Topic: **Systems Concept to Arms Control Verification**

Irmgard Niemeyer, Forschungszentrum Jülich GmbH, Germany, i.niemeyer@fz-juelich.de
Arnold Rezniczek, UBA GmbH, Germany, Rezniczek@uba-gmbh.de
Gotthard Stein, Consultant, Germany, g.stein@fz-juelich.de

One approach towards developing the systems concept to arms control verification has been to explore parallels with the IAEA's State-level concept (SLC) for safeguards.[1] The SLC has recently been advanced as a way to increase the effectiveness and efficiency of safeguards. The SLC sought to address the shortcomings in the traditional approach that focused on verifying the non-diversion of declared nuclear materials at individual nuclear facilities. Instead, by designing a safeguards regime that treats the state as a whole rather than as a collection of unrelated facilities, and by piecing together a broad range of information encompassing declarations, technical monitoring data, and other safeguards-relevant information such as open source, nuclear-related trade, and information from member states' national technical means, it may be possible to provide state-level confidence that commitments are being upheld.

A central component of the SLC is the development of a customized State-level safeguards approach (SLA), which describes the process for planning safeguards activities within a state. The SLA is comprised of three elements: 1) Analyzing plausible acquisition paths, 2) Establishing and prioritizing technical objectives, 3) Identifying applicable safeguards measures to address the technical objectives.

The acquisition paths to be considered under IAEA safeguards can be identified, visualized and analyzed in terms of their attractiveness.[2] However, for assessing potential cheating pathways, the model developed for safeguards needs to be extended. While the acquisition path analysis (APA) focuses on the sequence of activities which a State could consider to acquire weapons usable material, potential cheating paths also need to include number and types of warheads, both in storage and deployed, and number and types of the delivery systems. Figure 1 shows a first attempt to develop a physical model in the context of arms control.

Taking one of the model states used in two workshops on the application of a systems concept to arms control verfication[3] as example, potential cheating pathways were identified and analyzed. While the workshop scenario included mainly information on the military installations and capacities of the two model states, the civil nuclear fuel cycle (NFC) was assumed to be similar to the NFC of a well-known advanced industrialized country.

More than 400.000 technically plausible cheating paths were identified. Paths 1 to 6 cover the military domain only (see for example Figure2), while the first path including diversion from civilian facility ranks no. 31. The most attractive path including misuse of civilian enrichment comes with path 64 and the most attractive path including misuse of civilian reprocessing with path 91.

Verification objectives need to be specifically identified for arms control treaties, in order for the systems approach to be applied correctly. The IAEA has a well-defined "significant quantity" concept around which an APA can be organized; safeguards measures are designed to be capable of detecting the diversion of one significant quantity of material within four weeks of diversion.

It is also important to define a significant quantity of the controlled item in such a way that declarations made about it in relation to the treaty can be verified effectively. Because of the secrecy surrounding weapons systems, verifying that an item declared to be a weapon is a

---

[1] Please see also the position statement by Chen et al.

[2] Listner, C., Murphy, C.L., Canty, M.J., Stein, G., Reznicezek, A. & I. Niemeyer (2015): Acquisition Path Analysis Quantified - Shaping the Success of the IAEA's State-level Concept, JNMM (in print)

[3] Chen, C., Dreicer, M., Allen, K., Niemeyer, I., Listner, C. & G. Stein (2015): Developing a Systems Approach to Arms Control Verification – Results from the ESARDA Verification Technologies & Methodologies (VTM) Working Group Workshop. In: Proc. 56th INMM Annual Meeting, Indian Wells, July 12 – 16, 2015

weapon (and that it is in the declared status of deployment) could be challenging. Therefore definitions of category of weapon by deployment status (e.g. deployed or non-deployed, in reserve, inactive, disassembled, or weapon component) should be framed in a verifiable way, which also allows items that are declared as none of those categories to be verified as 'none of the above'. Significant detail concerning the activities of the nuclear enterprise and locations of declared weapons may need to be shared, and updates exchanged regularly, to facilitate verification of deployment status.

Systems level analysis, including acquisition path analysis can provide clear verification objectives for site visits based upon information already provided by the inspected state. Clear verification objectives may enable managed access procedures to be defined that met those objectives whilst protecting sensitive information.

The challenges associated with the protection of national security and non-proliferation information must be taken into account as a realistic physical model is developed that incorporates further intrusiveness. Existing ideas for managing access for routine and challenge inspections or new ideas will need to be considered. Verification that declared items are situated in their declared location may prove to be a relatively traditional matter of accounting, assuming suitable managed access procedures can be developed. In contrast, verifying the absence of undeclared items, either in declared facilities or undeclared facilities, could be perceived to be an onerous task. Nevertheless, early priorities in this area could focus of ensuring undeclared items cannot successfully be mated with delivery systems and there are parallels following this approach to verifying the absence of warheads on delivery systems as accomplished under NEW START at present.

Any advancement in arms reductions and disarmament is likely to proceed in a step-by-step way. Bilateral agreements are likely to provide the steps that will pave the way for more multilateral implementation. For example, future US/Russia disarmament treaties limiting warhead numbers may build the infrastructure for facility monitoring and inspection activities, and transparency and confidence-building measures amongst the de-facto nuclear weapons states may provide capital for more intrusive monitoring activities. Such a state-level methodology could help inform the direction of future negotiations, present day technology R&D, and assessment of possible effective verification regimes.

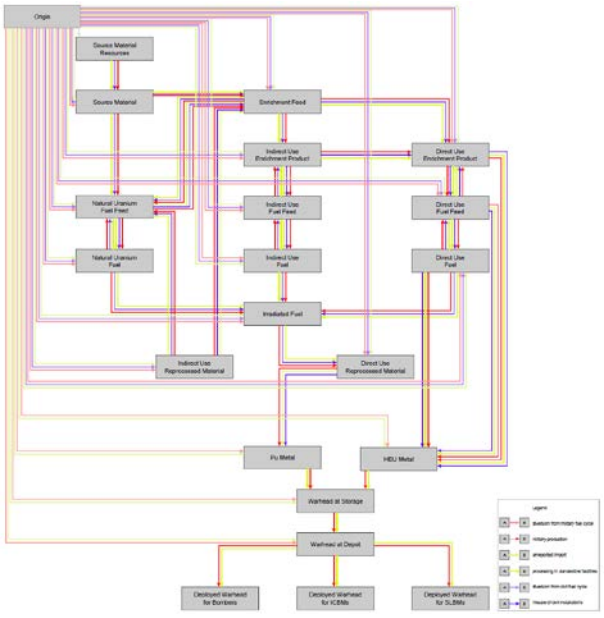

Figure 1: Adapted physical model

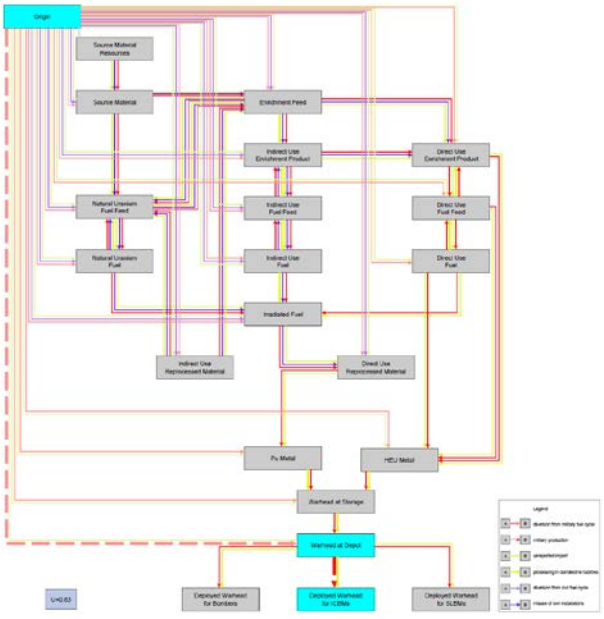

Figure 2: Most attractive cheating path