



# **Building a Nuclear Disarmament Verification Tool Kit**

Phase III Interim Report of the International Partnership for Nuclear Disarmament  
Verification

February 2022



Established in 2014 with support from more than 25 countries, with and without nuclear weapons, the International Partnership for Nuclear Disarmament Verification (IPNDV) began the third phase of its work in January 2020. Continuing to emphasize the shift from “paper to practice,” it has combined analytic work and exercises to advance the goals of developing, testing, evaluating, and refining concepts and approaches that can help build a tool kit for future nuclear disarmament verification. Phase III continues to reinforce the judgment from the first two phases that multilateral nuclear disarmament verification should be possible while protecting sensitive information. Over four days from November 29 to December 2, 2021, the Partners held an Interim Review to take stock of the work done since the launch of Phase III in January 2020. They reviewed this work with an eye toward refining their Programme of Work and setting work streams and priorities for the remainder of Phase III. This report highlights the accomplishments of the past two years and the direction of the Partnership going forward.

**Key Judgment of Phase I**

Although tough challenges remain, potentially applicable technologies, information barriers, and inspection procedures provide a path forward that should make possible multilaterally monitored nuclear warhead dismantlement while successfully managing safety, security, non-proliferation, and classification concerns in a future nuclear disarmament agreement.

## Shifting to Scenario-Based Analysis

Phase III began by establishing a Scenario Task Force to develop a detailed nuclear disarmament scenario. Known as the “Ipindovia scenario,” it comprised:



Figure 1. Ipindovia and Its Nuclear Sites

- A notional nuclear weapon possessing state—Ipindovia (Figure 1)—with a comprehensive nuclear weapon posture and infrastructure; and
- An illustrative Nuclear Weapon Reduction Treaty (NWRT) framework, which outlines:
  - Ipindovia’s obligation to reduce and dismantle, under multilateral verification, 500 of 1,000 weapons in its existing arsenal; and
  - A set of notional verification provisions to be conducted by a Multi-State Verification Body (MSVB).

Consistent with this scenario-based approach, Phase III also established an Inspector Task Group and a Host Task Group to better identify the unique perspectives of inspectors and hosts in nuclear disarmament verification. At the same time, Phase III established a Technology Track, both to independently assess technology options under the Ipindovia scenario and to bring a technology perspective to the work of each of the Task Groups by imbedding technology experts into those groups.

## **Refining Understanding of Inspector and Host Perspectives in Nuclear Disarmament Verification**

Both the analytic work of the Inspector and Host Task Groups and the exercises conducted using the Ipindovia scenario during the initial period of Phase III confirmed that both inspectors and hosts shared complementary goals. The inspectors wanted to confirm Ipindovia's compliance with its disarmament obligations; the hosts wanted to demonstrate Ipindovia's compliance in a safe, efficient, and cost-effective manner. At the same time, Phase III's work also highlighted the importance of balancing the differing perspectives of inspectors and hosts on specific verification issues and decisions.

In particular, within the Ipindovia disarmament scenario, inspectors placed greater emphasis on verifying not only the "correctness" of Ipindovia's declarations of nuclear weapons and infrastructure but also the completeness of such declarations. In other words, the inspectors proposed inspection activities from the very start to verify both the total inventory of Ipindovia's nuclear weapons as well as the absence of undeclared weapons or sites. For example, they sought routine access not only to active nuclear weapon sites in Ipindovia but also to former nuclear-weapon related sites. For their part, the hosts placed somewhat greater emphasis on protecting sensitive information, minimizing operational disruptions, and ensuring safety and security of personnel (including inspectors) at facilities subject to inspections. Thus, they argued that inspections should begin with declared nuclear weapon sites and that any access to former nuclear weapon sites should only take place later in the implementation process and even then, only on an ad hoc basis.

Declarations will play a central role in providing the framework for future nuclear disarmament verification. Phase III validated the Partnership's earlier breakdown among initial, baseline, and periodic declarations of treaty-accountable items and facilities as well as notifications of many specific types of activities for nuclear disarmament verification. Analysis and exercises also deepened understanding of the possible content of specific disarmament declarations. That work again revealed differences between inspectors and hosts with regard to the scope, level of detail, and timing of declarations.

## **Testing Monitoring and Inspection Concepts through Exercises**

In two exercises conducted in December 2020 and June 2021, the Partnership tested and evaluated monitoring and inspection concepts developed in Phases I and II. It used both the Ipindovia scenario and the framework of the 14-step model of the nuclear warhead dismantlement process developed in earlier phases (Figure 2). This work underscores the commitment of the Partnership to put its work into practice through realistic scenarios and hands-on activities.

### The 14 STEPS: IPNDV's Nuclear Weapons Dismantlement Lifecycle

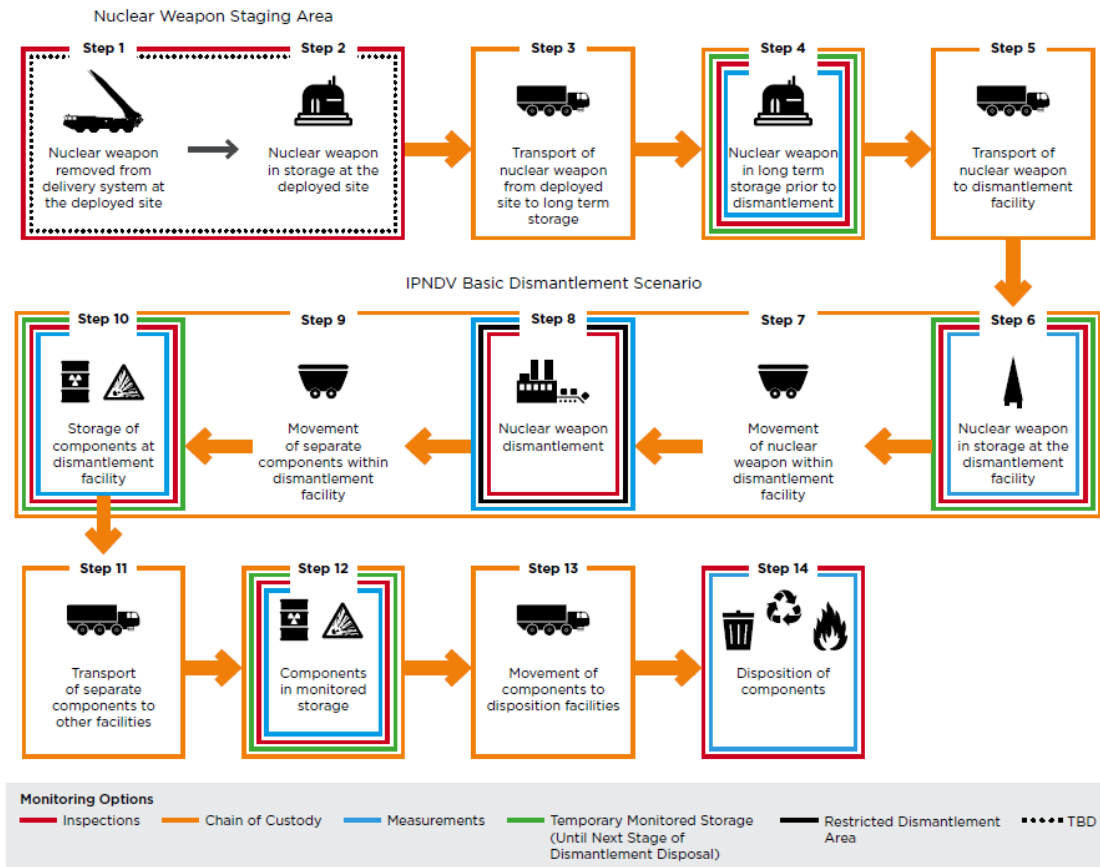


Figure 2. 14-Step Nuclear Dismantlement Model

In the first exercise, the December 2020 “Verification Planning Exercise,” Partners explored similarities and differences in the perspectives of inspectors and hosts while planning the start of an inspection regime, and the implementation of the verification provisions identified in the notional NWRT. The second exercise, the June 2021 “Dismantlement Inspection Exercise,” addressed verification of the removal, transport, and subsequent placement in on-base storage of a warhead from one of Ipindovia’s road-mobile intercontinental ballistic missiles (Steps 1 and 2 of the 14-step model). Participants drew on various processes, procedures, techniques, and technologies identified by the Partners in Phases I and II to complete specific monitoring and inspection tasks. In addition, the French-German Nuclear Disarmament Verification Exercise (NuDiVe) exercise, carried out at the end of Phase II but evaluated during Phase III, tested IPNDV monitoring and inspection concepts and approaches for the dismantlement of a nuclear warhead (Step 8 of the 14-step model).

These exercises validated the basic concepts and approaches in the IPNDV tool kit for the steps in question. At the same time, they also helped to identify issues related to the implementation of specific monitoring and inspection concepts. The exercises also underlined the different perspectives of inspectors and hosts, while suggesting ways to balance those differences. Finally, the exercises pointed to the importance of carrying forward the work already done in IPNDV to develop and refine a systems approach to nuclear disarmament verification. Such an approach would support, for example, the application of specific monitoring and inspection procedures, processes, techniques, and technologies at a given step in the dismantlement process as well as trade-offs across the overall process.

<b>Monitoring and Inspection Concepts Tested</b>
<ul style="list-style-type: none"><li>• Declarations and notifications</li><li>• Chain of custody, including use of unique identifiers, tags, and seals</li><li>• Containment and surveillance, including perimeter portal monitoring and closed-circuit TV (CCTV)</li><li>• Technical measurements (e.g., radiation detection)</li><li>• Visual observations</li></ul>

## Familiarization with Nuclear Sites

The exercises conducted in Phase III highlighted the importance for both inspectors and hosts of detailed familiarization with the types of nuclear weapon sites to be inspected as well as other



nuclear-weapons related activities. To that end, briefings on actual inspection processes under the START and New START treaties were provided to Partners. In addition, the Inspector Task Group did tabletop “walkthroughs” of a notional nuclear weapons base. Once in-person activities resume, it also will be possible to resume periodic site visits, as occurred in the earlier visit to the former nuclear weapon base at RAF Honington in the United Kingdom (Figure 3).

Figure 3. Visit to UK RAF Honington

## Developing and Refining Principles for Managed Access

### Examples of Managed Access Practices

- Use of shrouds, covers, and other means to protect sensitive information
- Limits on visual observation by inspectors (e.g., dedicated locations)
- No direct visual observation of nuclear warheads
- Restrictions on direct physical contact by inspectors
- Limits on size of inspection teams and time for access
- Limits on inspection equipment

Earlier phases of IPNDV’s work underlined the role of managed access principles and practices to help ensure that inspectors could carry out their tasks without access to proliferation-sensitive or other sensitive information. As part of preparation for the June 2021 exercise, the Partners developed a set of such managed access procedures. These principles and procedures were then tested in the June 2021 Dismantlement Inspection Exercise. Once again, a key insight concerned the need for additional thinking about not only the basic principles and practices, but their implementation under the specific conditions of the Ipindovia scenario.

## Evaluating Technologies for Nuclear Disarmament Verification

From supporting chain of custody to confirming the dismantlement of a nuclear warhead, technology can play an important role in the verification of nuclear disarmament. Since the start of Phase III, the IPNDV Technology Track evaluated the data from the measurement campaign hosted by Belgium in September 2019. The Belgian measurement campaign tested technology options to detect the presence or absence of plutonium, one type of fissile material that can be used in nuclear weapons. In an important finding, the Technology Track experts confirmed the potential effectiveness of technologies tested for the measurement of plutonium.

### Verification Technology Areas Evaluated by Technology Track

- Tags, seals, and unique identifiers
- Radiation measurement
- Perimeter portal monitoring
- CCTV

In addition, the Technology Track reviewed other technologies and confirmed the adequacy of the IPNDV Technology Data Sheets developed for those technologies related to nuclear disarmament verification in Phase II. Its work also provided greater insights into some of the technical challenges faced in effective and verifiable nuclear warhead dismantlement and options to meet those challenges. At the same time, it highlighted the importance of more detailed work in several areas, including “information barrier” technologies and approaches designed to provide general results of measurements while protecting sensitive information, CCTV technologies, and technologies for detecting highly enriched uranium. Still another area identified for further work is the possibility of “low measurement approaches” with less reliance on complex technology and more reliance on other monitoring and inspection tools.

## Sustaining Outreach across Communities

The IPNDV organized two panel discussions during the 2021 Institute of Nuclear Materials Management/European Safeguards Research and Development Association (INMM/ESARDA) conference: the first panel featured technology presentations from IPNDV members derived from the 2019 Belgian measurement campaign, and the second panel gave an overview of the Partnership, covering themes of technology and the future of nuclear disarmament verification. In addition, on September 29 and 30, 2021, IPNDV hosted a public virtual symposium on “Innovations in Nuclear Disarmament Verification” in which senior leaders and IPNDV experts presented the Partnership’s accomplishments since its establishment in 2014.

## Thinking Strategically about Nuclear Disarmament Verification

### Moving Toward Thinking Strategically

- Monitoring and inspection activities at multiple sites, for multiple warheads, and multiple processes
- Statewide verification of disarmament obligations
- Extended time period with repeated inspection visits
- Applying a Systems Approach

So far in Phase III, even as the Partners focused on testing the application of verification concepts and approaches in discrete steps of the Ipindovia scenario, they also highlighted the importance of thinking strategically about nuclear disarmament verification. Still using the Ipindovia scenario, this strategic thinking would complement the focus on individual steps in the 14-step model with a broader focus on verifying Ipindovia’s overall obligation to reduce and eliminate 500 nuclear warheads. During its Interim Review, the Partners identified a number of ways do so.

## Looking Ahead in Phase III of the Partnership

As Phase III continues, the IPNDV will continue to emphasize its shift from paper to practice. Through analytic work and exercises, it will dive deeper into developing and testing concepts and approaches for nuclear disarmament verification. Building on the evaluation of NuDiVe 2019, a modified multilateral NuDiVe exercise is planned for 2022. Some specific priorities will include capturing what is being learned through a guidebook of operational concepts for inspections (CONOPs), designing the next technology measurement campaign, and building toward a strategic focus on the overall nuclear disarmament process. The Tables 1 and 2 below summarize potential priorities going forward in different “baskets” of Partnership work.

## Appendix

<b>Phase III Going Forward – Baskets of Activities and Possible Initial Elements</b>
<b>Basket 1: Exercises (Initially Steps 3-4, Transport and Long-term Storage – building on lessons learned from June 2021 Steps 1-2 exercise)</b>
Initial exercise design, including specific objectives, structure, inspection history, lessons learned from past exercises
<ul style="list-style-type: none"><li>• Specify verification regime for Steps 3-4 (building on Phase II and lessons from June 2021 exercise)<ul style="list-style-type: none"><li>⇒ Declarations and notifications</li><li>⇒ Inspection and managed access provisions</li><li>⇒ Technologies applications</li></ul></li><li>• Pre-Exercise preparations by inspectors and host</li><li>• Familiarization activities – sites, related verification regimes</li><li>• Develop inspector and host plans to optimize verification methods</li><li>• Design sampling plans</li><li>• Develop communication plans and strategies</li><li>• Develop criteria for evaluating inspection process (host and inspector perspectives)</li><li>• Technology options familiarization</li><li>• Technology authentication issues</li><li>• Exercise</li></ul>
<ul style="list-style-type: none"><li>• Post-exercise assessment and write-up</li><li>• Application of evaluation criteria</li></ul>

<b>Phase III Going Forward – Baskets of Activities and Possible Initial Elements (2)</b>
<b>Basket 2: Thinking Strategically and Conceptually</b>
<ul style="list-style-type: none"><li>• Concept development<ul style="list-style-type: none"><li>⇒ What do we mean by “Thinking Strategically and Conceptually?”</li><li>⇒ Options for going beyond “single warhead, single site” approach<ul style="list-style-type: none"><li>– Multiple sites, single/ multiple warheads, different processes;</li><li>– Multiple warheads, single site, multiple visits;</li></ul></li></ul></li></ul>



<ul style="list-style-type: none"> <li>– Longer time period</li> </ul> <p>⇒ State-wide verification</p>
<ul style="list-style-type: none"> <li>• Completeness Issues <ul style="list-style-type: none"> <li>⇒ Concept development <ul style="list-style-type: none"> <li>– Definitions</li> <li>– Approaches, including role of declarations</li> </ul> </li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>• Approaches to balance host and inspector perspectives on correctness and completeness – building on December 2020 exercise</li> </ul>
<ul style="list-style-type: none"> <li>• Learning from other verification regimes (IAEA State-wide approach, New START)</li> </ul>
<ul style="list-style-type: none"> <li>• Systems Approach <ul style="list-style-type: none"> <li>⇒ Continued concept development</li> <li>⇒ Case studies, e.g., application of monitoring and inspection PPTT in a specific step</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>• Revisit Step 14 and disposition of fissile material from dismantled warheads</li> </ul>

<b>Phase III Going Forward – Baskets of Activities and Possible Initial Elements (3)</b>
<b>Basket 3: Technology Assessment and Application</b>
<ul style="list-style-type: none"> <li>• Technology measurement campaigns <ul style="list-style-type: none"> <li>⇒ Choice of technology to test, e.g., HEU, active neutron interrogation, directional sources of radiation</li> <li>⇒ Design of campaign</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>• Technology User’s Guides/Manual/Updated Technology Tables -- from practical user focus</li> </ul>
<ul style="list-style-type: none"> <li>• Low measurement options to verify compliance (compared to “tech heavy” approach)</li> </ul>
<ul style="list-style-type: none"> <li>• Information Barriers -- approaches-technologies-CONOPS</li> </ul>
<ul style="list-style-type: none"> <li>• Absence measurements <ul style="list-style-type: none"> <li>⇒ Country-wide</li> <li>⇒ Site-wide</li> <li>⇒ Room on a site</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>• Authentication of equipment issues and approaches</li> </ul>
<ul style="list-style-type: none"> <li>• Detecting high explosives</li> </ul>

### Phase III Going Forward – Baskets of Activities and Initial Elements (4)

#### Basket 4: Knowledge management and engagement within Partnership

- Building a guidebook of operational concepts for inspections (CONOPs) -- knowledge learned from past activities for inspections
- Maintain and embed IPNDV knowledge in specific activities
- Engagement within the Partnership and to new members via:
  - ⇒ Welcome packet – IPNDV 101
  - ⇒ Briefings for new members on expectations, experience sets needed
  - ⇒ Newsletter
  - ⇒ Products for non-technical members
- Broadening participation by existing Partners in exercises and other activities

### Phase III Going Forward – Baskets of Activities and Possible Initial Elements (5)

#### Basket 5: Outreach

- Promote IPNDV work and outcomes via outreach
  - ⇒ Presentations to technical and non-technical communities
  - ⇒ Engage Group of Governmental Experts on Verification (GGE), including Chair of GGE
  - ⇒ Quarterly briefings for stakeholders working nuclear disarmament verification
- Use IPNDV as a platform to bring together initiatives in this area to discuss ideas/areas of work – begin with presentations on NuDiVe 2019, Belgian Measurement Campaign
- Broaden participation in IPNDV
  - ⇒ Under-represented and non-represented regions
  - ⇒ Other countries with nuclear weapons
- Invite observers to exercises

## About IPNDV the International Partnership for Nuclear Disarmament Verification

The International Partnership for Nuclear Disarmament Verification (IPNDV), through a unique public-private partnership between the U.S. Department of State and the Nuclear Threat Initiative, brings together more than 25 countries with and without nuclear weapons. In this ongoing initiative, the partners are identifying challenges associated with nuclear disarmament verification, and developing potential procedures and technologies to address those challenges. Learn more at [www.ipndv.org](http://www.ipndv.org).