Analyzing Information on Nuclear-Related Trade, Industrial Capabilities and Technical Assistance in the Context of Safeguards Implementation and State Evaluation

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Abstract

The analysis of information on a State's nuclear-related trade, industrial capabilities and received technical assistance contributes to the State Evaluation process as well as Safeguards implementation under the State-level concept (SLC), and is an important part of the completeness assessment of the State's declarations under its Safeguards Agreement. This paper discusses the main sources of such information, and the collection and analysis approach in the context of State Evaluation, including the process of comparing and contrasting with information declared by the State. In addition, the results of such analysis combined with the State's declarations constitute the basis of the assessment of the State's nuclear fuel cycle (NFC) capabilities and the time required to complete NFC steps along Pu and/or HEU acquisition paths (known as Acquisition Path Analysis). Analysis of information on a State's nuclear-related trade, industrial capabilities and received technical assistance has a direct impact on the assessed time to complete an acquisition path, and thus influences the type, intensity and frequency of safeguards activities at HQ and in the field.

Introduction

The comprehensive evaluation of all safeguards relevant information is a longstanding element of the IAEA's State-level concept (SLC). [1] As part of this evaluation process, the IAEA's Department of Safeguards conducts analysis on States' nuclear-related trade, industrial capabilities, and received technical assistance (namely, assistance provided to States under the IAEA's Technical Cooperation programme). This report provides a holistic overview of how the IAEA conducts these areas of analysis, expanding on past reports which have focussed on single aspects of such activities; see e.g. Refs [2, 3]

Within the IAEA's Department of Safeguards, efforts to collect, process, and evaluate safeguards relevant information are led by the Division of Safeguards Information Management (SGIM), which provides the Department of Safeguards with services of data processing, secure information distribution, information analysis and knowledge generation necessary to draw independent impartial and credible safeguards conclusions. Evaluation activities are performed by State Evaluation Groups (SEGs), which consist of staff members from the Department of Safeguards' Operations Divisions and SGIM, with the appropriate expertise to evaluate all safeguards relevant information about a State.

Analysis of information on States' nuclear related trade and industrial capabilities

State Evaluation Groups in the Department of Safeguards make use of publicly available trade data sources when analysing safeguards relevant information on States' trade and industrial capabilities. Open source trade data can provide insights into the global trade flows of nuclear-related equipment

and materials, and the underlying industrial capabilities of States as possible users or manufacturers of such goods.

The data utilized is publicly available from statistical and transactional trade databases. While statistical trade data (for example, UN Comtrade) provides insight into the trade flows of commodities between States, transactional trade data (for example, trade records accessible via commercial providers) describe trade transactions between companies. In addition, States and industry may also provide the IAEA with information on nuclear-related procurements of safeguards relevance under a voluntary cooperation mechanism – the IAEA Procurement Outreach Programme.

The Department of Safeguards uses statistical and transactional trade data to monitor trade flows of nuclear-related commodities (particularly nuclear and source material, nuclear reactor components and related non-nuclear materials) and to detect indicators of undeclared exports or imports. Challenges are posed by the varying reliability of the data, which require a careful review and selection of relevant trade records. These challenges are addressed by the application of data automation and visualization tools and by analysis of the data in the context of all other available safeguards-relevant information.

For the analysis of States' industrial capabilities, SGIM uses two complementary approaches. The underpinning principles for these approaches are that they are non-discriminatory and objective; repeatable for evaluation of all States, regardless of the scale of their nuclear programmes; efficient, and effective.

The first approach makes use of statistical trade data to help assess States' general industrial capabilities that could support nuclear fuel cycle (NFC) activities. Trade data provides insight into the general trends and patterns in the trade of products that are indicative of underlying manufacturing capabilities or of the presence of industries which are relevant for the assessments of States' NFC capabilities. To facilitate this analysis, the IAEA and the European Commission have developed a tool: States' nuclear-related industrial capability maps. [4] These maps are based on a basket of industrial commodities in five main product categories (chemicals; high-tech materials; high tech products and equipment; precision manufacturing; and other relevant equipment and materials). The maps use a visual language displaying, among other things, trade balances; the share in world trade; and the revealed comparative advantage of States as exporters and importers of commodities in the industrial capability basket over a five-year period.

The second approach to assessing States' nuclear-related industrial capabilities involves identification in a State of any manufacturers of around 40 technology items which are assessed to be key technological inputs across the nuclear fuel cycle. Manufacturers are identified through online company profiles; tenders; and other sources of trade data. Results are compared for consistency with State-declared information.

The industrial capability maps and manufacturer-based analyses help State Evaluation Groups make informed and comparable assessments of States' NFC-related industrial capabilities.

Analysis of information on planned technical assistance to States

State Evaluation Groups (SEGs) also use information on States' received technical assistance from the IAEA in their evaluations of States' compliance with safeguards obligations. For example, the IAEA's Department of Technical Cooperation (TC) requires States to complete country profiles that summarize their needs and plans for nuclear technology for agricultural, health, industrial and energy purposes and

how they anticipate support from TC can meet those needs. SEGs compare that information with declarations and open source information for their consistency.

In addition, SGIM also evaluates the planned assistance requested by States through TC for:

1. any additional safeguards that might need to be applied according to INFCIRC/267 Annex; [5] and

2. the consistency of planned assistance including equipment, fellowships, and training with information obtained from other sources.

This review process also helps SGIM plan to look for and evaluate safeguards-relevant TC assistance once it is received, after the Board of Governors approves the TC Programme and implementation of the projects begins.

Analysis of information on States' received technical assistance

After a TC project moves into implementation phase, participating IAEA Member States may receive technical assistance via procurements of equipment or other items, fellowships or scientific visits, expert missions, workshops, or training courses. SGIM regularly reviews any technical assistance that was flagged during the review of planned TC assistance (as detailed above). Further, SGIM reviews all completed or in-progress technical assistance received by a State, to identify any assistance that might impact Safeguards in the State (per INFCIRC/267) [5] or may otherwise relate to the State's nuclear fuel cycle. The SEG is informed of any such received technical assistance, and analyzes this information for consistency with all other safeguards-relevant information, to include State declarations, information identified in other Safeguards analyses, and information collected in field activities.

Comparison of trade flows from public sources with information from States' declarations

SGIM recognizes the opportunity and benefits of an integrated analytical approach towards State evaluation between nuclear material trade flow information from public records, and State reporting data under a Comprehensive Safeguards Agreement and Additional Protocol.

As part of the State evaluation process, nuclear material transactions from both sources are corroborated for an extended period – usually five to ten years of historic records. For each material type, a consistency analysis on the multidirectional material movement in a given State is then performed and the trends of the open source trade information and state declarations over that period compared. Significant deviations are highlighted and reported to the Safeguards Evaluation Group.

In traditional analysis, consistency checks happen from a single type of data source. This method, while effective for its purpose, has the danger of leaving blind spots in transnational nuclear material movements. The effectiveness of the integrated approach is in its ability to identify potentially undeclared or incorrectly reported nuclear material transfers.

As an example to demonstrate this approach, the nuclear material accountancy (NMA) reporting of State A in Figure 1 below, if analyzed in isolation, is in balance. From the accurate correlation between trade data and NMA over the 5-year period, the deviation in 2016 has a higher degree of validation. In this case, SGIM would pose to the SEG hypotheses on the possible causes of the deviation, and follow-ups with State A would be initiated by the SEG, if necessary.

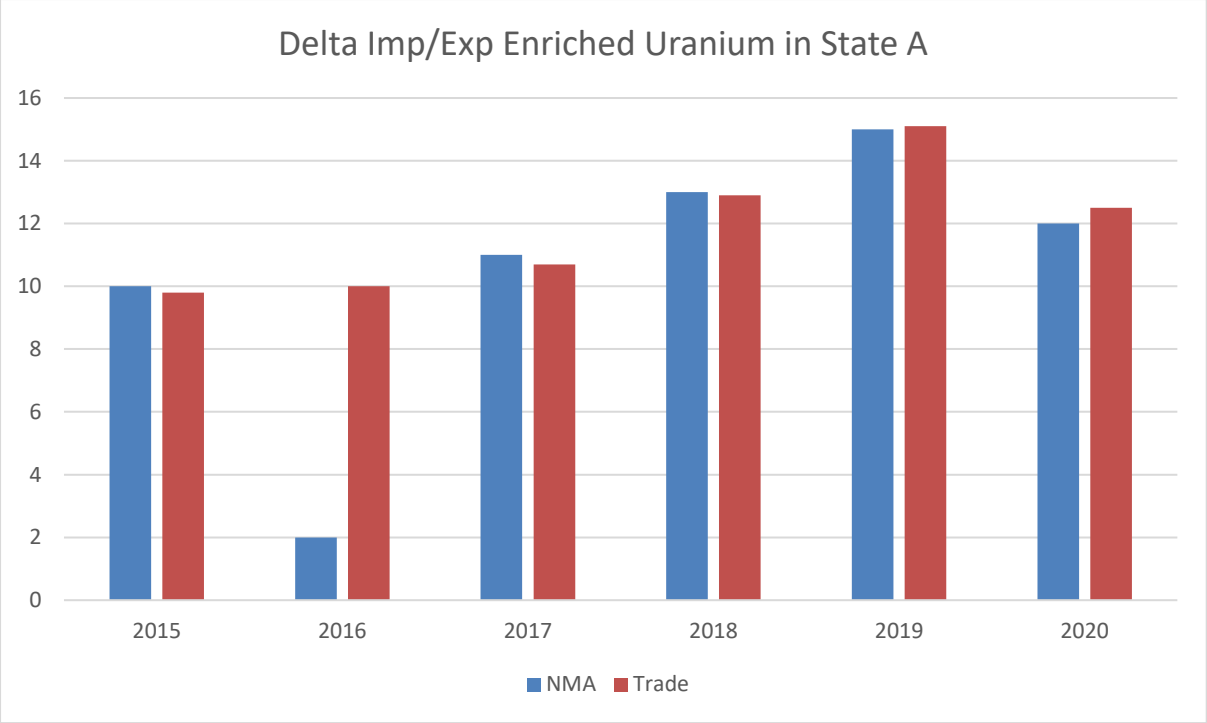

Figure 1. A hypothetical example of the comparison of trade flows reported in public sources with nuclear material accountancy for State A.

Transit matching and resolution of transit matching issues

NPT [1] Transit matching (TM) is the expression used to define IAEA activity to maintain information on transit accounts of nuclear material reported in INFCIRC/153-type format. TM is carried out on both foreign and domestic transfers of nuclear material. It is an important safeguards measure undertaken by the Department of Safeguards towards sound State evaluation. It is performed by matching the corresponding shipments and receipts of nuclear material reported by the States through the inventory change report (ICR) under INFCIRC/153-type safeguards agreements, voluntary offers, and INFCIRC/207. The matches are determined either by the Agency software (automated TM or machine matching) or manually through staff evaluation (human matching). A unique match group identifier is assigned and information on the matches is stored in the database. Other transfer information reported under the Voluntary Reporting Scheme, INFCIRC/153 Article 34(a) and (b), Additional Protocol declarations (Art.2 a.(vi)(b) and (c)) and INFCIRC/66-type agreements can be related or linked to the ICR, but the term TM does not apply since there is no corresponding definition of transit accounts under these reporting arrangements.

In 2020, the Agency received from 49 States[2] and Euratom more than 287 000 ICRs reporting foreign and domestic transfers from which around 90% were machine-matched and 9% were human-matched. Periodically, the Agency sends to the reporting State and its trading partners the semi-annual TM

[1] Treaty on the Non-Proliferation of Nuclear Weapons
[2] And Taiwan, China.

statements[3] and the quarterly import communications[4] listing any unmatched records of the previous periods[5] and requests feedback and resolution of these records. The unmatched records are analysed by the Agency as they may indicate reporting mistakes by the State, reporting delays by the partner State, differences in reporting obligation between States or between facilities/MBAs (material balance areas), or non-obligation in reporting by the partner State. It can also indicate diversion of nuclear material during trade and transport. The result of the TM analysis is used in the evaluation of the consistency and completeness of the import/export declarations by a state. It is a component in the analysis of the flow of nuclear material between facilities/MBAs within a State or flows into/out of a State. TM analysis is also considered when establishing key assessments in the Acquisition Path Analysis and is one of the safeguards measures included in the State Level Approach and in the Annual Implementation Plan. Taking the aforementioned into account, it can be stated that the State will benefit to provide feedback to the Agency to enable the resolution of the TM issues.

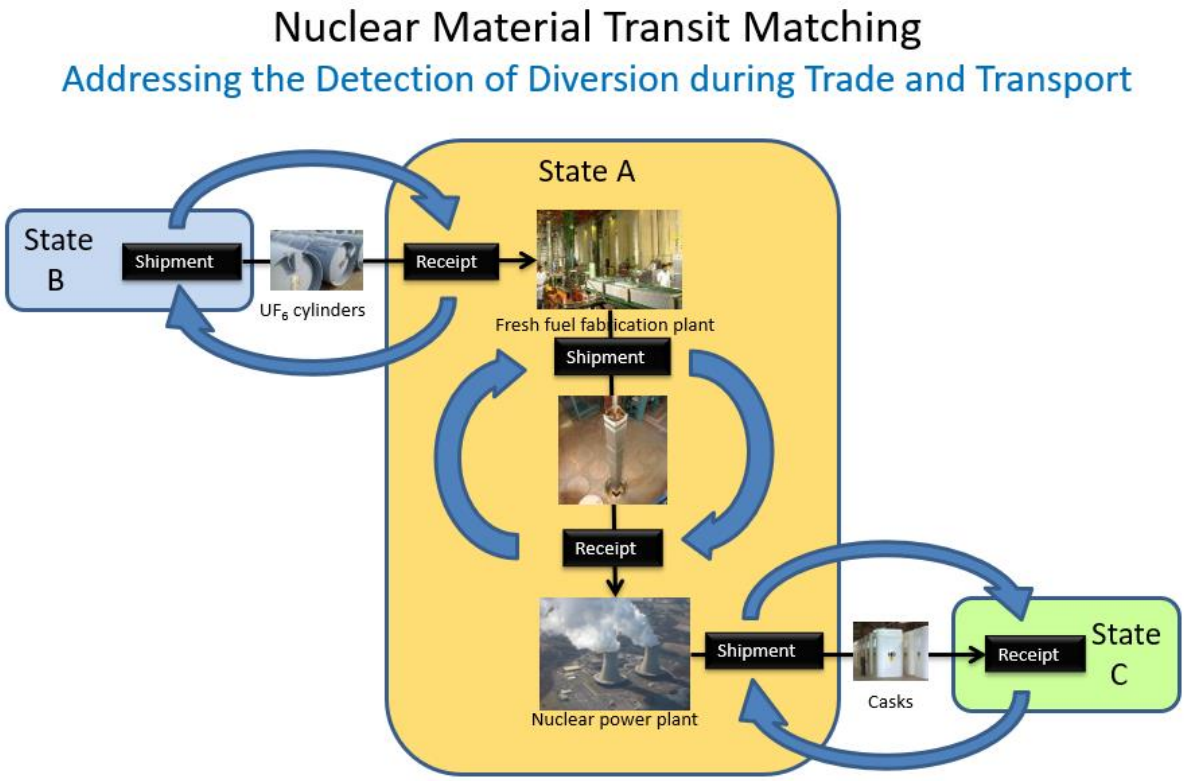

Figure 2. Nuclear material transit matching.

Efforts to overcome Additional Protocol input problems for streamlined comparison of the information with other sources

Since the roll-out of Protocol Reporter 3 (PR3) software in 2016, the majority of States compliant to the Additional Protocol (AP), have started using the software for the preparation of AP declarations.

[3] Subsidiary arrangements Code 4.1.1 requires the Agency to send a semi-annual TM statement to the State.

[4] The 1982 Consultants' meeting recommended to send quarterly import communications to help in the resolution of TM issues.

[5] Unmatched records in the Statement do not include sources, depleted uranium (DU) containers and ICRs with element weight below the established de minimis quantities (DMQ).

PR3 helps to streamline the information of States by structuring the input through distinct input fields or by the use of predefined country specific lookup tables containing facility/LOF (locations outside facilities) codes, site names, etc. which are editable by the user. [6] Higher data granularity was a requirement for an improved input validation tool implemented in PR3 to immediately identify missing obligatory or wrong data or by being guided to provide more information on a more voluntary basis. One example are the specification codes for exports of Annex II items, issued by the Nuclear Suppliers Group (NSG) over the years in amendments to the Trigger list – INFCIRC/254/Rev.2/Part 1, which are not obliged to be submitted as part of an AP declaration but are recommended to be listed if available.

The IAEA has continued to enhance the PR3 software, including to cover different reporting obligations of States, supporting varied domestic AP workflows, and improving user interfaces. A new version of PR3 in the near future will facilitate the handling of legacy data for the annual update.

The use of PR3 guarantees higher quality and increased consistency of data which are crucial prerequisites for analysis and valid data evaluations. In addition, data formatted in PR3 alleviate information extraction and comparison with other data sources.

Countries still using older Protocol Reporter formats or hardcopies to provide their AP declarations are highly encouraged to start using PR3.

Use of information analysis for the purpose of Acquisition Path Analysis

Acquisition Path Analysis (APA) is an analytical methodology used by the Department of Safeguards to assess and identify the technically plausible paths by which a State could hypothetically acquire weapons useable nuclear material. The APA is conducted by State Evaluation Groups. Each acquisition 'step' along an acquisition path has a 'lead-time' to design, demonstrate, develop and deploy NFC technology.[6] The lead-time will be a function of a State's existing NFC infrastructure as well as overall industrial capability. The lead-time together with the subsequent processing time to process nuclear material determines the amount of time to complete an APA step. The optimum combination of each APA step time along an identified path ultimately contributes to the time it takes to complete the entire acquisition path, recognizing that some steps along the path can be initiated/completed in parallel. The optimum combination determines the overall path's time, which will influence the prioritization of technical objectives (TOs) covering the key assessment of an APA step, which in turn will influence the scope, frequency and intensity of verification activities.[7] The formulation and prioritization of TOs is part of the overall development of the State Level Approach (SLA).

In order to assess a State's industrial capability for the APA process, the Agency reviews all available information regarding the State's indigenous capabilities to manufacture nuclear-related industrial infrastructure (technology, materials, equipment, expertise/experience and resources: i.e. items that have been especially designed or prepared for nuclear activities and nuclear-related dual-use items, as specified in Annexes I and II[8] of INFCIRC/540 and in the latest revision of INFCIRC/254/Part 2), including IAEA reports produced using the methodologies outlined above in the section "Analysis of

[6] E.g., APA paths involving the production and separation of Pu would require the deployment of an undeclared reprocessing/hot cell facility or the misuse/repurposing of a pre-existing facility.

[7] Each APA has scenarios and the time needed to complete those scenarios, and TOs are generated to address these scenarios. The minimum total path completion time affects the frequency of inspection for quantity purpose and the intensity respectively.

[8] And as declared under AP Article 2.a.(iv) and 2.a.(ix).

information on States' nuclear related trade and industrial capabilities". The result of this analysis is used to assess the State's ability to indigenously develop an NFC technology, which is linked to the lead-time required for this. The State's industrial capability may vary for different technologies, so each NFC step's technology is evaluated separately when evaluating the relevant APA step. While the declared nuclear infrastructure (past/current R&D and nuclear program) is the determinant factor in this assessment, and the overall NFC-related industrial capability including non-nuclear industry is used as a secondary factor in estimating the lead-time for each NFC step, giving SEGs an opportunity to adjust the lead-time.

Technically and well-founded APA results play an important role and have a direct impact on the allocation of Agency resources both in the field and at HQ. This in turn influences the effectiveness of verification activities and ultimately the Agency conclusions.

Conclusion

The analysis of information on a State's nuclear-related trade, industrial capabilities and received technical assistance contributes to the State Evaluation process as well as Safeguards implementation under the State-Level Concept, and is an important part of the completeness assessment of the State's declarations under its Safeguards Agreement. The analysis is founded on multiple data sources – State declarations, open sources, internal IAEA databases, voluntarily provided information – and requires various expertise and cooperation throughout the Department of Safeguards.

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