Considerations on Safeguards Approach for Small Centrifuge Enrichment Facilities

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ABSTRACT

The safeguards' objectives for enrichment facilities encompass the detection of the diversion of declared nuclear material and of facility misuse. The safeguard's approach presently applied for commercial centrifuge enrichment facilities is based on the Hexapartite Project and seems not to be directly applicable to cases of small plants. Since ABACC started its operation one of the main problems faced was the application of safeguards to small centrifuge enrichment plants for testing centrifuges in cascade mode or for small LEU production. These plants consist of a few fully independent cascades, does not operate in a routine basis and panels prevent visual access to the centrifuges and their surroundings for preserving sensitive information. For such plants misuse scenarios seems to dominate, particularly those associated with feeding the plant with undeclared LEU. This paper presents a concise analysis of misuse strategies in small centrifuge facility and alternative safeguard's approach, describing the main control elements to be applied. The particularities arising from the existence of panels or boxes covering the centrifuges are specifically addressed. Two alternatives approaches based on the application of a transitory perimeter control to increase the effectiveness of unannounced inspection and on the application of permanent perimeter control are presented.

1.- Introduction

The objective of this paper is to present procedures and arrangements required between the safeguard's organizations, the State Authority and the operator to implement verification activities at a small centrifuge enrichment facility presented as an example case. Two alternatives safeguards approaches are assessed. Both approaches are based on nuclear material accountancy, environmental swipe sampling and performing unannounced inspection to the cascade area and F/W Station. To increase the effectiveness of the unannounced inspections the first approach considers the establishment of a continuous and transitory perimeter surrounding the cascade area. Another approach takes into account a continuous and permanent perimeter.

2. Description of the Example Case

The considered facility is used for testing centrifuge enrichment process for future commercial production with few fully independent cascades, each one with its own feed and withdrawal (F/W) station and vacuum system located in adjacent rooms. Boxes or panels prevent visual access to the centrifuge and their surroundings for preserving sensitive information.

The plant produces UF6 enriched below 5% enrichment, the tails are depleted up to 0.3% in U235 and natural uranium, depleted or low enriched uranium can be used as feed material. The inventory of nuclear material at the facility is very low and the throughput is less than 1 SQ. The UF6 is handled in 8A and 12B cylinders and all the cylinders to be connected or reconnected to the process or to be shipped out from the plant passed through a small UF6 store area in order to be available for verification. For accounting purposes the inventory changes and inventory lists are recorded in unified uranium.

The information required in the operational program depends on the approach applied but in any case is provided in advance, the upper enrichment limit expected is declared for each campaign and all the UF6 cylinders intended to be used as feed material or withdrawal are available for verification prior its connection to process or shipment.

3.- Safeguards Criteria Requirements

As the usual inventory/throughput in this facility is less than 1 SQ, an annual PIV and confirmation of all the transfers are required by the present Safeguards Criteria. During the inspections, the verification of operator's measurement system and the examination of records and reports shall be carried out. On the other hand, as the inventory involved is less than 1SQ, the borrowing criterion is not required.

Additional measures, as environmental swipe sampling, can be implemented in order to confirm the absence of unrecorded production of direct use material (HEU) and to confirm the enrichment level is not higher than declared.

Taking into account these criteria, it seems that for those kind of facility the misuse scenarios are the dominant concern, particularly those associated with feeding the plant with undeclared LEU.

The verification activities addressed to assure that declared nuclear material is not diverted, to confirm that the plant operates as declared and to detect any signatures of facility misuse are implemented under the framework of the comprehensive safeguards agreement. The potential existence of undeclared material is not excluded. Inspection activities specifically addressed to detect

undeclared material should be applied under other legal framework or specific agreement between the parties.

4. - Diversion Scenarios

The diversion of declared nuclear material can occur by reporting false flow data or MUF inflation. As the amount of material in process is very low and the nuclear material is handled in small items, the scenario of reporting false flow seems to be the relevant one. To conceal the diversion gross, partial or bias defect are introduced into uranium or isotope content in some items, complemented with the falsification of data.

Facility can be misused trough the production of high-enriched uranium (HEU) or low enriched uranium with enrichment higher than 5%. Undeclared production of low enriched uranium with enrichment lower or equal 5% shall also be considered.

5.- Safeguards Approach

The safeguard approach for a particular facility is a complete set of safeguards measures and procedures that result from the analysis of some credible diversion strategies, the safeguards goals, the legal framework and external factors or boundary conditions applicable to such facility.

Assuming the traditional IAEA safeguards goals and INFCIRC/153 legal framework, two different sets of boundary conditions are proposed for the example facility in order to compare the arrangements required between the safeguards organizations, State System and facility operator at such facilities, although they have low separative work capacity and small throughput/inventory.

The first set of boundary conditions are typical of R&D facilities, where the operator requests to protect sensitive information until the technological know-how for commercial application has been obtained. As the sensitive information are the size and type of centrifuges and the separative work capacity of each cascade (only the total separative work capacity is declared), the following external conditions can be pointed out:

- Existence of panels restricting the visual access to the centrifuges
- Operational declaration by campaigns.
- No surveillance into the cascade hall.
- No access to the process scales.
- Unannounced access to the cascade hall.
- NDA measurement in the cascade hall.
- Establishment of a perimeter encompassing the F/W Station and cascades hall (large movement of cylinders).

Under these boundary conditions a safeguards approach can be prepared, based on:

- Measures to detect the production of HEU or LEU higher than 5%; swipe samples can be taken at any location where the baseline has been done. Points of the baseline located in the cascade hall can be sampled during unannounced inspections. The remaining points can be sampled at any opportunity.

- Nuclear material accountancy by performing one annual physical inventory verification (PIV) and interim announced inspections quarterly for verifying internal and external flows. Special procedures have been implemented in order to verify adequately the external and internal flow of nuclear material, upper enrichment limit and inventories, although the operational program is declared by campaign. Such procedures assure that declared UF6 cylinders are not connected to the plant or disconnected from the plant without being available for verification

- Unannounced access to the perimeter (cascade hall and connected cylinders at F/W Stations is proposed to verify that the plant operates as declared and that any credible misuse can be discarded. During these inspections the perimeter integrity is verified and NDA measurement are applied to the panels and to any other container existent inside the perimeter.
  The large movement of cylinders through the perimeter boundary excludes the possibility of implementing a permanent perimeter. Because that a transitory perimeter is implemented by C/S measures covering the period of time need by the inspectors to arrive at the perimeter entrance once the unannounced inspection is notified.
  Other activities are addressed to detect signs of undeclared operation or the presence of hidden cylinders behind the panels. NDA measurements are carried out through the panels in the cascade hall to verify that there is no nuclear material accumulated behind the panels.
  In addition, during the access to the F/W station, the inspectors verify that only declared cylinders are connected to the plant. To preserve the information of the separative work capacity of each cascade, a link between the cylinders selected for verification purposes and any particular cascade is avoided.

The panels, the location of the F/W stations into the cascade hall and some concerns/ restrictions from the operator side, introduced a lack of transparency and flexibility that result in a set of heavy inspection activities, long time demanding and less costly effective. Therefore an unannounced inspection at the facility can take more than eight hours.

Changes in the boundary conditions and/or the facility design can introduce important modifications into the safeguards approach allowing the implementation of less intrusive safeguards measures.

A new safeguard approach can be proposed if some boundary conditions are changed.

- If the operator declares the separative work capacity of each cascade, it is possible to implement a random SWU and mass balance as verification measure, based on the availability of a periodical and detailed operational program and on access to the process scales.

- If the F/W stations are fully separated from the cascade hall, there is no movement of cylinders through the perimeter boundary (cascade hall) then a permanent perimeter can replace the transitory perimeter and only NDA measurement related with replacements of centrifuges are necessary.

In this case is easy to observe some immediate advantages regarding the previous approach. The activities during the unannounced inspections demand minimum permanence in the cascade hall. The most time consum activities, like the surveillance review is carried out far away from the cascade hall. In addition, other intrusive activity as verification of the replacements of failing centrifuges can be arranged on planned bases.

Conclusion

Through the example presented in this paper we can observe the impact of the external factor on the facility specific safeguards approaches. While more restrictive external factors had been introduced from the National System / Facility operator side, more intrusive and time demanding will be the verification activities.
The new technologies and the increased reliability of the containment and surveillance systems allow, under cooperative and transparent relations between the Safeguards control organizations (regional or international) and the national system involved, that some concerns from the operator side can be considered. It implies additional costs, time, efforts, new developments and creative mind to find alternative ways to meet the safeguards goals while an appropriate detection capability can be maintained, the installed separative work capacity is small and the proliferation risk very low.
However, when any of these basic conditions change, the safeguard approach should evolve towards more standardize models introducing new elements in order to strengthen any weak point.