Safeguards by Design (SBD) for Gas Centrifuge Enrichment Plants

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Attachment 3

Safeguards by Design (SBD) Introduction

- The “Safeguards by Design” approach is intended to ensure that international and domestic safeguards, and physical protection requirements are fully integrated with safety and operational considerations from the outset of the design process of a new nuclear facility.

- Many, if not most nuclear facilities currently monitored by the IAEA have been retrofitted for international safeguards. Implementation of Safeguards by Design could help avoid costly and time-consuming retrofits and make safeguards more effective and efficient.

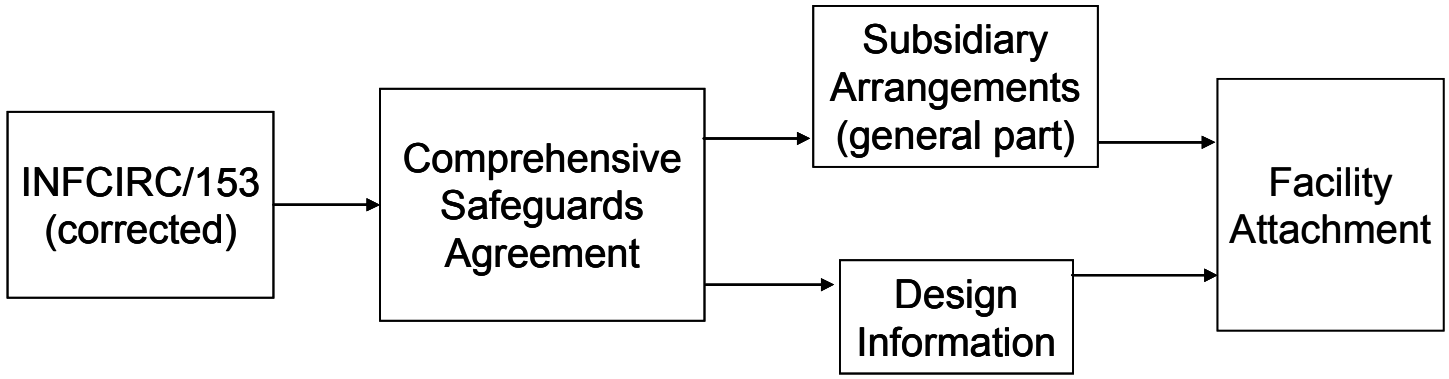
- Safeguards by Design has the potential to benefit all stakeholders (facility owner/operator, domestic regulatory agency, IAEA)

Safeguards by Design (SBD) Topics

- International safeguards requirements
- Safeguards approaches for GCEPs
- Safeguards technologies for GCEPs
- Design features for implementation of safeguards at GCEPs

Safeguards Requirements (CSA & SSAC)

- A “State” party to a Comprehensive Safeguards Agreement (CSA) with the IAEA shall establish and maintain a system of accounting and control of all nuclear material subject to safeguards under the CSA.
  - The State organizes a system called the State System of Accounting and Control (SSAC) to interface with the IAEA



Safeguards Requirements (DIQ)

- Within the United States, for DOE or NRC regulated/licensed facilities, the Design Information Questionnaire (DIQ) for a facility must be provided to the IAEA within 45-days of its selection by the IAEA from the Eligible Facility List (EFL).

- The DIQ includes, but is not limited to:
  - Identification of facility stating its purpose (including nuclear material type), status (planned or operating), construction date if applicable, location, site layout, facility layout & operating mode (number of shifts)

- DIQ “Model Responses” for similar facilities exist

Safeguards Requirements (MBAs/KMPs)

- Design Information (DI) is used by the IAEA to define and negotiate (with the SSAC and designer/operator) MBAs and KMPs based on models established for similar facilities.
  - "Model Responses for an Enrichment Facility DIQ" ISPO-24, ISPO-Task C.9, Vol. 2, May 1979.

Safeguards Requirements (AP)

- The “Unites States” also has an additional safeguards agreement with the IAEA based on INFCIRC/540, the “Additional Protocol (AP)," which goes beyond the Comprehensive Safeguards Agreement (CSA), INFCIRC/153

- The U.S. Additional Protocol (AP) includes, but is not limited to:
  - A “site” declaration consisting of a description of each building on the site, including its use, and if not apparent from that description, its contents, as well as map of the site (as defined in the DIQ) if the facility is selected for IAEA safeguards
  - A description of the scale of operation for each location (if any) on the site that is engaged in manufacture of centrifuge rotor tubes or the assembly of gas centrifuges for the plant, or any other location in the US
  - An IAEA right of Complementary Access (IAEA inspector access), on 2-hours notice, to any location on the “site” in conjunction with a DIV or an inspection, and to any other U.S. location not on the site (e.g., R&D not involving NM) on 24-hours advance notice.
  - IAEA use of environmental sampling under the AP is subject to statutory limitations in Subtitle E of the AP Implementation Act
  - US has the right to manage access to prevent dissemination of proliferation sensitive information, to meet safety or physical protection requirements, or to protect proprietary or commercially sensitive information, provided that such measures do preclude the IAEA from conducting activities to provide credible assurance of the absence of undeclared activities or NM at the location in question, or resolve a question about correctness/completeness of, or inconsistency in, information declared to the IAEA
  - US has an unqualified right to employ managed access to protect from disclosure activities of direct national security significance to the US, or information or locations associated with such activities

Safeguards Requirements (Facility Attachment)

- The facility operator, SSAC, and IAEA all participate in preparation of the facility attachment describing the IAEA safeguards approach.
  - Typically the IAEA prepares the initial draft based on established models for existing facilities
  - The final version is then negotiated among the operator, SSAC, and IAEA
  - Facility attachments can be quite detailed specifying IAEA instruments and equipment, their frequency of use, and locations for containment/surveillance

Safeguards Objectives for GCEPs (IAEA)

- Detection of the diversion of declared materials (DU, NU, and LEU)
- Detection of the production of LEU (at the declared enrichment level) in excess of declared amount
- Detection of the production of higher than declared enrichments (HEU)

Safeguards Objectives for GCEPs (IAEA Goal Quantities)

- At an enrichment facility the IAEA needs to cover:
  - Loss detection
    - Diversion of 75-kg of 235U in the form of LEU within one year
    - Diversion of 25-kg of 235U in the form of HEU within one month
  - Detection of facility misuse
    - Undeclared material (production of HEU or undeclared LEU)
    - Search for indicators of potential facility misuse (e.g., cascade reconfiguration)

Safeguards Approach for GCEPs

- INFCIRC/153, Paragraph 29, states the CSA "should provide for the use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures."

- Design Information Verification (DIV), re-verification, and environmental sampling complement accountancy, and containment and surveillance, providing evidence of facility misuse.

Safeguards Approach (Accountancy)

- During the Physical Inventory Verification (PIV), feed and withdrawal stations, chemical traps, cold traps, and waste storage may be inspected with portable instruments.

- Feed, product & tails cylinders
  - enrichment is randomly verified by NDA
  - weight is randomly verified by a portable load cell balance system, or the operator's accountancy scale
  - sealed cylinders are inspected and verified for the absence of tampering by the random replacement of tamper-indicating seals

Safeguards Approach (Containment & Surveillance)

- Containment & Surveillance is used inside and outside cascade halls to detect
  - Reconfiguration of piping behind walls
  - Tampering of IAEA instrumentation
  - Undeclared withdrawals from sampling locations
  - Tampering of UF_6 cylinders at F/W

Safeguards Approach (NDA examples)

- Process Pipe Measurements
  - Cascade Header Enrichment Monitor
    - Passive gamma with x-ray fluorescence
- Hold-up Measurements
  - Portable Neutron Hold-up Counter
    - ^{3}He counter
- Panel Measurements
  - Neutron and gamma scans to detect UF_6 cylinders (through walls) in cascade halls
    - NaI & slab neutron detectors during multiple inspections

Safeguards Approach (Advanced – not yet standard practice)

- In-line flow and enrichment measurements through a sample line connected to, and in parallel with, the process pipe
  - Pressure drop across an orifice for flow
  - NaI detector for enrichment

- Laser Identification of Cylinders
  - Laser identifies cylinder by unique intrinsic features (spatial irregularities)

Safeguards Approach for GCEPs (DIE/DIV)

- Design Information (DI) provided to the IAEA is Examined (E) and Verified (V). DIE/DIV starts with the design phase and continues on through construction, commissioning, operation, maintenance and modification, shut-down, and decommissioning.
  - The IAEA may perform DIV during construction
  - The IAEA secures design information considered sensitive, at the facility
  - Sensitive design information not safeguards relevant need not be provided to the IAEA

Safeguards Design Features for GCEPs

- There should not be sub-basements or concealed spaces contiguous to the cascade halls that could be used as undeclared processing areas
- The header piping routed to and from the cascade hall must be easily traceable
- Space for portable surveillance cameras must be provided that permits an unobstructed view of the loading zone for each feed and withdrawal station, which may be used during Physical Inventory Verification (PIV)
- Consideration should be given to providing space for Cascade Header Enrichment Monitors
- Space should be provided for portable instruments to be used during PIV at feed and withdrawal stations, chemical traps, cold traps, waste storage, and in some cases the cascade halls
- Space for IAEA laboratory and equipment must be determined

SBD for GCEPs (Summary)

- SBD for GCEPs has been introduced by way of describing requirements, and providing examples of safeguard approaches.

- Suggested follow-on SBD activities include:
  - More detailed discussion of IAEA techniques and technologies
  - Identification of GCEP design features that enable IAEA monitoring with reduced cost to the owner/operator and IAEA