncommon severe weather conditions, accident, contamination event, natural disaster or act of war. This documentation may foresee such situations and describe procedures or approaches agreed between the State and the IAEA that can facilitate the achievement of safeguards objectives under such circumstances.

6.5. Basic essentials for IAEA inspectors

IAEA inspectors are carrying out their work in facilities, and they require basic essential support to meet their objectives.

Inspectors need a dedicated office space to work (a desk and chair), a power outlet, internet connection, access to a bathroom, drinking water, some storage space, a change room, a printer and a paper shredder. While these sound quite simple, complications frequently arise.

Inspectors are typically escorted while working at a facility. If the gender of the escort is not the same as the gender of the inspector, then going into the change room, or providing access to a locked bathroom, may be very awkward. At several facilities, for safety reasons the women’s bathroom has an entry access code that is only known to women.

Example: If the inspectors’ work area is also used to store IAEA equipment racks with servers and other instruments, the heat generated by these units can create an inhospitable work environment. It is essential that facilities ensure adequate air ventilation is supplied, not only for the inspectors but for the longevity of the equipment, and protection against fire. One facility operator periodically walks through the IAEA storage space with the inspectors to check the conditions and identify any needed improvements. Operators should routinely discuss housekeeping and safety with the inspectors and periodically check that office and storage rooms are safe, hospitable and compliant with facility safety requirements. Some large facilities track the location of the inspectors on site using the facility badges, so that the location of visitors is known during an emergency.

IAEA work spaces should have posted signage regarding emergency exit routes and procedures. The work space should not be too isolated, so that inspectors can request support of facility staff when needed.

Many facilities are located a long distance from any towns. IAEA inspectors may prefer to remain at the facility to have lunch due to long delays associated with leaving the facility and finding a place to eat and returning to the facility. It is helpful if the facility assists the inspectors by allowing the inspectors to eat in the facility cafeteria or offering other alternatives. For facilities that are not easily accessed by public transportation, IAEA inspectors will appreciate advice or assistance in transporting themselves and their equipment to and from the hotel and the facility, to and from the airport, and for mid-day meals as necessary.

6.6. Operational support to inspectors

Many activities carried out by inspectors require the support and assistance of facility operator staff and equipment. For example, facility staff perform movements of nuclear material items, take samples, escort inspectors to ensure their safety and provide for radiation protection. Using facility equipment requires trained and qualified operators to be available to operate it. Cranes or forklifts may be needed to move and weigh items, so equipment failure can have a significant impact on achieving inspection goals.

Testing facility equipment such as cranes or load scales before inspectors arrive allows time for repair or replacement without impacting the inspection schedule.

During inspections, it may be necessary for material to be moved to a location where it can be measured by the IAEA (weighing, NDA). In addition, during maintenance or servicing, some IAEA equipment will need to be accessed using facility equipment (ladders, scaffolding, scissor lift).

Example: The operator and SRA can better prepare to support the inspection activities when information is provided in advance regarding the schedule, planned activities and needed equipment. When advance information does not jeopardize the objectives of the inspection, the IAEA will provide it. If specific activities cannot be described in advance, then the IAEA will indicate the need for a forklift (so that its battery can be charged), or a crane (so that its operation can be tested) without saying exactly how it will be used.

The IAEA sends inspectors as well as technicians to facilities to service and install equipment. In many cases, particularly for installation, operator support and specialized contractors are needed. It is helpful for the IAEA and the operator to discuss the activity and determine what equipment, tools and infrastructure (ladders, scissor lifts, forklifts) are available at the facility and what might need to be contracted in advance.

Certified electricians are often needed for electrical hook-ups and wiring. An engineering review by a licensed professional engineer may be needed for approval of equipment installation. The operator and the IAEA can discuss requirements and identify any needed specialized support, giving the operator time to put contracts in place; if the work will occur in a high security area or radiation zone, additional time may be required to authorize third party contractor access.

6.7. Accompanying inspectors

SRAs have the right to accompany IAEA inspectors during their inspections.

INFCIRC/153 Paragraph 89
The Agreement should provide that the State shall have the right to have inspectors accompanied during their inspections by representatives of the State, provided that inspectors shall not thereby be delayed or otherwise impeded in the exercise of their functions.

When such accompaniment does not impose delays, but rather facilitates the smooth implementation of safeguards activities, improves communication and understanding, and improves the ability of the IAEA to meet its safeguards objectives, accompaniment can provides benefits to both the IAEA and to the operator.

The SRA can act as an **informed and supportive authority** to facilitate effective communication (resolving language barriers in some cases) between the IAEA inspectors and the operator. The site safeguards manager (or site representative) for a particular site can also effectively communicate with the IAEA, SRA and other operator staff.

In addition to the SRA, IAEA inspectors may need to be escorted by a representative of the facility operator, such as a security officer, a safety officer or a radiation protection officer. An escort may have a maximum number of people they can accompany, as directed by internal policies, and it is helpful if the escort is the same gender as the people they are escorting. It is also essential that the escorts can facilitate communication with the IAEA inspectors in the agreed language for that facility (which is specified in the Facility Attachment). Construction projects can limit access; when construction is underway, the inspectors and operators should coordinate to avoid unsafe areas while still achieving inspection objectives.

The operator/SRA should inform the IAEA regarding escort policies. In order to facilitate access in a timely manner, inspectors and escorts may wish to establish a meeting place and time at the facility and exchange contact information. It is also helpful for the facility to identify alternates if the designated escort cannot be reached by the IAEA upon arrival at the site. IAEA inspectors should clearly understand where they are allowed to go with and without an escort at a facility.

6.8. Facility-specific training for IAEA inspectors

IAEA inspectors often require facility-specific training in order to safely carry out their activities. The facility is responsible to provide the necessary training and to notify the inspectors in advance if their training certification period is nearing expiration and re-training will be required.

The inspectors need to factor the need for **re-training** into their inspection schedule, so early notification is necessary. Inspectors may also need **different types of training** at different facilities, because States may not have one standardized training requirement.

Inspectors should be made aware of the security and safety requirements, such as alarms and evacuation procedures. Safety routes, security plans, and evacuation procedures are often conveyed through orientation training (where applicable). As part of their standard health and safety programmes, most facilities require any IAEA inspector to take facility-specific training prior to accessing the facility as a guest worker. If this kind of training is not required, the information can be provided in a pre-inspection briefing.

IAEA technicians and equipment specialists may need different training than inspectors in order to accomplish their objectives, which may include installation of equipment, maintenance or testing. These individuals may need to undertake activities such as climbing ladders, working with tools or connecting wiring. The facility operator needs to inform the IAEA staff in advance of the boundaries associated with their planned activities and their training. For example, the facility operator may not allow IAEA inspectors, irrespective of their training, to perform tasks with the potential for electrocution or to affect other facility systems.

The amount and nature of training required for inspectors depends on the facility type and the nature of the work being performed in the field. Specialized training will be needed for work in areas with elevated radiation hazards, working at heights, difficult to access areas, etc. This may include respirator fit testing, fall arrest training and confined space training.

Example: IAEA equipment operates on a particular voltage and frequency. Several facility operators mark electrical outlets with the specifics of the associated voltage and frequency, which is helpful to the inspectors and technicians. The DIQ provides information on the primary voltage and frequency supplied to a facility.

The facility also needs to provide IAEA inspectors and technicians with safety equipment such as shoes, safety glasses, hard hats, anti-contamination clothes and respirators, or inform the inspectors in advance if they need to bring any equipment of their own.

Example: The operator or SRA should inform the IAEA of the particular training requirements based on the work being performed at the site and the inspector's training status. Many operators have a computer system for tracking the training requirements for each inspector and the training completed. This system helps them to notify the IAEA in advance if an inspector's training is coming due for renewal. In many cases, specialized training conducted on site may only be offered at certain times and with a limited numbers of participants. Quick or standardized training may be completed on the morning of an inspector's visit, but more intensive or specialized training may require advance coordination to schedule it at an appropriate time to allow objectives to be met in a timely manner. Computer-based training that can be conducted by the inspector prior to coming on site helps to avoid delays upon arrival at the facility.

For hazardous areas where IAEA inspectors frequently need access, the operator may adopt the standard practice of ensuring all inspectors are certified and up to date on the training required (respirator fit, fall arrest training). By doing this, delays in the field can be minimized as all inspectors that arrive at the facility are trained for all foreseen activities.

6.9. Customs clearance of IAEA equipment and samples

The IAEA needs to ship safeguards equipment and samples (nuclear material as well as environmental samples) between headquarters, regional offices and locations in States. This requires that the shipment is cleared by Customs at the entry/exit points in the State.

Communication between Customs and the SRA is needed to ensure that procedures are established and followed in **clearing IAEA equipment and samples through Customs**, without charging duties or requiring inspection of the shipments.

An important function of an SRA is to facilitate the import and export of IAEA equipment and samples to and from the State and establish coordination mechanisms with the Customs office. Inspections can be delayed if IAEA equipment necessary for its in-field activities is delayed by Customs clearance procedures. Delay may be caused if the Customs office charges the IAEA for duty for import and export of its inspection equipment. The *Agreement on the Privileges and Immunities of the IAEA* exempts the IAEA and its property from payment of customs duties in respect of articles imported or exported by the IAEA for its official use.[17]

Example: A State has established binding protocols among Customs, the Ministry of Foreign Affairs, the Atomic Energy Authority, universities and other organizations involved in the implementation of safeguards. The protocols specify the obligations of the various parties and the procedures that facilitate interaction amongst them. The Customs Office at the airport has a copy of the protocol to facilitate the clearance procedures for IAEA equipment and staff through Customs and Immigration. Under this protocol, the SRA provides to the Customs Office updated information regarding the IAEA inspectors designated for the State.

Procedures also need to be in place for inspectors that are carrying equipment into and out of the State by vehicle (for example in a car or on a plane), in case an inspector is stopped at a border by a Customs official who is not familiar with the IAEA. In case such procedures are not yet developed, or in any situation where there is uncertainty involving the IAEA, a good practice is for the Customs official to contact the SRA directly to request advice.

6.10. Use and storage of IAEA equipment at facilities

Verification activities require the use of a wide variety of instruments and equipment. Some of these remain on-site in storage, and some are carried away by inspectors when they leave the site. The IAEA often provides an equipment cabinet where items can be stored under seal, but the operator needs to provide a location where the cabinet can be stored safely. Likewise, if an equipment cabinet is not available, it is helpful for the operator to provide a dedicated sealable area for storage of IAEA equipment.

IAEA equipment can become contaminated during use, and may need to remain in a radiation area. Some equipment requires the use of a radiation source which can pose complications for

[17] Agreement on the Privileges and Immunities of the IAEA, INFCIRC/9/Rev2, section 8(b).

shipping and disposal. The State or operator may need to make arrangements for the disposal of obsolete or damaged equipment, particularly if it has been contaminated once written-off and declared for disposal by the IAEA.

Example: IAEA equipment is shipped to a facility only after advance discussions between the SRA, operator and IAEA. The IAEA conveys to the operator the dimensions of the equipment container, the weight and how best to handle it (fragile, must remain in vertical orientation). One SRA has assisted in the exchange of information by working with the facility safeguards manager to prepare a procedure for notifying the receiving department. The SRA instructs the facility regarding handling the receipt, specifying that it is not to be opened, where it should be delivered and stored, and what will be done with it when the IAEA arrives.

6.11. Opening meeting

Each day that an IAEA inspector or technician arrives at a facility or location to carry out safeguards activities (or on the first day of a multi-day visit), an opening meeting is very useful to establish a common understanding between the IAEA, the SRA and the operator of the activities to be carried out. The participants of such a meeting should include the SRA, the key staff members at the facility, and the IAEA inspectors. Any supporting personnel that would have a key role in the access should also be invited, such as radiation safety or technical support staff. The opening meeting can be used to:

- Introduce the IAEA inspectors or technicians to the key facility staff members;
- Identify the individual at the facility primarily responsible for the IAEA activities;
- Describe the planned inspection activities to be conducted by the IAEA;
- Address any questions or concerns;
- Identify any necessary actions that need to be completed by the operator or SRA to support the inspection activities;
- Review the planned schedule of activities and logistics;
- Review safety and radiation protection measures; and
- Review relevant procedures as necessary.

These meetings need not be lengthy or formal. The scope, length and participants of the meeting will be based on the work plan for the verification activity.

It is helpful to exchange phone numbers at the meeting so the key facility staff and the inspectors can communicate throughout the day(s). If visitors are not allowed to keep their phones while in the facility, they should have access to a phone, such as the phone of an escort. The State is obliged to facilitate the inspectors’ communication during their access.

Example: An agenda for an opening meeting at one facility typically includes the following topics:

- *Discuss any unusual conditions at the facility, such as a room with contamination or a safety hazard, or if there are any special arrangements for clothing or hard hats;*
- *Identify the designated safeguards contact at the facility for that access, as well as an appropriate alternate, and contact information;*

- *Provide a facility operational status briefing (i.e. indicate the process status, potential operational problems which can hinder verification or access, describe the current and recent operations, etc.) so the IAEA inspectors and SRA have up to date information on the operations and situation at the facility;*
- *Discuss when and how lunch and breaks will take place;*
- *Identify the radiological technicians and escorts;*
- *Discuss what will happen in the event of a shift change during the course of the in-field activities; and*
- *The IAEA staff should discuss their planned activities, convey sample selection information and communicate any changes from the notification.*

For planned inspections where issues might arise, a videoconference could be held between IAEA, SRA and the operator in order to clarify requirements before inspectors travel, such as inspector training needs, anticipated verification activities and the associated technical support and equipment.

Example: Several operators have a staff briefing before an IAEA inspection, to explain to all relevant staff members the IAEA activities that are anticipated and to discuss what support will be needed. Knowledge of what the inspectors are planning to do and aiming to achieve helps to garner support from the staff, and this also allows management to encourage positive interactions with inspectors.

At the start of a shift or the beginning of a work day, when staff changeover occurs, the manager may add the IAEA inspection to the agenda of the shift change briefing to make everyone aware of the activities and solicit their support.

6.12. Resolving difficulties during in-field activities

Occasionally, during IAEA verification activities a situation could arise that might indicate a possible problem, such as a discrepancy. The Safeguards Glossary defines a *discrepancy* as:

> "an inconsistency found in the facility operator's records, or between facility records and State reports, or between these records and inspector observations or indications resulting from containment and surveillance measures. Discrepancies that cannot be resolved (i.e. ascribed to innocent causes or otherwise satisfactorily explained) may lead to the determination that declared nuclear material is unaccountably missing. A discrepancy involving one significant quantity or more of nuclear material is classified as a possible anomaly."

When a possible discrepancy is identified, addressing it might involve checking the accounting and operating records, reviewing reports, re-measuring items or re-checking item locations, identification and seals. Every reasonable effort is made to resolve an issue before the inspectors return to IAEA headquarters, and it is in the best interest of the operator and SRA to facilitate its timely resolution to avoid the need for follow up activities. However, some issues cannot be resolved quickly. When a problem remains unsolved, some nuclear material may need to be stored under IAEA seal and remain there for further evaluation.

Some discrepancies or possible anomalies may be **avoided** through clear communication at the beginning of the inspection.

This is particularly true when facility events have occurred, or events are planned, that could produce data that might indicate a discrepancy or possible anomaly. It is very helpful for such discussions to take place in advance, to allow for compensatory measures to be put in place to avoid a possible anomaly.

Example: A facility operator informed the IAEA that a camera might be blocked during an activity. The operator and IAEA discussed the activity and determined how to position the cameras to avoid loss of continuity of knowledge. These kinds of discussions are important during situations (such as opening a reactor core) when items are moved or shipped.

Example: A large tool box was brought into an area where nuclear material under IAEA surveillance was located. The tool box was large enough so that nuclear material items in this location could fit inside of it. Also, the tool box blocked the camera view in certain locations, requiring re-establishment of the physical inventory. Fork lift trucks could also block the camera's view and potentially be used for material removal. Large items can block sensors such as radiation monitors, causing readings that might indicate a discrepancy. The operator changed procedures to use tool boxes that were smaller and worked with the IAEA to position cameras so that fork lifts would not block the view of the nuclear material.

Example: Translucent plastic sheets are often hung to surround construction areas for safety purposes. This sheeting can also block the effectiveness of surveillance to view a spent fuel pool or other material. Lead blankets hung around a spent fuel pond to shield radiation might block a view or interfere with radiation monitors. Discussions held with the IAEA in advance can result in a solution to enable safety objectives to be met while not interfering with IAEA surveillance.

Once inspection activities have commenced, on occasion there are breakdowns of equipment or schedule changes due to operational or safety issues. A wide variety of unexpected events can occur, due to issues such as human error, equipment failure, power outages, illness, accidents, or even the presence of potentially dangerous animals (such as snakes and monkeys). In these situations, the operator's support and ingenuity can help to overcome problems so that verification goals can be met. Effective communication among the IAEA, SRA and operator staff is needed to identify and implement an effective solution.

Example: A research reactor may be shut down for an extended period of time. This may result in pool water becoming cloudy, limiting the ability to use a Cerenkov viewing device for verification purposes. Some fuel elements may have to be removed from the core in such a situation, to enable NDA measurements to be performed. Bird excrement can also cloud spent fuel pool water. Techniques to prevent birds from nesting may be warranted. In cases where the environmental conditions are severe, respirators may be required to work in the area.

The severity of the consequences of such events can also vary. Some events can undermine the ability to meet the verification objectives and require a return visit by the inspectors. Some examples of possible inconsistencies or discrepancies are provided in Annex 8.

6.13. Closing meeting

Following the completion of IAEA safeguards activities at a facility or location, it is useful to hold a ‘closing meeting’ with the same participants as attended the opening meeting. This meeting does not replace the formal reporting on the inspection or access that is provided through the issuance of a formal statement (i.e., paragraph 90(a), 90(b) of INFCIRC/153 (Corr.), or Article 10.a., 10.b., 10.c. of INFCIRC/540 (Corr.) statements – see Chapter 10.5 of *IAEA Services Series 21*).

A closing meeting facilitates useful exchanges in an informal setting, among the IAEA inspectors or technicians, the facility staff and the SRA. It allows for the participants to share feedback, discuss any problems that were encountered or acknowledge any particularly effective support.

All participants in the meeting can discuss issues or lessons learned and describe any expected follow-up actions. Inspectors can provide a verbal summary of their activities conducted, such as: reviews of accountancy reports and operator records, physical inventory verification, organisational issues, radiation protection, workflow, samples taken, seals removed or replaced, use of equipment, and any concerns or issues encountered. The operator can take the opportunity to address issues as possible before the inspector leaves the facility.

IAEA inspectors in the field are **not authorised to commit** the IAEA to any actions or make any decisions or conclusions regarding the outcomes from the inspection activities or access. Inspectors are also not authorised to sign the minutes of a closing meeting. Inspectors can acknowledge the documents or objects they were provided (such as photos, removed seals or facility documentation), and can acknowledge their participation in a meeting.

The operator can retain a record of the meeting to document for its internal purposes good or poor performance, allocate immediate corrective actions and take note of any additional inspector requests. The operator may wish to review the record of the meeting with the individuals involved in the inspection or access. A standardised set of questions capturing good and poor performance in areas such as measurement quality, records and report quality, material access arrangements, organisation and resource allocation can be helpful.

If the facility or SRA wishes to keep a record of a closing meeting, the minutes could be recorded as a ‘note to file’ rather than a formal agreement or decision. The IAEA communicates the results of its verification activities through the official statements that are issued only after all information has been analysed.

6.14. Action tracking and follow up

The IAEA issues a formal statement providing results and observations following inspections, DIV and complementary access. The SRA (and potentially the operator) should establish a tracking system that records and tracks any corrective actions or additional requests. Actions should be assigned to a specific individual, with a clear task description and agreed target completion dates.

Example: A large facility has developed a tracking system to retain historic information in a readily retrievable form. An individual is assigned responsibility to review the observations/actions and ensure appropriate follow up activities are carried out. Poor performance trends are reviewed and corrective action taken. The system owner periodically reviews the outstanding action and works with staff members and management to reach a timely resolution.

The IAEA also keeps track of follow-up actions resulting from a verification activity, and monitors the resolution of actions over time.

The IAEA's statements are provided to the SRA. It is important for the SRA to **transmit the relevant information to the appropriate operator**, highlighting results and any requests made by the IAEA that may affect the operator.

Facility operators benefit from learning about the results of inspections, not only when an issue or problem is raised, but also when there are no issues and the inspection objectives are fully met.

6.15. Considerations regarding IAEA inspections at LOFs

Due to the widespread use of uranium in industrial and medical applications, most States will have some nuclear material at LOFs. Section 8 of this SIP Guide addresses safeguards implementation at LOFs. The IAEA typically performs verification activities at LOFs less frequently than at facilities, and so the SRA plays an important role in assuring that nuclear material at LOFs is properly accounted for and controlled, and that LOF operators are prepared for an IAEA inspection. For this reason, SRAs in many States perform national inspections at LOFs.

Example: An SRA conducts at least one national inspection every three years at each LOF.

The SRA should maintain communication with the safeguards contacts at each LOF and ensure that contact information is updated as needed. The SRA may wish to communicate with the staff of LOFs periodically regarding safeguards and could usefully post information on a web page for easy access.

Example: In addition to posting information on a website, one SRA organizes a biennial workshop for the safeguards contacts from LOFs to share information and raise awareness of safeguards requirements. In case of any problems with the provision of safeguards-relevant information to the SRA, the accounting officers are asked to contact the SRA to get instructions and advice about implementation of all requirements of the Atomic Act (which forms the basis of the legal framework in the nuclear field in the State). This avoids the provision of inaccurate information to the SRA.

The role of the SRA is very important during IAEA inspections at LOFs. Employees of LOFs may not speak English (which is the working language spoken by IAEA inspectors) and many of them may not understand the objectives of an IAEA inspection or complementary access. The SRA can explain the objectives and inform them about the results.

7. IAEA USE OF EQUIPMENT

7.1. Introduction

The IAEA uses various types of equipment during its verification activities in the field, including cameras, scales, NDA measurement systems, radiation detectors, geographic positioning system (GPS), sensors and unattended monitoring systems, together with the associated computer equipment, data acquisition packages and electronics to support these systems. To support the documentation of interviews conducted during CA, inspectors also carry voice recording instrumentation. Some of the IAEA systems are installed in the facility, requiring infrastructure such as wiring, electricity, lighting, conduit, cabling, cabinets, storage space, racks and internet connectivity.

Efficient and reliable operation of all IAEA equipment requires close cooperation between the IAEA, the SRA and the facility operator. IAEA safeguards equipment can be viewed in a photo-essay[18] and is described in the periodically updated publication titled *Safeguards Techniques and Equipment*[19].

7.2. Portable equipment

Some IAEA equipment is portable, and is brought to a facility by the inspectors from IAEA headquarters. Occasionally, when inspections are frequent, portable equipment may be stored at a facility in a cabinet, under an IAEA seal. To support complementary access, inspectors carry a tool kit of portable instruments (see Figure 12) used to meet the various objectives of such access. Instruments include a device for measuring a room dimensions (a laser range finder), a camera, an HM-5 handheld radiation detector, a global positioning system (GPS), flashlight, swipe sampling materials, a voice recorder and spare batteries.

FIG.12. – IAEA tool kit of portable instruments

[18] http://www.iaea.org/newscenter/multimedia/photoessays/sg/equipment/

[19] http://www-pub.iaea.org/MTCD/Publications/PDF/nvs1_web.pdf

7.3. Unattended and remote monitoring systems

The IAEA relies heavily on the use of unattended monitoring systems (UMS) and surveillance cameras systems (SURV) to provide continuous monitoring at declared nuclear facilities around the world. Many unattended monitoring systems use NDA equipment to record the movement of nuclear material, such as a gate monitor that tracks movements of spent fuel from the core to the spent fuel pond at a nuclear power plant.

Remote monitoring: a technique whereby safeguards data collected by unattended C/S, monitoring and measurement systems are **securely transmitted off-site** via communications networks (to IAEA headquarters, a regional office or another IAEA location) for review and evaluation. (*IAEA Safeguards Glossary 2001, paragraph 8.16).*

There are currently hundreds of these systems installed and operating in a robust, reliable, and effective manner under a broad range of environmental conditions. An unattended monitoring system is any monitoring system comprised of one or more sensors that is designed to maintain continuity of knowledge of nuclear material or a facility operation. Unattended monitoring systems may or may not transmit data to a location outside the facility (IAEA headquarters in Vienna or one of the IAEA regional offices). Unattended systems with remote transmission of data:

- Provide a high level of assurance by automatically monitoring the flow of nuclear material 24 hours a day, 365 days a year, without the need for constant inspector presence;
- Reduce the impact on the facility operator by allowing uninterrupted facility operation;
- Reduce the impact on the IAEA by decreasing the number of inspector visits and thereby reducing inspection costs including the high cost of travel;
- Reduce radiation exposure to personnel and allow monitoring in radiation areas too dangerous for humans; and
- Use a variety of sensors such as radiation, pressure, temperature, flow, vibration and electromagnetic fields to collect qualitative or quantitative data.

Unattended monitoring systems often operate in challenging environments. Data losses need to be prevented due to the significant technical and economic impacts on the operator, State and the IAEA when nuclear material inventories need to be re-established after loss of continuity of knowledge. The growing reliance on unattended systems and the need to maintain safeguards significant data demand high reliability. A defence-in-depth approach is taken, including:

- Duplicate sensors and data collection modules;
- Back up battery power on all data collection modules;
- Uninterruptible power supply in each data collection cabinet;
- Removable data storage cards on the data collection modules;
- Industrial computers including passive cooling and solid state drives; and
- Provision of facility mains power that has back up power capability.

All unattended systems go through rigorous environmental testing during development and in-house testing prior to installation in the field. Components of unattended systems are designed for an extended mean-time-between-failure (MTBF), typically in excess of 150 months. Due to the cost and reliability needs associated with replacements, these systems stay in the field for extended periods of time. For example, the radiation sensor portion of one of the first UMS installations in the late 1980s is still being used thirty years later.

Annex 9 explains the important role of the operator and SRA in supporting remote monitoring systems and provides technical specifications regarding the **infrastructure needed** for operating these systems at facilities.

7.4. Non-destructive assay measurement equipment

Non-destructive assay equipment refers to techniques that measure characteristics of nuclear material without removing it from its container or changing its chemical or physical properties. The most widely used NDA instruments measure the radiation emitted by the various isotopes of the elements of interest (uranium, plutonium, thorium), with the most commonly used instruments measuring gamma rays and/or neutrons. Physical measurement techniques such as weight, volume, thickness of container walls, and light emission/absorption, are often coupled with NDA measurements to determine the quantity of nuclear material being measured.

NDA instruments (see Figures 13 and 14) use detector, such as scintillators or solid state semiconductors, to respond to emitted radiation, and multichannel analysers to collect the responses of the detectors and convert them into a form that can be analysed by the user. Detectors used by the IAEA include sodium-iodide (NaI), high purity germanium (HPGe) and cadmium-zinc-telluride (CdZnTe). Gas filled tubes are also used, that contain helium-3 or xenon, for example. Many NDA instruments require cooling prior to their use and batteries often must be charged for portable instruments. Some instruments are small and portable, carried in a briefcase or small rolling suitcase. Other instruments are large and heavy, and often remain stored at a facility under IAEA seal. Some NDA instruments are installed at a facility and used in unattended mode, with results transmitted remotely to the IAEA or collected at the facility for later review by an inspector.

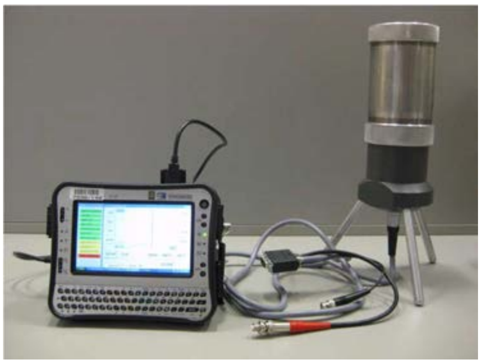

FIG.13. Miniature multichannel analyser with NaI detector and portable computer

FIG.14. High-level neutron coincidence counter

7.5. Sensors

Sensors used by the IAEA are designed to sense many different phenomena throughout facilities. For UMS the most common sensors are for radiation; a small sample of these sensors (silicon diode, ionization, fission chambers) is shown in Figure 15. These sensors are then enclosed in a tamper indicating housing that could include radiation shielding and moderators, which can substantially increase the weight of the overall housing. The housing is mounted according to the safeguards approach to monitor the appropriate phenomena.

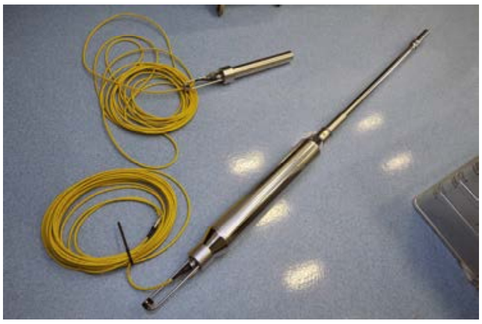

FIG.15. Radiation detectors

FIG.16. Surveillance camera

Surveillance applications always use an optical sensor; depending on lighting and other conditions, infrared optical sensors and underwater optical sensors may be used. Figure 16 shows the new Next Generation Surveillance System (NGSS) camera mounted in a nuclear facility.

In addition to radiation and optical sensors, other types of sensors may be used, such as an ultrasonic sensor on the primary core coolant loop of a research reactor (see Figure 17) to determine the velocity of the cooling water. This flow sensor in combination with resistive temperature sensors on the same loop (see Figure 18) help the IAEA to determine the power output of the reactor and calculate the plutonium produced in the core of the reactor.

FIG.17. Installing a flow sensor

FIG.18. Tamper indicating cover

In carrying out activities at a facility, consideration should always be given to the possibility of impeding a sensor’s or camera’s function. For example, an overhead crane used during maintenance could block a camera’s view, or a moveable lead shield could block a radiation sensor. All foreseeable operating conditions, including activities carried out during facility maintenance, should be considered before mounting IAEA equipment. Facility modifications can also impact upon the operation of IAEA equipment.

Example: Some facility maintenance activities can impact upon sensors function, such as welding and circuit breaker maintenance. The facility operator communicated plans for carrying out maintenance to the IAEA in advance, so the potential impacts could be mitigated. When the facility carries out work during an IAEA equipment failure, and the work results in nuclear material being difficult to verify (such as transferring spent fuel to dry storage) then an anomaly may result which cannot be resolved. Communication helps to avoid these situations.

Some abnormal events, such as water leakage, can impact the functioning of IAEA equipment. The SRA or operator should communicate with the IAEA in case such an event occurs. Environmental conditions can also impact the use of sensors. High humidity, extreme temperatures, rain water or condensation can cause problems. For example, water retained in piping that is used for guiding sensors can short out the electronics and destroy the sensor. Capping the end of access piping can prevent this problem.

7.6. Sealing systems

The IAEA uses active and passive tamper indicating seals to meet a variety of objectives. The primary use of seals is to maintain the integrity of a container during the time between inspections. The container might hold nuclear material, or it might hold IAEA equipment or reference standards.

Tamper indicating enclosures are also used by the IAEA for various purposes; for example, tamper indicating conduits enclose cabling that connects sensors to a data collection cabinet, which is also under IAEA seal. Figure 19 shows a typical metal seal and its application on a data collection cabinet and a neutron non-destructive assay sensor, respectively. The most commonly used IAEA seal is a metal 'CAPS' or e-cup seal. A new glass seal is under development for future use.

Facility staff should **avoid damaging** IAEA seals and tamper indicating housings. An ineffective seal or enclosure can cause an anomaly and trigger additional verification activities. Keeping in mind the need to **protect the integrity of seals** when planning and carrying out facility work activities is essential to prevent such situations.

FIG.19. Examples of metal seals and their applications

Understanding the facility design and operating parameters helps the IAEA determine appropriate sealing measures. The operator can support sealing and containment activities from the beginning through early discussions and provision of accurate and up-to-date design and operational programme information. Once seals are in use, changes to the environmental, climatic and other conditions which could affect the performance of the seal should be notified to the IAEA. Seals failure is a common cause of anomalies, and can result in a requirement to re-establish the physical inventory, which is time consuming and costly.

From time to time, a facility operator may need to **break** an IAEA seal and should inform the IAEA if that occurs. This could happen due to an emergency such as a water leak that requires an IAEA seal to be broken in order to access the location and prevent electrical damage. Or a seal may be broken due to an accident. A procedure should be established for notification to the SRA and IAEA of intentional and accidental seal damage; this notification can be transmitted simultaneously via email to both organizations.

There are electronic seals such as VACOSS and EOSS which are designed to be opened and closed multiple times to facilitate operations. These seals record information about opening and closing them, and can be used in conjunction with a surveillance system, which will monitor and record the status of the seal to maintain continuity of knowledge about the nuclear material during times when the seal is opened.

Active seals are often used in nuclear power plants. Figure 20 shows an iCobra fibre-optic seal that creates a reference image which is verified in situ by the iCobra reader, using an interface for display and verification of a variety of seals. The reference image is shown in Figure 21.

FIG.20. iCobra seal reader

FIG.21. Fiber optic seal reference image

7.7. Tamper indicating enclosures

For unattended monitoring systems, sensors are connected to data collection cabinets, which are blue and usually contain 19-inch width racks with heights typically varying between 0.5 to 2 meters in height (see Figures 22 and 23). To provide physical access to the signals and the collection instruments, the enclosures are sealed and provide tamper indication. The

IAEA verifies the integrity of the seals and the enclosures on cabinets, junction boxes, tubs, tamper indicating conduits and elsewhere.

The IAEA equipment cabinets need to be in secure, air conditioned (temperature, humidity), low radiation areas with **reasonable environmental controls** to ensure that IAEA staff and equipment are not exposed to excessive heat, cold, dust, vibration, electrical transients or other detrimental phenomena. Support for delivery and installation, data retrieval or transmission and maintenance is also needed, with access to both the front and rear doors.

Important points regarding cabinets and IAEA equipment installation include:

- Installation requires delivery and transportation support from the operator (and contractors), as well as electrical connection, mechanical fitting when needed (e.g. to mitigates risks associated with earthquakes);
- Location of the cabinets (sensors, junction boxes) should support easy technical access for maintenance (with access to both the front and rear doors);
- The IAEA equipment installation needs to take into consideration any potential interference with the operation of the facility (e.g. magnetic interference might affect the safety systems of a reactor);
- Disposal of IAEA systems parts should also be considered (limited life of equipment); and
- Cabinets should be labelled (in some cases, similar or the same cabinets are used by multiple entities at the facility (such as EURATOM and IAEA cabinets).

FIG.22. IAEA cabinet

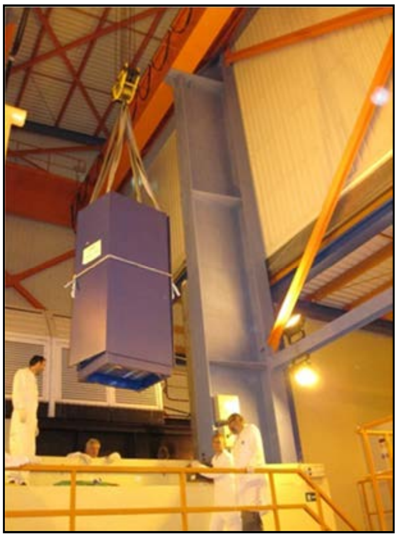

FIG.23. Installation support

7.8. Data generators

Data collection units (also known as data generators, which convert analog signals to digital data) are contained in the IAEA secure cabinets. Two data collection units are shown in Figures 24 and 25. Figure 24 shows the components for a DCM-14 data generator, which is the most common optical data generator and sensor used currently, though it is in the process of being gradually replaced. Figure 25 shows a MiniGRAND radiation-based data generator.

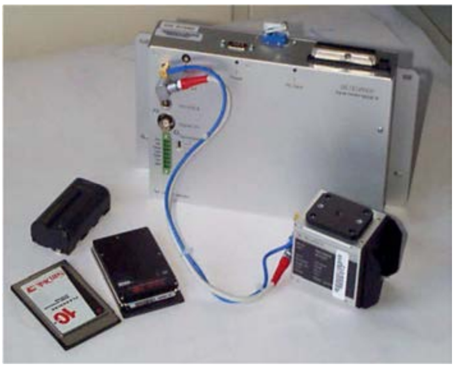

FIG.24. DCM-14 Data Generator

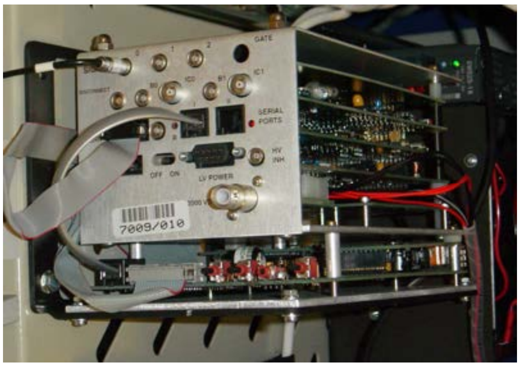

FIG.25. MiniGRAND Data Generator

7.9. Operational aspects of IAEA equipment

Operating parameters for different kinds of IAEA equipment (e.g. light levels, radiation levels, humidity, motion) should be specified and documented in advance of installation. The operator can support the IAEA equipment preparation and operation by providing:

- Information concerning the environmental and operational constraints, such as the need to wear full face masks, gloves (how many, what type) and safety glasses. Safety of IAEA staff should always be ensured when accessing/operating equipment and conducting any activities at the facility.
- Clear guidance on the facility/State requirements such as specific electrical codes, seismic requirements, standards and equipment certification requirements.
- A detailed description of operational activities so that equipment operation can be designed to minimize interference between facility operations and the equipment performance: obstructing field of view, presence of shielding, presence of other sources of radiation, etc.
- An assessment made by the operator to confirm that the IAEA installed equipment will not compromise operational performance, and facility safety and security objectives.

Example: The IAEA, SRA and operators may wish to prepare a technical document that specifies the operating parameters for each piece of equipment, including temperature ranges, humidity, power supply, light levels and radiation levels. Questions can be addressed such as how long of a power outage requires an advance notification, or how low of lighting will require compensatory lights. The IAEA can accommodate some situations, such as low lighting, by using infrared or installing temporary lighting, but advance notice must be given. The operator can also put in place compensatory measures as agreed.

7.10. Facility infrastructure needed to support the use of IAEA equipment

The ability to provide access to stable reliable power and to data transmission capability (wired or wireless) throughout a nuclear facility is the ideal infrastructure to support current

IAEA needs and will also allow flexibility for future safeguards technology upgrades and installations. One might refer to these basic needs as the minimum safeguards equipment infrastructure set.

The IAEA will request that its systems receive mains power that has back up capability from diesel generators and/or uninterruptible power systems based on battery storage. This is often referred to as Class II power that supports secondary safety systems in the facility; in some countries this is referred to as 'elements important for safety systems'. The basic elements of any of these systems include sensors, data collection cabinets and cabling for both power and signal transmission. The basic facility support needed includes:

- Space for sensors and cabinets;
- Installation support for sensors and cabinets;
- Installation of cabling for sensors (to provide both power and data transmission) and mains power for the cabinets;
- Stable internet connectivity when remote monitoring is foreseen.

To install a system, the IAEA will typically contract with the responsible party at the facility. The IAEA engineers and technicians are responsible for all of the installation work within the IAEA cabinets and sensor housings. All of the IAEA UMS and SURV systems and technicians have TUV (German: Technischer Überwachungs-Verein, English: Technical Inspection Association) certification to ensure the systems are safely designed and installed.

Example: Some operators mark all IAEA data and mains cabling and any associated circuit breaker boxes and outlets in both English and the official language of the State to avoid inadvertently impacting IAEA systems during routine maintenance. This also helps to ensure plugs that provide power to IAEA camera cabinets or other equipment cabinets are not unplugged accidentally by staff at the operator, which could result in system failure and loss of continuity of knowledge.

SRA or operator assistance may be needed for obtaining internet connectivity at the facility and at the specific location of the IAEA remote monitoring cabinet. Consideration will need to be given as to whether wireless or wired connectivity is the most cost effective and reliable solution. The operator may need to work with the local internet service provider to assist with connectivity issues. Sharing the facility's LAN with the IAEA's systems could provide a temporary solution when connectivity is lost.

7.11. IAEA review of data

The data collected by the UMS/SURV systems is periodically reviewed by the IAEA. Where possible, the IAEA prefers to transmit the collected data to its headquarters in Vienna or one of the regional offices (Tokyo, Toronto). The digital data can be transmitted via internet, satellite or telephone lines. Cost is a factor in determining how and if the data will be transmitted.

There are two types of data collected by IAEA equipment: facility data and IAEA equipment state of health (SOH) data. SOH is data directly obtained from the various components of the

IAEA UMS/SURV that allows the IAEA to determine the operating status of these systems. Transmitting this information back to Vienna is an important way to enable the IAEA to respond early to negative indicators from the transmitted or retrieved SOH data prior to any component failure.

The IAEA remote monitoring unit in Vienna is **available to resolve technical issues**, and most of such issues that occur in the field can be resolved from Vienna. The RM systems are designed to avoid single point failure. Having an international-capable phone available in the RM equipment room is useful.

Whether the facility data can be transmitted outside of the facility and/or the State is a matter for negotiation between the State and the IAEA. When remote monitoring is not implemented, facility data is typically hand carried back to IAEA headquarters using removable media such as a flash drive or compact disc.

When facility data is not transmitted outside the facility, the IAEA inspectors need to review the data at the facility **during inspections**. It is preferable to perform the review in a dedicated IAEA office at the facility. Reviewing the data at the collection cabinet is the least preferred option due to access considerations and potential radiation dose concerns. There are often questions that need to be answered by the operator to facilitate the review.

Data review software is often unique to the sensor suite. Figure 26 shows the GARS (General Advanced Review Software) data review station for SURV. Figure 27 shows a display of data from a flow monitor for review of fuel movements.

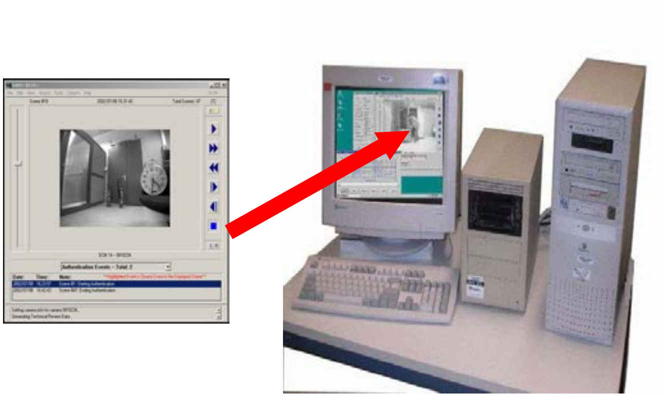

FIG.26. GARS

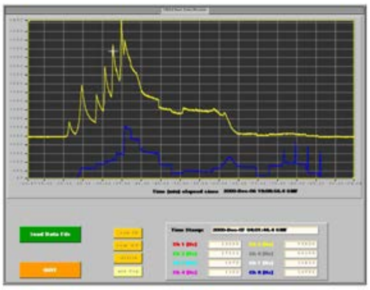

FIG.27. Data review display

If the data review indicates any possible discrepancies between the operator’s declaration of activities and what the IAEA independently verifies, the IAEA inspector will try to resolve the discrepancy with the SRA/operator. IAEA technical experts review and act upon the SOH data as necessary. The operators should be aware that on-site data review is part of the IAEA verification activities and cannot be postponed.

Off-normal operations may cause the IAEA algorithms to report a possible discrepancy; it is helpful if the operator notifies the IAEA in advance of unexpected events that would affect the typical operating parameters.

7.12. IAEA equipment maintenance

Preventive maintenance for IAEA equipment is a planned activity with a long lead time. The operator can support IAEA planning by providing detailed information about any changes to the operational activities/programme that may impact the maintenance schedule, such as power plant outages, core opening and construction.

In any case of equipment failure, the IAEA will respond as soon as possible to repair or replace the equipment. Planned upgrades are also scheduled according to need. Routine maintenance activities are typically determined by battery life, including backup batteries on each data generator and the backup batteries on the local UPS units. Typically, battery maintenance takes place on intervals from two to three years, but the period is determined by the service life of the various components. Regional offices have spare parts inventories in addition to those stored in Vienna.

Example: Many operators of facilities that have a substantial number of installed IAEA systems provide a storage area under IAEA seal for spare parts and replacement batteries. This reduces the logistical complexities associated with frequent shipping, and most importantly, ensures that parts are available when needed so that systems can continue to function.

Sometimes equipment cannot be repaired or maintained at the facility but has to be returned to IAEA headquarters in Vienna. The IAEA maintains a schedule for servicing each equipment item; this schedule is conveyed to IAEA inspectors so they know when equipment needs to be returned to Vienna. The IAEA also maintains an inventory checklist of what equipment is contained in each IAEA cabinet. Inspectors check that everything that is needed is contained in the cabinet and resupplies it as needed. Inspectors periodically check the cabinets for operating status and may request assistance to resupply materials.

7.13. Joint-use equipment

In performing its safeguards activities, the IAEA might be requested by an external party (e.g. facility operator, SRA) to share safeguards equipment. There may also be cases where the IAEA requests the use of equipment owned by an external party. Sharing of equipment is consistent with paragraph 31 of INFCIRC/153 (Corr.), which encourages the Agency to “make full use of the State’s system of accounting for and control of all nuclear material subject to safeguards …” and to “avoid duplication of the State’s accounting and control activities”. Sharing of safeguards equipment is referred to as ‘joint use’ and is made on the basis of arrangements between the IAEA and the SRA/operators. Benefits of joint-use equipment may include:

- enabling the IAEA to obtain data that would not otherwise be available;
- reducing total costs;
- reducing the workload of the operator by reducing installed equipment; and
- reducing radiation dose to operators, IAEA inspectors or technicians.

To facilitate the joint use of equipment, arrangements need to be put in place to ensure that the IAEA's independent verification is not undermined; that the data produced by the equipment is authenticated and reliable; and that the safeguards effectiveness is not reduced. In addition, the costs of necessary authentication measures should not exceed the envisioned savings.

For equipment that is jointly shared by the operator and the IAEA, the SRA and the IAEA, or among all three, the maintenance schedule and associated costs are coordinated. The IAEA may seal a part of a system, and use standards to confirm performance. Data from jointly used operator equipment must be authenticated by the IAEA in order to be used. This requires early coordination to work out authentication issues prior to design, installation and operation. The data is usually shared by the IAEA with the SRA based on arrangements agreed between the two organizations. Sometimes the total set of data is sent to the IAEA and a subset is sent to the SRA.

In addition to the installed system, handheld instruments such as radiation detectors or scales might also be jointly shared by the IAEA and the SRA. For example, an ICVD, as shown in FIG. 28, that is owned by an SRA might be brought to a facility during an inspection and used by IAEA inspectors. Joint use of equipment is further addressed in the *SIP Guide on Collaborative Approaches to Safeguards Implementation*.

FIG.28. IAEA inspector using an Improved Cerenkov Viewing Device © IAEA Dean Calma

7.14. IAEA authorization of equipment for safeguards use

All equipment used by the IAEA for safeguards purposes is subject to a rigorous testing and authorization process. Equipment may be authorized for a particular application or facility type, or may be broadly authorized for general use. The IAEA is working to increasingly standardize the equipment features and components, to ensure security, authentication and modularity for efficiencies.

7.15. Technology evolution

As with any technology area, changes occur over time and these changes are incorporated into the IAEA suite of equipment. The systems discussed in this Guide, while representative, are expected to change over time as new generations and new technologies become available. However, while commercial technology may rapidly change, with the long lifetimes established for IAEA installed equipment, it is common for fielded systems to remain unchanged for over a decade. Only as older generations of equipment are replaced through a dedicated upgrade effort will a new generation replace one that has been fielded. Because of the importance of robust, reliable and effective systems, the IAEA follows a careful and rigorous review and testing process before fielding new unattended monitoring, sealing or surveillance systems.

8. SAFEGUARDS IMPLEMENTATION AT LOCATIONS OUTSIDE FACILITIES

8.1. Introduction

A LOF is a physical location. For nuclear material accountancy purposes, a State and the IAEA may establish one material balance area (MBA) for each LOF or one MBA for several or all LOFs in the State, with each physical LOF representing one KMP in the MBA. In the latter case, the MBA for multiple LOFs can be referred to as a 'catch-all MBA for LOFs'. This is discussed in more detail in the *SIP Guide on Provision of Information to the IAEA*.

8.2. Submitting information on LOFs

Information in respect of nuclear material at LOFs must be provided to the IAEA, as well as updates to that information which reflect changes that have occurred. Nuclear material at LOFs is part of the State's inventory and must be accounted for, controlled and reported by the State to the IAEA. Information about LOFs includes the geographic location, the use and possessor of the nuclear material, and procedures and organizational responsibility for nuclear material accounting and control. A template is available for reporting information about existing and new LOFs, and can be found at the *Resources and Assistance for States* webpage under 'Forms and Templates' (see www.iaea.org/safeguards).

An effective licensing and notification requirement in a State will help to ensure **all nuclear material in the State is known to, and under the regulatory control of, the SRA and reported** to the IAEA. Licensing is further discussed in the *SIP Guide on Establishing and Maintaining State Safeguards Infrastructure*.

8.3. Nuclear material at LOFs

Many LOFs contain nuclear material used for shielding, such as depleted uranium in shielding containers holding sources of ionizing radiation and shielding of sources in medical-purpose irradiators. LOFs are often consuming nuclear material in a process, such as natural uranium in the form of an oxide that is used during various chemical analyses or at ceramics factories for coloring of glass.

8.4. Facilitating access to LOFs

It is very helpful to obtain the GPS coordinates of each LOF so that the physical location can be found easily. The postal address often does not match the physical address. The SRA should describe IAEA inspections to the LOF operators in advance of an actual IAEA inspection, so that they will be aware and prepared. The SRA should work with the accountancy officer at a LOF to develop procedures for facilitating access to IAEA inspectors and the conduct of verification activities. Sometimes the equipment containing nuclear material, such as a Teletherapy unit in a hospital, is not easily accessible so clear procedures for access are needed.

It is useful to collect information about possible limitations or obstacles which can occur during inspections (operational limitations, health/safety problem for inspectors/visitors). This is important especially in the case of depleted uranium shielding surrounding high activity sources or difficult to access material. For example, some depleted uranium shielding is used in inaccessible locations such as tanks, blast furnaces, coal mines and military installations. It is important to keep track of these locations and inform the IAEA in advance regarding any access issues.

It is a good practice to encourage users of high activity sources to **consider alternatives** that do not need the depleted uranium shielding, thus resulting in less radiation dose, fewer regulatory controls and improved safety.

The SRA should also require updated information about the status of the companies operating LOFs. In case of bankruptcy, the radioactive sources or nuclear materials could be sold or lost or the physical protection could become inadequate. To avoid such situations, the SRA should ensure all owners/licensees understand their obligations in maintaining security and accounting for sources containing nuclear material subject to safeguards.

The SRA should keep information about **operational status** of LOFs. This can be very helpful when planning inspections or facilitating the IAEA inspection activities.

The IAEA conducts inspections at LOFs infrequently, so procedures that have been prepared by SRAs to facilitate inspections are not exercised often. The SRA should conduct periodic national inspections at LOFs (at least once per three years as a good practice) to maintain their preparedness to facilitate inspection activities and to keep in contact with safeguards points of contact at each LOF.

Example: Some States periodically conduct an outreach campaign to collect obsolete nuclear material and radioactive sources and place them in one location under the control of a suitable State institution. These repositories can also be used like a library to provide sources to licensed users; borrowing and returning sources can reduce the inventory of controlled items in a State.

8.5. Carrying out in-field activities at LOFs

The SRA should communicate with a LOF prior to an IAEA inspection. Due to the infrequency of IAEA inspections at LOFs, the responsible persons may be relatively unprepared. It is helpful to explain the purpose of the inspection and answer questions in advance. In many cases the location of a company's office where the IAEA inspectors will arrive is different from the location of the company's working areas (where the inspectors will carry out inspection activities). The distances can be large, so advance planning by the SRA and LOF operator for transportation of the inspectors may be required.

The national regulatory framework should be consistent with the safeguards obligations of the State and allow the IAEA to undertake all necessary safeguards activities in the State. As inspectors can use various measurement devices during inspections, it is helpful to inform the company representatives about intended measurements of the SRA or the IAEA. The LOF operator should also be aware that the inspectors may take environmental samples or photos.

During an opening meeting, the SRA should **inform** the company representatives of the purpose and the nature of the inspection, including the legal basis, the preliminary schedule, and a description of the activities the inspectors are likely to carry out. The SRA should make the company aware that the inspectors may take photos, take environmental swipe samples, and use radiation detection equipment.

During the closing meeting, the SRA can inform the company representatives about any issues encountered, offer recommendations (if any) and express gratitude for cooperation during inspection.

Example: One SRA has prepared a brochure that is given to LOF operators to familiarize them with IAEA safeguards, including reporting, access and interactions with the SRA. An SRA conducted outreach seminars for LOF operators describing their obligations and the necessary practical arrangements during an IAEA inspection or access.

9. RESOURCES AVAILABLE TO STATES RELATED TO FACILIATING IAEA VERIFICATION ACTIVITIES

Many resources are available to States regarding IAEA verification activities. Guidance and reference documents and descriptions of training opportunities are posted on the *Resources and Assistance for States* webpage at www.iaea.org/safeguards. The IAEA offers advisory mission services that can be requested by a State; the IAEA Safeguards (or SSAC) Advisory Service (ISSAS) missions focus on safeguards implementation, including a State's legal and regulatory framework, reporting and declarations, facilitating IAEA verification, and other topics. States and regional networks also offer training related to IAEA verification. Several training and cooperation opportunities are listed in the *SIP Guide on Establishing and Maintaining State Safeguards Infrastructure*. More information can be requested by writing to the IAEA at official.mail@iaea.org.

BIBLIOGRAPHY

Note: Many of the referenced documents below can be found for convenience at www.iaea.org/safeguards/.

INTERNATIONAL ATOMIC ENERGY AGENCY, Agreement on the Privileges and Immunities of the Agency, INFCIRC/9/Rev2, IAEA, Vienna (1967).

INTERNATIONAL ATOMIC ENERGY AGENCY, The Agency's Safeguards System, INFCIRC/66/Rev.2, IAEA, Vienna (1968).

INTERNATIONAL ATOMIC ENERGY AGENCY, Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/140, IAEA, Vienna (1970).

INTERNATIONAL ATOMIC ENERGY AGENCY, The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/153 (Corrected), IAEA, Vienna (1972).

INTERNATIONAL ATOMIC ENERGY AGENCY, Model Text of Subsidiary Arrangements (General Part) to Comprehensive Safeguards Agreements (1974).

INTERNATIONAL ATOMIC ENERGY AGENCY, Standard Text of a Protocol to an Agreement, GOV/INF/276/Annex B, IAEA, Vienna (1974).

INTERNATIONAL ATOMIC ENERGY AGENCY, Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards, INFCIRC/540 (Corrected), IAEA, Vienna (1998).

INTERNATIONAL ATOMIC ENERGY AGENCY, Design Measures to Facilitate Implementation of Safeguards at Future Water Cooled Nuclear Power Plants, IAEA Technical Reports Series No. 392, Vienna (1998).

INTERNATIONAL ATOMIC ENERGY AGENCY, Guidelines and Format for the Preparation of Declarations Pursuant to Articles 2 and 3 of the Model Protocol Additional to Safeguards Agreements, IAEA Services Series No. 11, IAEA, Vienna (2004).

INTERNATIONAL ATOMIC ENERGY AGENCY, Modified Text of the Protocol to an Agreement Concluded on the Basis of GOV/INF/276, Annex A, GOV/INF/276 Mod 1 and Corr. 1 Annex B, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Statute, as amended up to 23 February 1989, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Milestones in the Development of a National Infrastructure for Nuclear Power, IAEA Nuclear Energy Series No. NG-G-3.1, IAEA, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, The Nuclear Material Accounting Handbook, IAEA Services Series No. 15, IAEA, Vienna (2008).

INTERNATIONAL ATOMIC ENERGY AGENCY, Safeguards Implementation Guide for States with Small Quantities Protocols, IAEA Services Series No. 22, IAEA, Vienna (2013).

INCOSE Systems Engineering Handbook – A Guide for System Life Cycle Processes and Activities, Version 3.1 (2007).

SEVINI, F., et al., Development of IAEA High Level Guidelines for Designers and Operators – Safeguards-by-Design, IAEA Safeguards Symposium, IAEA, Vienna, (2010).

ZHAO, K. et al, International Target Values 2010 for Measurement Uncertainties in Safeguarding Nuclear Materials, STR-368, IAEA, Vienna (2010).

ABBREVIATIONS

AP	Additional Protocol
CA	Complementary Access
CSA	Comprehensive Safeguards Agreement
C/S	Containment and Surveillance
DIE	Design Information Examination
DIQ	Design Information Questionnaire
DIV	Design Information Verification
DSL	Digital Subscriber Line (means of internet service)
EEL	Essential Equipment List
FA	Facility Attachment
GARS	General Advanced Review Software
GPS	Global Positioning System
INFCIRC	Information Circular
ISO	International Standards Organization
ISSAS	IAEA Safeguards (or SSAC) Advisory Service
KMP	Key Measurement Point
LAN	Local Area Network
LII	List of Itemized Inventory (or List of Inventory Items)
LOF	Location Outside Facility
LP	Laissez Passer
MBA	Material Balance Area
MTBF	Mean Time Between Failure
MUF	Material Unaccounted For
NGSS	Next Generation Surveillance System
NNWS	Non-Nuclear-Weapon States (party to the NPT)
NSG	Nuclear Suppliers Group
NWS	Nuclear Weapon State (party to the NPT)
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
PIL	Physical Inventory Listing
PIT	Physical Inventory Taking
R&D	Research and Development
RM	Remote Monitoring

RSAC	Regional System of Accounting for and Control of Nuclear Material
SIP	Safeguards Implementation Practices (i.e. SIP Guides)
SIR	Safeguards Implementation Report
SNRI	Short Notice Random Inspection
SOH	State of Health
SQP	Small Quantities Protocol
SRA	State or Regional Authority (responsible for safeguards implementation)
SSAC	State's System of Accounting for and Control of Nuclear Material
SURV	Surveillance Camera System
UI	Unannounced Inspection
UMS	Unattended Monitoring System
VOA	Voluntary Offer Agreement
VPN	Virtual Private Network
VRS	Voluntary Reporting Scheme

ANNEX 1 – TABLE OF CONTENTS OF MODEL SUBSIDIARY ARRANGEMENTS (GENERAL PART)

Code	Subject
1.	Regular channels of communication
1.1	Communications from Agency
1.2	Communications from [................]
2.	National system of accounting for and control of nuclear material
2.1	Measures foreseen in the Agreement
2.2	Specifications of information to be provided; and information provided by [.........]
3.	Provision of information by [..............]
3.1	Information on facilities and on nuclear material outside facilities
3.2	Radiological protection
3.3	Initial report
3.4	Accounting reports
3.5	Special reports
3.6	Information on international transfers
4.	Provision of information by the Agency
4.1	Agency statements
4.2	Information on inspections
5.	Publication of information by the Agency
6.	Termination of, exemption from and reapplication of safeguards
6.1	Model proposal for termination
6.2	Model request for exemption
6.3	Model communication on re-application of safeguards
7.	Advance notifications of international transfers
7.1	Model notification of intended export
7.2	Model notification of expected import
8.	Model inventory for [............] of nuclear material subject to safeguards
8.1	Agency statements of book inventory of nuclear material for [ ]
8.2	Model export account for [..............]
9.	Inspections and inspectors
9.1	Model inspection assignment
9.2	Authority granting and renewing inspectors' visas
9.3	Periodic inspection programme
9.4	Arrangement for samples (sampling certificate)
10	Report forms and explanations for their use

ANNEX 2 – FACILITY LIFECYCLE STAGES AND ASSOCIATED SAFEGUARDS ACTIVITIES

The following table describes the stages of a nuclear facility's lifecycle, beginning with the planning stage and ending with decommissioning. Safeguards activities that should be addressed during each stage are described in the third column.

Facility Lifecycle Stage	Description of the Stage	Examples of Safeguards Activities of States and the IAEA
Planning	Undertaking evaluation and assessment to make a decision regarding construction of a facility.	State declares its official nuclear plans over the next 10 year period in its 2.a(x) declaration. IAEA analyses all safeguards-relevant information about the State.
Select a design	Selecting a design, issuing a bid.	State selects a design/vendor; initiates safeguards-by-design dialog with vendors and IAEA.
Pre-construction	Begins as soon as the decision has been taken by the State to construct or to authorize construction. It includes the planning, design and engineering activities that precede actual construction.	When applicable, a modified SQP becomes non-operational State rescinds SQP.[20] State submits early design information in an initial DIQ; State and the IAEA negotiate and conclude subsidiary arrangements if none exist; State and the IAEA discuss a Facility Attachment. The IAEA examines the design information and conducts technical assessments, establishes authority files for the facility to enable accountancy reporting, develops a preliminary safeguards approach, works with State to plan for safeguards equipment installation, and plans resources for safeguards implementation.
Construction	Begins with site preparations, and continues until the facility is ready for commissioning. Includes manufacturing and assembling of components, erection of civil works and structures, installation of components and equipment and functional testing.	State submits more detailed design information, facilitates design information verification, sets up facility accounting system. IAEA finalizes Facility Attachment, installs equipment (may be declared as a joint use between IAEA and operator, IAEA and SRA or all 3, may include: surveillance and unattended monitoring systems, process monitoring, conduit and cabling), conducts DIE, DIV, prepares the essential equipment list.

[20] See Service Series 22, Chapter 13.

Facility Lifecycle Stage	Description of the Stage	Examples of Safeguards Activities of States and the IAEA
Commissioning	Begins after completion of construction and before the facility is considered to be functional. Systems and equipment undergo extensive acceptance testing against specifications and performance criteria. Nuclear material may be used for testing.	The State provides the IAEA with a commissioning schedule, to facilitate joint IAEA-State participation in the testing of equipment and systems. IAEA tests equipment and validates and authenticates systems, in coordination with State/Operator, conducts DIV. IAEA may request amplification or clarification of the DIQ as needed. Inspections begin to take place when nuclear material arrives at the facility; the State begins to submit nuclear material accounting reports (PIL, ICR, LII) upon receipt of the nuclear material. If nuclear material is imported, the State provides advance notification of the import prior to its receipt.
Operating	Begins after commissioning is completed and when nuclear material has been introduced to the facility such that it may function for its declared purpose.	SRA and operator support IAEA access. IAEA carries out inspections (and complementary access under an AP), equipment maintenance and upgrades, updates to technology, DIV.
Maintenance or Modification	This will coincide with other facility lifecycle phases, such as operating in particular. This phase involves planning for, and conduct of, any maintenance or modification work at the facility.	The State informs the IAEA as soon as plans are made to perform maintenance and/or modifications to existing safeguards-relevant structures, systems or equipment (as specified in the Facility Attachment). A work plan and schedule is provided to the IAEA. The IAEA evaluates whether or not such work will require further evaluation, which may require amplification or clarification from the State. Maintenance (outages, for example) may necessitate inspections and DIV, such as during reactor core opening and fuel movements. This phase may facilitate access to locations that are typically inaccessible. Any safeguards-relevant change in the design or operation of systems or equipment will require DIV based on an updated DIQ. Modifications may lead to a change to the safeguards approach,

Facility Lifecycle Stage	Description of the Stage	Examples of Safeguards Activities of States and the IAEA
		IAEA monitoring systems, and Facility Attachment.
Shut-down	Involves the interruption of routine operations of the facility (or a part of it) for a period of time (typically greater than one month). During this phase, NM remains in the facility and it could be restarted.	The State informs the IAEA as soon as plans are made to place the facility into shut-down mode, as well as to restart it. A schedule is provided identifying the planned duration of the shutdown. Inspections and DIVs continue. Complementary access continues where an AP is in force.
Extended shut-down	In such a situation, the facility retains nuclear material, often in the core of a reactor which is no longer operating. The staff of the facility is significantly reduced, and operations are underway to decommission the facility.	The activities are the same as in the case of Shut-down status. Logistics for providing access to such a location may be more complicated due to the lack of staff. Inspections and DIVs continue. Complementary access continues where an AP is in force.
Closed-down – State of Preservation	Begins when routine operations have been stopped and nuclear material has been removed to the extent possible, but the facility has not been decommissioned for safeguards purposes. The facility remains in a 'state of preservation' as long as decommissioning activities have not begun. A facility which is fully completed but never commissioned and where nuclear material was never introduced would remain in this lifecycle stage until it qualified for a decommissioned status (explained below).	The State informs the IAEA as soon as plans are made to place the facility into Closed-down status. For a closed down facility, inspections and DIV continue. For a never commissioned facility, DIV continues to confirm the operating status of the facility.

Facility Lifecycle Stage	Description of the Stage	Examples of Safeguards Activities of States and the IAEA
Closed-down – State of de-commissioning	This phase begins when the facility is closed-down and the State informs the IAEA of its decision to begin decommissioning.	The State will remove or render inoperable essential equipment and structures. The IAEA will conduct DIV and evaluate the essential equipment list, verify removal and/or rendering inoperable of essential equipment; assure complete and correct design information; assure absence of undeclared activities; and verify the status of the facility. The IAEA will also remove its monitoring systems, as needed.
Decom-missioned for Safeguards Purposes	This phase is a lifecycle phase that the IAEA uses to describe a decommissioned facility for which the structures, systems and equipment essential for a facility's operations have been verified by the IAEA as removed or rendered inoperable so that the facility can no longer be used to store, handle, process or utilize nuclear material.	Once the IAEA has verified that a facility is in this phase, DIV discontinues. However, continued confirmation of decommissioned status occurs via complementary access in States where an AP is in force. The IAEA will remove any remaining monitoring systems or they may request the operator to dispose of some parts or all of the systems.

ANNEX 3 - CASE STUDY ON DESTRUCTIVE ASSAY SAMPLING AND ANALYSIS

This annex provides a case study describing how a State and the IAEA can work cooperatively when there is a discrepancy between the result of DA sample analysis and the State's declaration for a bulk handling facility. In this case, the SRA had established its own nuclear material accounting verification system, which included national inspections at a bulk handling facility. The SRA analysed samples of nuclear material using the same techniques as the IAEA. The facilities in the State had rules consistent with national law regarding the sampling of nuclear material. Examples of the law and the facility procedure are below.

Example Domestic Law (Inspection)
"Pursuant to the international agreement, civil servants or persons designated by the IAEA may access places of business, factories, ships, research facilities and sites of those who handle internationally regulated items or conduct related research activities, and sample a minimum amount of materials for testing within the scope put forth in the international agreement."

Example Facility Nuclear Material Control and Accounting Rule
"When an inspection is underway, the Operator shall cooperate to the fullest extent possible in activities such as sampling and transporting, and shall provide radiation protection clothes, devices and materials within the scope of the Radiation Safety Management Rule of the Operator if inspectors so request."

When the IAEA requested samples of nuclear material batches present at the facility for destructive analysis, the SRA also collected samples from the same batches. The IAEA sent one sample to its laboratory for testing and one to the facility archive for storage. The IAEA used the result of DA sample analysis to verify the facility's declared amount of nuclear material and to assess the performance of the facility's measurement system. The SRA sent its sample to a certified laboratory for analysis, and used the results in its national accounting system.

If the difference between the IAEA's results and the facility's declared mass is statistically significant, the IAEA conducts additional analysis and investigation to determine if the difference is significant in terms of safeguards. Differences outside control limits may result from, e.g. heterogeneous batches or estimated accounting values. (For example, if powder with 4% uranium enrichment is used to manufacture a batch of fuel pellets, the pellet's uranium enrichment is assumed to be 4%; a measurement of each pellet is not performed.)

The IAEA may request an explanation from the SRA or the operator or may analyse an archive sample. In one case, the SRA had already performed its analysis of the sample from the same batch, so the IAEA requested the SRA to provide its analysis before the IAEA measured the archive sample. The SRA responded in a timely manner, and the IAEA determined that the difference between the IAEA's analysis and the declared amount was caused by the facility's use of nominal data (use of estimates should be avoided).

ANNEX 4 – EXAMPLE FACILITY PROCEDURES TO SUPPORT A PIV AT A BULK HANDLING FACILITY

The activities listed below are provided as an example for procedures to prepare for a PIV at a bulk handling facility. To prepare for a PIV at an item facility, only a subset of these activities would be applicable.

Prior to Notification of Selection / Non-Selection for PIV

- IAEA requests the SRA to provide a PIT work plan for all facilities/LOFs for the year; the SRA requests information from the operators.
- The SRA forwards the PIT work plans to the IAEA to assist with scheduling and provides any other relevant information for coordination of the IAEA's subsequent PIVs.
- SRA requests estimates of inventory levels for major inventories from the operators and sends to the IAEA. Upon receipt of the estimates, the IAEA and SRA compare the data with inventory levels at past PIVs to estimate the effort required to support the PIV (e.g. the number of IAEA and State inspectors required, and the projected length of the inspection).
- Discuss with the operator whether overtime work during a PIV is an option; overtime can often be limited or unavailable. PIV activities are typically confined to regular working hours whenever possible.
- Discuss any special training requirements for SRA and IAEA staff with the operator, such as respirator fit training, fall arrest training, etc. Inform the IAEA of the training requirements and schedule the training in advance of the PIV or include it in the inspection schedule.
- Determine whether an in-process PIT will take place. If an in-process PIT is to be performed, notify the IAEA of the date and present them with the option to attend if the facility is selected for a PIV.
- Make arrangements with the facility regarding entrance requirements for IAEA staff.

Notification of Selection/Non-selection for PIV

The SRA immediately informs the relevant facility operators regarding which facilities are selected and not selected for a PIV and describes the activities to be performed.

Pre-PIV activities on site

All equipment needed for the PIV should be brought on site, cleared by the operator, and batteries charged (usually on the last working day before the PIV). Liquid nitrogen cooling of IAEA detectors should be completed prior to arrival. The operator will provide a draft copy of the list of inventory items (LIIs) to the IAEA prior to the PIV. This may be accompanied with a list of planned moves to avoid selection of an item that may be processed prior to arrival. (This is a time-saving measure to allow IAEA inspectors to generate their measurement sampling plan in advance of their arrival on site.) The operator reviews relevant source documentation and records and prepares to provide them to the IAEA upon request.

Opening Meeting

An opening meeting is held with staff from IAEA, SRA, and the facility to make introductions and agree on a schedule for activities during the PIV. The schedule should:

- Include the verification of all major material types along with manpower requirements for each activity, both from the IAEA (number of inspectors) and the facility (number of escorts, operators, technicians);
- Material should be verified in the order most convenient for the facility operator (e.g. feed material verified first to allow production to resume, or verification of specific finished product to allow shipment, etc.);
- Include the number and type of IAEA measurements to be taken on each inventory type;
- Incorporate any special issues or needs (e.g. high dose rate areas, respirator training, weather conditions, security concerns);
- Include the taking of nuclear material samples by the IAEA, as this can involve extra operator support; and
- Make provisions for any associated DIV activities.

The agreed schedule must be detailed but flexible enough to accommodate unforeseeable circumstances, such as equipment issues, operational requirements, unfavourable weather, or other such delays. A means of communication should be determined (e.g. cell phones).

Closing Meeting

Closing meetings are held at the end of each day of the PIV to review what was completed as compared to what was scheduled and make any necessary adjustments. A final closing meeting is held at the conclusion of the PIV to review the activities undertaken and discuss what worked well and any recommendations for improvements for future PIVs. Any additional requirements or actions should be noted by the operator with responsibilities and timescales clearly allocated.

Records and Reports

Any accountancy documents resulting from the PIV are transmitted in a timely manner to the SRA and to the IAEA as required.

ANNEX 5 – CASE STUDY IN FACILITATING COMPLEMENTARY ACCESS WITH 24 HOUR ADVANCE NOTIFICATION

Even during the earliest discussions regarding the implementation of the additional protocol in a State, an SRA can begin preparing for complementary access to be performed. This case study describes the experiences of one State with a large fuel cycle. The SRA carried out internal preparations to ensure its staff members were prepared to fulfil their duties and external outreach to ensure licensees were aware of their responsibilities during a CA. This case study describes preparations for a 24-hour advance notice CA.

Procedures and guidance were prepared to respond to a CA, including internal SRA guidance that directed staff activities during a CA at any licensed facility.

Pre-Access Notifications and Coordination

The CA process began with the initial notification from the IAEA, which specified the location, date and time, purpose, and other important details necessary for planning. CAs take place during regular working hours, but the SRA had set up a continuous, round-the-clock communication centre where the notification was received. The centre confirmed receipt of the notification to the IAEA, and notified the SRA staff members responsible for responding to a CA. Each staff member received a phone call that automatically connected to a conference call line with a communications officer who reviewed the content of the CA notice with the staff members. An electronic copy of the notification document was also sent to them via email. Other emails were sent to a distribution list to notify other individuals within the State, at the request of the staff members on the conference call.

The SRA staff then notified the operator of the location of the CA. For every location associated with a declaration line item, and for every site, the SRA requires a point of contact (and back up) to be identified who is responsible to receive notifications of CA requests by the IAEA. This person serves as the primary focal point for all CA related communication between the SRA and the location. The SRA provides a copy of the CA notice from the IAEA which includes the names of the inspectors, a letter confirming the basic information about the CA, and the names of the SRA staff members who will attend the CA. Additionally, the SRA requests answers to a series of questions designed to gather as much information as possible so that any necessary preparations can be made to facilitate the CA. The SRA also reviews with the operator the relevant declaration information and reviews the activities that are expected to take place during the CA. The stated objectives of the CA are also reviewed.

The SRA and the operator also discuss any need for managed access, identify necessary facility staff to be present, review training requirements (safety training) and equipment (safety shoes, hardhats, gloves), determine if there are any areas where access will not be permitted due to health or safety concerns (e.g., high radiation areas, construction zones). A list of questions and considerations to guide these discussions is provided below.

- What facility personnel will need to be present to allow access to all relevant areas of the facility?
- What are the normal business hours for the facility (for the day of the IAEA visit)?
- Are there any major events or activities occurring on site the day of the CA?
- Will the SRA staff be able to use cell phones while on site?
- Is the need for managed access foreseen at your location? Please describe.
- Documents that will be needed by the IAEA include site maps, building maps, declaration related information. The site map should identify all buildings/locations on the site.
- What office space can be made available for the SRA staff and for the IAEA during the CA?
- What health and safety requirements do you have for visitors to your facility and can any of the requirements be satisfied before the visit (i.e. online training)?
- Do you have sufficient safety equipment for all participants?
- Arrange a time (preferably 1.5 to 2 hours before the start of the CA) for a pre-entrance meeting to familiarize the SRA with the location and to work out any managed access.

The purpose of a pre-entrance meeting is to review the details about the expected CA activities, discuss any areas where managed access may need to be applied, discuss any issues concerning health and safety requirements, review the general flow of the day’s activities and ensure the roles and responsibilities of each party are understood. The SRA may wish to conduct a walkthrough of the site and identify managed access approaches (e.g., ceasing operations, shrouding equipment, turning off computer monitors), potential health and safety concerns, and ensure alternate routes are identified in case of any restrictions. Managed access must still allow completion of activities by the IAEA inspectors to ensure the purpose of the CA can be fulfilled.

When the IAEA arrives, the SRA goes with the facility staff to greet them at the site entrance and to verify the credentials of the inspectors. Once satisfied that the IAEA inspectors are those indicated in the notification, the facility will process the inspectors and their equipment into the facility. A briefing will be held to clarify expectations, roles and responsibilities, health and safety requirements, procedural issues, and the general timeline for the CA. It is helpful for the operator to provide a short presentation on the site operations, while avoiding marketing or promotional information. The facility provides copies of documents (marked and numbered) to the IAEA for use during the CA, including a site map and other supporting documentation as relevant to the purpose of the CA. The operator then escorts the inspectors and SRA staff to the area(s) specified in the CA notice. The IAEA may ask questions, take pictures (as discussed during the entrance briefing), write notes, and request access to various buildings, rooms, and other areas as determined to be necessary. When the IAEA has completed the activities, the facility staff will escort the IAEA inspectors and SRA staff back to the location of the entrance meeting for any necessary document reviews, follow up questions, or to begin an exit meeting.

The exit meeting provides an opportunity to review the activities performed and note any unresolved questions or requests. Documents that were distributed will be collected and returned to the facility for disposition or documented and officially released to the IAEA inspectors. Photos taken during the CA will be reviewed by the facility operator to ensure there is no inadvertent inclusion of proprietary or commercially sensitive information. Any follow up items will be assigned to a responsible entity. The IAEA inspectors are then escorted out of the site. The SRA and operator may wish to further discuss follow up actions and identify any lessons learned.

Some lessons learned in the course of conducting CAs in this State include:

- <u>Communication between the IAEA, the SRA and the operator</u>
  In order to allow the various representatives to perform their necessary roles and responsibilities, establishing a clear and consistent communication channel is important. In general, the facility staff should have discussions with the IAEA with the participation of the SRA. Requests from the IAEA should be made to the SRA.

- <u>Early identification of safety restrictions</u>
  It is important that the organization determine in advance if there are health or safety concerns with the CA. If health and safety concerns result in the IAEA being denied access to areas of interest, the SRA will need to consult with the inspectors to determine an acceptable alternative. The use of managed access should help to accomplish the goals of the IAEA while ensuring the health and safety of personnel.

- <u>Errors in AP declarations</u>
  In the event that an error is discovered in an organization’s declaration, the staff should immediately notify the SRA and provide the corrected data. While minor errors should not present a serious problem, it is important to convey the correction in a timely manner.

- <u>General Preparation and Outreach</u>
  In order to be successful, careful preparations should be made for CA. Mock CA may be useful in testing new procedures, familiarizing staff with CAs, and anticipating where problems may occur. In particular, the SRA should help organizations to understand what the IAEA is trying to accomplish.

In another State, after entry into force of its additional protocol the State submitted its initial declaration. The 2.a(iii) declaration included the site of the ‘Nuclear Studies Centre,’ where a research reactor, a radioisotope production building, a waste treatment building and a waste storage building were located.

After performing a PIV of the research reactor, IAEA inspectors conducted their first 2-hour notification complementary access on the site. The inspectors requested access to the waste treatment and storage buildings. Before entering the buildings, the IAEA inspectors walked through the site with the initial declaration and a satellite image in hand. This walkthrough allowed the IAEA inspectors and the site representative to discuss the site declaration and agree on some improvements to be made during the first update of the declaration.

In addition, the walkthrough allowed the IAEA to discuss locations indicated in the satellite image that did not appear to correspond to the actual existing locations. Some examples included a demolished shed and the shadow of a tree.

This complementary access, which covered mainly visual observation, involved technical staff from the buildings visited as well as radiation protection specialists, security and safeguards representatives and representatives from the SRA. It was very helpful for the SRA as well as for the IAEA to walk through the site together.

ANNEX 6 – EXAMPLE PROCEDURE FOR FACILITATING IAEA COMPLEMENTARY ACCESS

The IAEA can provide the SRA with 24-hour notice of a complementary access or 2-hour notice if IAEA inspectors are already on a site. The SRA response to CAs will be treated slightly differently depending on whether they are 24-hour notice or 2-hour notice.

Any IAEA request for a CA should be dealt with **immediately upon receipt**.

Process for a 24-hour notice CA

CA notices are typically received by the SRA via secure email. The initial notification is followed by a phone call from the IAEA to SRA to confirm that the email was received. Upon receipt of a 24 hour notice, the SRA contacts the relevant operator or organization immediately.

- SRA staff confirms whether or not someone from the SRA will accompany the IAEA;
- SRA staff makes necessary logistical arrangements with the operator (agreeing who will be attending the CA from the SRA, who is the responsible staff member, what are the access procedures, times of arrival, etc.).

If SRA does not attend a 24-hour notice CA

If the SRA does not attend the CA, there should be an opening teleconference with the operator and the IAEA inspectors who are to perform the CA, to ensure that goals for the CA are clear. An official record of the teleconference should be filed.

After the CA, the SRA should contact the operator and:

- Request a quick verbal or email account of the CA, providing a high-level summary, addressing any issues which may require follow-up;
- Request the operator to submit a detailed written report describing the activities carried out during the CA.

Process for a 2-hour notice CA

If an SRA official is not present at a facility during an IAEA inspection, then the SRA will not be on the site when the notification of a 2-hour-notice CA is presented to the IAEA inspectors. In such a case, it is unlikely the SRA would be able to attend the CA. Usually, SRA inspectors accompany IAEA inspectors during inspections, so they are available for a 2-hour notification CA.

If SRA is on-site for a 2-hour notice CA

Where time permits, a brief meeting should be held with the licensee and the inspectors who are to perform the CA, to ensure that goals for the CA are clear. The meeting should cover:

- What documents will be required and whether they must be supplied during the CA, or afterwards;

- How access to requested areas will be granted (managed access may apply);
- What arrangements are required concerning the use of cameras or radiation detection/measurement equipment, the taking of environmental samples, etc.; and
- Whether personal protection equipment is required, and/or supplied.

If SRA is not on-site for a 2-hour notice CA

Upon becoming aware that the CA has taken place, the SRA should request from the operator:

- A quick verbal or email description of the CA, summary of the activities, any issues which may require follow-up, to be sent immediately;
- A copy of the IAEA CA notice, either via fax or email; and
- An official written report detailing the activities carried out during the CA, to be provided within a reasonable timeframe.

On-site activities

Below is a list of guidelines for SRA staff that are present for a CA, whether 2-hour or 24-hour notice:

- Whenever possible, hold a brief opening meeting with all three parties (SRA, IAEA, operator representatives) prior to the CA to ensure that the goals of the CA are clear.
- Topics such as managed access, taking of photographs or samples, or any health and safety issues should be addressed.
- Ensure that the facility operator provides access to the areas listed in the CA notice, using managed access as envisioned in the relevant declaration. The SRA must ensure that any uses of managed access by the operator are justified and consistent with the declaration.
- Monitor the consistency between the activities conducted and locations or processes accessed with the objectives listed in the CA notice. Additional activities (beyond the scope of the CA notice) that are requested by the IAEA during the CA may be negotiated on a case-by-case basis in agreement with the operator and SRA representatives.
- Note should be taken of all areas visited by the IAEA, and of whether the IAEA inspectors took any environmental samples, measurements (physical measurements, radiation measurements, GPS readings), or photos.

Follow-Up Activities

The operator should produce a CA report and submit it to the SRA following the CA. This report should be produced regardless of whether the SRA attended the CA, and should include:

- Date and time that complementary access notification was received;
- Date and time complementary access began;

- List of participating IAEA personnel;
- List of other participating persons from the facility or the SRA;
- Brief chronology of events and activities during the CA, including places visited and IAEA activities, especially as pertains to use of equipment and sample taking;
- A description of managed access used during the CA (if any);
- A description of any difficulties encountered during the complementary access and, where appropriate, how they were resolved/addressed; and
- A list of any outstanding issues or actions identified either formally or informally by the IAEA.

ANNEX 7 - CASE STUDY ON ROLES AND RESPONSIBILITIES IN PREPARING FOR IAEA ACCESS

The following is provided as an example of allocation of the roles and responsibilities of the SRA in facilitating access to the IAEA, based on the practices of one State.

The specific roles and responsibilities of various stakeholders will differ from one State to another; however, it is recommended to **document the roles and responsibilities** and share the information with all involved parties to create a common understanding.

The SRA is responsible for:

- All official communications between the State and the IAEA;
- Liaising with the IAEA with regards to the dates for access and the planned activities, and to establish a detailed schedule for the operator;
- Allocation of responsibilities as per the inspection schedule;
- Discussing and resolving problems in facilities at management level; and
- Compiling and submitting a report (on each access) for management.

The SRA staff member assigned to a particular IAEA access activity is responsible for:

- Preparation of a schedule and notification to the location of the schedule and activities to be performed;
- Preparation of an inspection report;
- Assisting facilities with preparations for an access, such as taking a physical inventory, assembling documentation, checking facility equipment performance, etc.;
- Assisting facilities to comply with State and IAEA requirements;
- Assisting the IAEA inspectors during the inspection;
- Verification of the correct operation and calibration status of measurement equipment;
- Follow up of any requests from the IAEA and/or facility;
- Evaluation of the report of material unaccounted for (MUF) report;
- Verification of the validity and correctness of information on possible causes of MUF;
- Verification of shipper/receiver differences and uncertainties in the book inventory;
- Examine the design information to determine if any updates are required;
- Auditing of the nuclear material accounting and control systems implemented by the facility operators to determine the effectiveness thereof; and
- Evaluation of the health, safety and environmental impact of inspection.

For Complementary Access, the SRA is responsible to:

- Arrange for access at the location and operator availability;
- Have a copy of the latest additional protocol declaration for the particular location. If there are any changes in the AP declaration, record and submit to the Senior Manager for future updates;

- Provide the IAEA inspectors with unrestricted access to buildings and/or areas specified on their notification;
- In case of any visual images taken, the State inspector should make sure they get a copy of all images taken and retain them in internal records;
- In case environmental swipe samples are taken, receive at least one swipe taken from the same location as the one the Agency inspectors have;
- In the case where equipment and/or process areas are considered commercially sensitive, implement managed access in accordance with agreed procedures. Managed access is to be negotiated through the safeguards manager and the representative of the particular facility/building/ company in advance of a complementary access.

Inspection Planning

The SRA staff member responsible for a particular facility may wish to prepare an inspection plan for each inspection, including such aspects as:

- Equipment installation, calibration and setting up dates (if required);
- Receiving IAEA equipment that will be shipped for the access;
- Facility to be inspected/verified;
- Date of the inspection;
- Sealing of material for verification of non-borrowing (if required); and
- Facility operator staff member and lead IAEA inspector.

The SRA should also determine specific personnel requirements for the completion of the inspection, e.g. operator staff that are qualified for overhead cranes, forklifts, manipulators, etc. The installation, removal, transportation, calibration and setting up of equipment to be used by the IAEA during the inspection/PIV also must be coordinated.

Logistics Support

The SRA should work with the operator/organization to determine logistical needs for the access. Such issues should be considered as:

- Transportation for the IAEA inspectors and their equipment to/from the airport and to/from the hotel and the location(s) to be accessed;
- Assistance with booking a hotel for IAEA inspectors (to advise particularly on location and security);
- Identification of appropriate escorts (considering the gender of the inspectors);
- Providing for translation and interpretation as needed;
- Determining any training requirements and safety rules and equipment for the inspectors;
- Making allowance for weather conditions (e.g. water, clothing, etc.);
- Clearing of IAEA inspectors and equipment through Customs; and
- Providing for meals for the inspectors during the access (e.g. transportation for a mid-day meal).

Documentation

The SRA works with the facility safeguards manager to verify the format and timeliness of the list of inventory items (LII) and general ledger, to ensure that documentation submitted to the IAEA inspector is correct and complete. The facility's document control system is an important element of its quality management system. For documentation, in addition to document control, retention and archiving, the following aspects should be considered:

- Duplicate items;
- Material category and element code;
- Inclusion of any pending transfers;
- Indication of material received since the previous inspection;
- Indication of material in process;
- Indication of sealed items;
- Comparison of LII hard copy and electronic data; and
- Material unaccounted for (MUF).

Physical inventory verification (PIV)

A pre-inspection meeting is held at the facility to discuss planned activities. A PIV will involve the following kinds of activities:

- Item counting and tag checking;
- Item verification (non-destructive assay or sample taking);
- Verification of the operating characteristics of measuring equipment;
- Application and checking of C/S measures;
- Verification of material to be transferred;
- Examination of records; and
- Report comparison and book update.

IAEA Samples

The facility safeguards manager should prepare shipment documentation according to the specified procedures, for all the samples taken at the facility during the inspection and ensure that the samples are shipped to the IAEA.

ANNEX 8 – EXAMPLES OF IDENTIFICATION AND RESOLUTION OF A POSSIBLE INCONSISTENCY OR DISCREPANCY

Example 1: In preparing a 2.a(iii) declaration (a site declaration), the State identifies and describes the functions of all buildings on the site, together with an annotated site map or layout. In one State, a building was declared as within the site premises with the description, 'space debris observation'. No additional information was provided. While on the site, the IAEA provided a 2-hour notification of a CA. At lunch time, the IAEA informed the SRA and operator of the particular building that the IAEA wished to access. The operator then informed the IAEA that the building belonged to another Ministry (the Ministry for Space) which was located in another city a long distance from the site.

The equipment in the building was controlled remotely by the staff of that Ministry. The staff only visited the site twice per year. It appeared that no access would be possible within the timeframe of the notification. The IAEA explained that the operator should have either obtained a key to the building, or discussed the situation with the IAEA and considered removing the building from the site declaration as it was not functionally related to the facility. To address the situation, the SRA contacted all involved Ministries and had a staff member fly to the site with the key to the CA location within working hours.

While awaiting the staff member's arrival, the IAEA inspector went to the building to freeze the situation and contacted HQ to determine what compensatory measures could be taken to resolve the situation. The staff member was not able to arrive within working hours, so the IAEA sealed all possible penetration accesses for the night and returned the next day to complete follow-up actions when access was possible. The cooperation and efficient coordination of the State enabled the IAEA to achieve its objectives of the CA despite the problem. The future access to the building was also addressed through discussions between the SRA, operator and IAEA.

Example 2: During a PIV at a large bulk facility, much of the equipment used for verification activities is unattended and in remote transmission mode. The procedure in place is to proceed with measurements of selected items during the whole week and perform evaluation of the results at the end. Due to a technical problem (most probably a virus transferred to the computers of the respective equipment) the IAEA saw that all saved measurements performed for almost two days were lost.

While the technical problem was not caused by the facility, the cooperation of the operator and the SRA were essential to recovering the situation. Additional work was required by everyone. A new sample selection was done and operator started to bring samples automatically using a crane transfer system. Unfortunately, the system broke down and samples had to be brought manually which involved increased doses and the need for additional radiation technicians. The operator, IAEA and SRA assessed and controlled the radiation risks, succeeded in sampling and performing measurements and worked beyond working hours to complete the PIV. As a result, the IAEA was able to perform all activities within the original time schedule and attain all objectives. These objectives were seen as shared objectives of the IAEA, SRA and operator.

ANNEX 9 – REMOTE MONITORING SYSTEMS

The IAEA has significantly expanded the use of remote monitoring (RM) throughout the world; as of 2014, over 280 systems are connected worldwide and data transmission is protected by a Virtual Private Network (VPN). Troubleshooting & some system maintenance activities can be performed from IAEA headquarters in Vienna to ensure continued performance. The use of remote monitoring systems does not necessarily require any additional capability on the part of an SRA or an operator.

Remote monitoring systems often include surveillance cameras that are remotely controlled, containment monitoring systems and NDA equipment. The IAEA can remotely receive and review data about nuclear material accounting in near-real-time. However, like any system, events can occur which impede the system's performance. A case study below describes how the IAEA, SRA and facility operators communicate with each other to maintain and repair IAEA equipment when problems are discovered.

Surveillance cameras collect image data and transmit it to a server; the data is either stored in the server or transmitted to a remote monitoring server at IAEA headquarters through a VPN. If a State and the IAEA have entered into an information sharing arrangement, image data may also be transmitted to the State. If the SOH data does not arrive at the server in Vienna, the IAEA immediately requests the SRA to either reset the system's server or to check the communication cables for internet or telephone. Since nuclear facilities are often located in remote areas, the SRA will typically contact the facility operator to request that they check the system and cables. The facility should have procedures in place that specify how to treat IAEA installed equipment at the facility.

Upon receiving a request from the SRA to check the IAEA's equipment, the facility operator will first check the status of the RM system server, which may be located at, for example, a spent fuel storage area. The facility operator will check the server's screen and light signal to indicate it is working properly. If the server is not working, the operator resets the server according to the manual. If a reset does not return the server to normal operations, the operator will then examine the internet modem or communication cables. A majority of problems are resolved by resetting the server or rebooting the modem.

The operator then notifies the SRA, and the SRA contacts the IAEA to check whether SOH data is being received from the monitoring system. The problem is resolved when the IAEA confirms that the SOH data is arriving properly.

Some common causes for problems include overheated or aged servers or outdated cables. In these cases, the IAEA may request the SRA to examine the equipment or cables to verify that the problems will not impede inspection activities.

States are obliged to provide technical support such as installation, maintenance and repair of equipment so that the IAEA can carry out its inspection activities in accordance with safeguards agreement. Some States conclude specific cooperation arrangements (such as a memorandum of understanding) with the IAEA that define their respective roles and responsibilities, and may include procedures for certain cooperative activities. Such arrangements may also specify cost sharing.

> ***Possible language for inclusion in an IAEA-State cooperation arrangement***
>
> *"In emergency cases the State may be requested by the IAEA to arrange for the resetting of the Remote Monitoring server."*
>
> *"The State and the IAEA will perform periodical checking of the State of Health of the Remote Monitoring system, and notify the other side of any equipment abnormalities when discovered."*
>
> *"The State will bear the costs of installation of all IAEA supplied equipment and cables, all electrical power operating expenses and communication expenses."*

The malfunction of RM equipment should be addressed as soon as possible to avoid impacting inspection activities. Close cooperation and communication between the IAEA, SRA and facility operators is essential. Most of the issues with RM system performance can be addressed without significant financial impact. However, cables or equipment items will eventually require replacement and this will cost money, so it is important to define roles and responsibilities of the IAEA and the State regarding the maintenance or repair of equipment. This is often addressed in the Facility Attachment, or may be discussed in meetings or defined in cooperation arrangements. For example, the IAEA and a State may set out an arrangement whereby the IAEA may be responsible for the maintenance of RM equipment while the State takes care of the communication equipment. Cooperation arrangements are a useful means of determining responsibility for installation, operation, maintenance and repair activities and costs.

The information provided below may be useful in making arrangements for installation of IAEA RM systems at a facility.

Basic requirements for RM system data transmission

Transmission:	once per day, can be scheduled to occur at any time.
Data Amount:	approximately 20-25 MB per day.
Transmission Duration:	approximately 30 minutes (depending on connection type)
Backup Transmission:	not necessary because IAEA systems buffer data to transmit when communications are restored.

The two most common remote monitoring communication methods are:

1. The installation of a broadband link (ex. xDSL) near the IAEA cabinet (preferred).
2. The use of "LAN-Sharing" where the IAEA uses the existing facility LAN and Internet connection to transmit data.

These two options are discussed in more detail below.

Requirements for a broadband connection for IAEA RM system

The provider must assign a fixed IP address or supply an address via DHCP for the IAEA RM Server. The connection from the xDSL line must be Ethernet. All protocols should be allowed to pass. Required protocols are:

- IPSEC and IKE: UDP on port 500 + 4500 for Network Address Translation (NAT) environments.
- IPSEC Encapsulating Security Payload (ESP) (IP type 50) with no NAT.
- The only kind of ISP authentication that is supported is PPPoE (Point to Point Protocol over Ethernet), no authentication to the provider is preferable. Most broadband connections offer enough bandwidth to support SG remote applications.
- The provider should turn off any firewalls or IP filtering.
- Full access to the xDSL modem from Internet-side.

Requirements for LAN-sharing

IAEA equipment can also transmit over a facility’s local area network (LAN). IAEA communications are protected by a hardware VPN device located in the cabinet, so encryption and authentication of data is secure. Facility firewall administrators must allow one specific outside IP number to establish a VPN tunnel with the IAEA cabinet. The above protocols (IPSEC, IKE, and ESP) must be allowed in and out to IAEA equipment. The facility may also VLAN the IAEA data to isolate this traffic from normal facility traffic (but this is optional).

The IAEA works with facility IT personnel to make the connection as secure as needed to meet facility standards. Further, data transmission can take place during off-business hours to avoid interfering with operational use.

CONTRIBUTORS TO DRAFTING AND REVIEW

Albqoor, M.	Jordan Nuclear Regulatory Commission, Jordan
Binner, R.	International Atomic Energy Agency
Bohlolo, H.J.	The South African Nuclear Energy Corporation, Republic of South Africa
Bouwmans, L.	European Atomic Energy Commission
Burger, S.	Canadian Nuclear Safety Commission, Canada
Cisar, V.	International Atomic Energy Agency
Cooley, J.	International Atomic Energy Agency
Edmonds, N.	Sellafield, Ltd, United Kingdom
Gazze, C.	International Atomic Energy Agency
Ianiri, R.	International Atomic Energy Agency
Iontchev, P.	International Atomic Energy Agency
Jraut, A.	National Centre of Nuclear Energy, Sciences and Technologies, Morocco
Jung, S.	International Atomic Energy Agency
Khabir, K.	International Atomic Energy Agency
Kim, M.S.	Korean Institute of Nuclear Non-proliferation and Control, Republic of Korea
Lee, J.S.	International Atomic Energy Agency
Lewis, R.	International Atomic Energy Agency
Luvsantseren, E.	International Atomic Energy Agency
Mandl, W.	International Atomic Energy Agency
Martikka, E.	Radiation and Nuclear Safety Authority, Finland
Mathews, C.	International Atomic Energy Agency
Moran, B.	International Atomic Energy Agency
Morin, M.	Institute of Radioprotection and Nuclear Security, France
Newton, T.	International Atomic Energy Agency
Parise, D.	International Atomic Energy Agency
Pitt, R.	International Atomic Energy Agency
Regula, J.	International Atomic Energy Agency
Schanfein, M.	Idaho National Laboratory, United States of America
Seguis, J.	Philippines Nuclear Regulatory Institute, Philippines
Shawky, S.	International Atomic Energy Agency
Stastny, O.	State Office for Nuclear Safety, Czech Republic
Suseanu, I.	International Atomic Energy Agency

Tsvetkov, I.	International Atomic Energy Agency
Tandogan, E.	International Atomic Energy Agency
Vincze, A.	Hungarian Atomic Energy Authority, Hungary
Xiao, J.	International Atomic Energy Agency

IAEA
International Atomic Energy Agency

No. 23

ORDERING LOCALLY

In the following countries, IAEA priced publications may be purchased from the sources listed below or from major local booksellers.

Orders for unpriced publications should be made directly to the IAEA. The contact details are given at the end of this list.

AUSTRALIA
DA Information Services
648 Whitehorse Road, Mitcham, VIC 3132, AUSTRALIA
Telephone: +61 3 9210 7777 • Fax: +61 3 9210 7788
Email: books@dadirect.com.au • Web site: http://www.dadirect.com.au

BELGIUM
Jean de Lannoy
Avenue du Roi 202, 1190 Brussels, BELGIUM
Telephone: +32 2 5384 308 • Fax: +32 2 5380 841
Email: jean.de.lannoy@euronet.be • Web site: http://www.jean-de-lannoy.be

CANADA
Renouf Publishing Co. Ltd.
5369 Canotek Road, Ottawa, ON K1J 9J3, CANADA
Telephone: +1 613 745 2665 • Fax: +1 643 745 7660
Email: order@renoufbooks.com • Web site: http://www.renoufbooks.com

Bernan Associates
4501 Forbes Blvd., Suite 200, Lanham, MD 20706-4391, USA
Telephone: +1 800 865 3457 • Fax: +1 800 865 3450
Email: orders@bernan.com • Web site: http://www.bernan.com

CZECH REPUBLIC
Suweco CZ, spol. S.r.o.
Klecakova 347, 180 21 Prague 9, CZECH REPUBLIC
Telephone: +420 242 459 202 • Fax: +420 242 459 203
Email: nakup@suweco.cz • Web site: http://www.suweco.cz

FINLAND
Akateeminen Kirjakauppa
PO Box 128 (Keskuskatu 1), 00101 Helsinki, FINLAND
Telephone: +358 9 121 41 • Fax: +358 9 121 4450
Email: akatilaus@akateeminen.com • Web site: http://www.akateeminen.com

FRANCE
Form-Edit
5 rue Janssen, PO Box 25, 75921 Paris CEDEX, FRANCE
Telephone: +33 1 42 01 49 49 • Fax: +33 1 42 01 90 90
Email: fabien.boucard@formedit.fr • Web site: http://www.formedit.fr

Lavoisier SAS
14 rue de Provigny, 94236 Cachan CEDEX, FRANCE
Telephone: +33 1 47 40 67 00 • Fax: +33 1 47 40 67 02
Email: livres@lavoisier.fr • Web site: http://www.lavoisier.fr

L'Appel du livre
99 rue de Charonne, 75011 Paris, FRANCE
Telephone: +33 1 43 07 50 80 • Fax: +33 1 43 07 50 80
Email: livres@appeldulivre.fr • Web site: http://www.appeldulivre.fr

GERMANY
Goethe Buchhandlung Teubig GmbH
Schweitzer Fachinformationen
Willstätterstrasse 15, 40549 Düsseldorf, GERMANY
Telephone: +49 (0) 211 49 8740 • Fax: +49 (0) 211 49 87428
Email: s.dehaan@schweitzer-online.de • Web site: http://www.goethebuch.de

HUNGARY
Librotade Ltd., Book Import
PF 126, 1656 Budapest, HUNGARY
Telephone: +36 1 257 7777 • Fax: +36 1 257 7472
Email: books@librotade.hu • Web site: http://www.librotade.hu

INDIA
Allied Publishers
1st Floor, Dubash House, 15, J.N. Heredi Marg, Ballard Estate, Mumbai 400001, INDIA
Telephone: +91 22 2261 7926/27 • Fax: +91 22 2261 7928
Email: alliedpl@vsnl.com • Web site: http://www.alliedpublishers.com

Bookwell
3/79 Nirankari, Delhi 110009, INDIA
Telephone: +91 11 2760 1283/4536
Email: bkwell@nde.vsnl.net.in • Web site: http://www.bookwellindia.com

ITALY
Libreria Scientifica "AEIOU"
Via Vincenzo Maria Coronelli 6, 20146 Milan, ITALY
Telephone: +39 02 48 95 45 52 • Fax: +39 02 48 95 45 48
Email: info@libreriaaeiou.eu • Web site: http://www.libreriaaeiou.eu

JAPAN
Maruzen Co., Ltd.
1-9-18 Kaigan, Minato-ku, Tokyo 105-0022, JAPAN
Telephone: +81 3 6367 6047 • Fax: +81 3 6367 6160
Email: journal@maruzen.co.jp • Web site: http://maruzen.co.jp

NETHERLANDS
Martinus Nijhoff International
Koraalrood 50, Postbus 1853, 2700 CZ Zoetermeer, NETHERLANDS
Telephone: +31 793 684 400 • Fax: +31 793 615 698
Email: info@nijhoff.nl • Web site: http://www.nijhoff.nl

Swets Information Services Ltd.
PO Box 26, 2300 AA Leiden
Dellaertweg 9b, 2316 WZ Leiden, NETHERLANDS
Telephone: +31 88 4679 387 • Fax: +31 88 4679 388
Email: tbeysens@nl.swets.com • Web site: http://www.swets.com

SLOVENIA
Cankarjeva Zalozba dd
Kopitarjeva 2, 1515 Ljubljana, SLOVENIA
Telephone: +386 1 432 31 44 • Fax: +386 1 230 14 35
Email: import.books@cankarjeva-z.si • Web site: http://www.mladinska.com/cankarjeva_zalozba

SPAIN
Diaz de Santos, S.A.
Librerias Bookshop • Departamento de pedidos
Calle Albasanz 2, esquina Hermanos Garcia Noblejas 21, 28037 Madrid, SPAIN
Telephone: +34 917 43 48 90 • Fax: +34 917 43 4023
Email: compras@diazdesantos.es • Web site: http://www.diazdesantos.es

UNITED KINGDOM
The Stationery Office Ltd. (TSO)
PO Box 29, Norwich, Norfolk, NR3 1PD, UNITED KINGDOM
Telephone: +44 870 600 5552
Email (orders): books.orders@tso.co.uk • (enquiries): book.enquiries@tso.co.uk • Web site: http://www.tso.co.uk

UNITED STATES OF AMERICA
Bernan Associates
4501 Forbes Blvd., Suite 200, Lanham, MD 20706-4391, USA
Telephone: +1 800 865 3457 • Fax: +1 800 865 3450
Email: orders@bernan.com • Web site: http://www.bernan.com

Renouf Publishing Co. Ltd.
812 Proctor Avenue, Ogdensburg, NY 13669, USA
Telephone: +1 888 551 7470 • Fax: +1 888 551 7471
Email: orders@renoufbooks.com • Web site: http://www.renoufbooks.com

United Nations
300 East 42nd Street, IN-919J, New York, NY 1001, USA
Telephone: +1 212 963 8302 • Fax: 1 212 963 3489
Email: publications@un.org • Web site: http://www.unp.un.org

Orders for both priced and unpriced publications may be addressed directly to:

IAEA Publishing Section, Marketing and Sales Unit, International Atomic Energy Agency
Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Telephone: +43 1 2600 22529 or 22488 • Fax: +43 1 2600 29302
Email: sales.publications@iaea.org • Web site: http://www.iaea.org/books

14-48811

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA
ISSN 1816–9309