

# VERIFICATION RESEARCH, TRAINING AND INFORMATION CENTRE

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## **SUPPORTING MULTILATERAL DISARMAMENT VERIFICATION**

### **NPT Review Conference Presentation: Supply and Demand for Multilateral Verification of Disarmament**

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#### **Technical work under the project**

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The final presentation of the day will focus on the practical work we are presently conducting at VERTIC. Our work has had two main aspects. First, we've been busy assembling a project group, which has had a guiding role on our internal work, which is the other aspect. Our work has been focusing on both policy and technical issues of multilateral disarmament verification.

The project group comprised 52 researchers from eight countries and one intergovernmental organisation. It met six times in various compositions since 2012. To date, about 40 various working papers have been presented to these meetings. Those papers, as well as the meetings themselves, have been kept in complete privacy in order to enable and encourage free debate on the issues under discussion, but we do intend to summarise and publish them in some sort of a research compendium later this year.

Three non-governmental organisations participated. The Institute for Security Studies, based in South Africa, has been an exceptionally valuable partner, and so has the Vienna Centre for Disarmament and Non-Proliferation. Wilton Park, an executive agency of the UK Foreign & Commonwealth Office, has also helped organise a series of conferences on multilateral verification.

As Larry noted, our ongoing survey work has provided valuable insights into the demand for multilateral verification of disarmament. This demand is quite real. Satisfying it will require a broad set of tools for the international community to draw upon, including equipment and scientific techniques, as well as procedures to organise the verification process and legal agreements.

Our practical work under this project aims to identify which of these tools are currently available, to review their application, and to support the development of new ones that may be needed for future verification challenges.

Understanding the gap between supply and demand in multilateral verification of disarmament will also allow us to explore the current capacity of the IAEA, and its ability to play a leading role in nuclear disarmament verification. It will also help us to build capacity among the agency's member states, especially the non-nuclear weapons states, for them to better contribute to the debate on disarmament verification.

We organised the project into four distinct work streams:



1. Nuclear fuel cycle modelling.
2. Scenario development.
3. Verification solutions.
4. Equipment.

## Nuclear fuel cycle modelling

A significant portion of work performed under this project has focused on nuclear fuel cycle modelling. The idea is simple: We wanted to create a virtual environment onto which verification solutions could be examined and tested. These environments provide a set of boundary conditions for our examination, which enables us to validate our solutions.

Our efforts focused on creating a model of a fictional nuclear weapons-state on the brink of disarming, including information on its arsenal, its nuclear infrastructure, and the geopolitical context that led it to develop, and eventually relinquish, its nuclear weapons. Working in this detailed and comprehensive fictional environment, participants in our future simulations will be able to identify practical and specific problems concerning the verification of nuclear disarmament, and develop solutions applying a range of political, legal and technical tools. This model can be used to inform both table-top exercises, and virtual reality applications.

One of the central features of the model is a detailed account of the nuclear arsenal of our surrogate nuclear weapons-state. Drawing only on unclassified, publicly available sources, we have charted the full history of the state's development of nuclear weapons, from its initial proliferation efforts, through to its weaponisation research and its deployment of a diverse range of weapons. We have provided estimates, again based on open-source assessments, of the fissile content of the different kinds of warheads, as well as an overview of their main non-fissile components. These details are necessary to model the weapon dismantlement process, and to test ways in which to verify it.

Knowing the number of deployed and stockpiled weapons is also important, as it allows us to better understand the time frame of the disarmament endeavour—as well as examining solutions to the problem of *undeclared* weapons or material.

Verification, however, goes beyond the process of weapons dismantlement, and in order to capture that, our model also covers the surrogate state's nuclear infrastructure. We have strived to make it as detailed and believable as possible, basing it on extensive research into the historical development of nuclear science and technology in different countries. We have created maps and schematics for the facilities connected to the state's nuclear fuel cycle, and for the larger sites that host them. These include facilities such as centrifuge enrichment halls, nuclear reactors, as well as the weapons assembly plants. These have been developed to the best of our knowledge, drawing from what is known of different real world examples.

Most importantly, our nuclear infrastructure model is not limited to the maps and schematics of the facilities, but includes crucial information on the flow of nuclear materials. Starting from the launch of the very first nuclear facility in our fictional state, we are able to generate accurate material flow data covering every year of operations, and every facility, from the state's uranium mines to its weapons storage and

long-term nuclear waste stockpiling. To do so, we have used some of the best professional software currently available, such as Oak Ridge's SCALE software package for modelling nuclear reactors. We have also ensured that operational parameters were always consistent with technology available at that point of time. VERTIC has already tested this approach on different fictional states, possessing different nuclear infrastructures, and we are currently in the process of completing and fine-tuning the model that will be used in our future simulations.

By providing this level of detail, our simulations will enable participants to tackle wider issues related to disarmament verification. These include securing stockpiles and potential sources of weapons-usable material throughout the fuel cycle, ensuring that the disarmament process cannot easily be reversed, and evaluating the impact bringing formerly unsafeguarded facilities under control would have on the IAEA Safeguards system.

#### Scenario development:

The complexities of nuclear disarmament, however, are not limited to technical considerations. In any real world situation, much would also depend on the precise provisions of a disarmament agreement, and on the structure and contents of a verification protocol. Documents of this kind require a great effort of drafting and preparation, and could not be produced in a single simulation: because of this reason, we have decided to provide the full text of a possible disarmament agreement, already in force in our fictional simulation, and the full first draft of a verification protocol. This approach has the additional advantage of providing participants with the big picture, allowing them to focus on practical issues.

To construct the two agreements, we have used the structure of applicable treaties in the nuclear sector and beyond, in order to identify key provisions and formulations. For the disarmament agreement, we have drawn upon partial disarmament treaties, conventions banning other kinds of weapons, and treaties establishing nuclear weapons-free zones. Our primary intention was to produce a document that was tailored to the fictional geopolitical background we have established, and to set down the terms of disarmament in a clear and rigorous way, that also reads as a viable text. This approach has also guided our work on the verification agreement, which we have supplemented with our expertise in verification techniques, and with the insights drawn from experiences such as the UK-Norway Initiative.

Obviously, we will have to carefully review the contents of the 'P-5 Glossary of Key Nuclear Terms' and perhaps include this language in our simulations, should we consider it workable.

#### Verification solutions:

All of our work in crafting this model has been guided by the idea of setting down the key variables of a disarmament situation, in order to break the larger problem of disarmament verification into a set of smaller challenges, for which solutions could be proposed and tested. This has also been our guiding principle when planning the future simulations that will be underpinned by the model. For this reason, we have devised a series of stages to the general process of disarming a state of its nuclear weapons, and we have designed specific simulations for each stage.

The first simulation will reproduce the negotiation of a verification agreement, laying down the scope and limits of the verification activities, and defining in precise terms what inspectors are and are not allowed to

do. Participants will take the role of negotiators from the state parties to the disarmament agreements, and envoys from the IAEA. They will then discuss the first draft of the verification agreement and negotiate the final formulation of some of its points.

Later simulations will use the verification agreement, as finalised during the first stage, and apply it to the surrogate state's nuclear infrastructure. This stage is the one that could benefit most from Virtual Reality applications, allowing participants to navigate a 3D model of a nuclear facility, or it could be run as a tabletop simulation, using the maps and schematics provided. Given the vast range of activities included under a disarmament campaign, different iterations of this simulation could focus on developing and testing verification techniques for specific facilities, further dividing the wider problem in its fundamental components.

### Equipment

Our equipment work stream aims to identify specific design requirements for equipment to be used in multilateral verification of disarmament. Verification procedures involve the use of a wide and diverse range of different technological instruments. While many of these are currently available, even through commercial channels, using these instruments inside nuclear facilities to verify materials that may have classified or proliferation-sensitive attributes presents a unique set of challenges, which need to be addressed ahead of time.

The first specific challenge, well-known across the arms control community, is that equipment must capture data of sufficient quality and accuracy to be useful to inspectors, while not revealing proliferative or sensitive information.

The second challenge is that this equipment will have to be built to exacting standards, to satisfy different sets of constraints. Operating on the field, and in facilities where hazardous materials such as fissile material and high explosives are handled, will impose stringent safety and security requirements to the equipment.

Our goal is to analyse and consolidate this broad range of constraints and requirements, and use it to guide research in future verification instruments. These requirements can be used during our simulations, as an additional resource that our participants can draw upon when developing verification solutions, as well as beyond that, for example in an analysis of the equipment most commonly used in the field at this time.

### Conclusion

As I have demonstrated in this presentation, the practical work under this project has been heavily invested in creating new tools and methodologies for identifying current and future challenges to the multilateral verification of nuclear disarmament. We believe tackling these challenges and demonstrating the feasibility of multilateral verification of disarmament is a key step in building support for it across the international community.

For this to happen, it is essential for all IAEA member states to be involved in the debate, and our goal is to support and to encourage all non-nuclear weapons states to engage with these issues. Our simulation series covering the different aspects of multilateral verification of nuclear disarmament aims to include expertise

from different countries, and to use them to gain new insights on the matter. These simulations may start later this year. For these reasons, I invite you all to join our future work.