Contents

Working Group 4 Deliverable
Part I. Introduction to the Verification of Nuclear Weapons Declarations

Working Group 4: Verification of Nuclear Weapons Declarations

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Abstract

This paper introduces the work of Phase II of the IPNDV's Working Group 4 (WG4). We put forward the key questions we attempted to answer while working on verifying nuclear weapons declarations. This report includes how declarations fit into the disarmament context and identifies multiple different declarations that will be required during different stages of disarmament. By understanding this context and the requirements for declarations, we provide a more thorough and targeted approach to understanding how they may be verified. We set out the principles and objectives of verifying these declarations, as well as the process of verifying them. We also set out certain types of declarations that will be particularly critical, and their associated data and on-site inspection requirements. Finally, in order to focus the work of the group, we set out a generic scenario under which an initial declaration is made on the number of nuclear weapons in a State. This scenario is used by the group to elaborate in more detail how such a declaration could be verified. The results of this more detailed work are detailed in our other papers. To enable a full understanding of all of our papers, we included a short list of frequently used terms.

Introduction to the Work of Working Group 4

Based on the IPNDV Phase II program of work, Working Group 4 (WG4) has explored how to verify a declaration of a number of nuclear weapons in a State, identifying the different questions and challenges that materialize when attempting to do so. It has also elaborated multiple options relating to verifying nuclear weapons numbers that could be of use to future negotiators.

The challenge of verifying nuclear weapons numbers raises questions such as:

- What types of declarations are necessary to determine the number of nuclear weapons in a State or location, and the differences between declarations to establish a baseline and for long-term monitoring?
- What should be the scope of the required verification regime (including how to ensure balance among the principles of effectiveness, efficiency, confidence building, and non-interference)?
- What types of declarations, documentation, and supporting information should be expected as part of inspection and monitoring under a nuclear disarmament agreement and what challenges do specific nuclear sites have?
- How to confirm items are as declared under an agreement, but even more complicated, can we establish the absence of undeclared nuclear weapons, especially in an entire State?
- How to verify numbers and status when access to all systems may not be timely?
- How to keep track of numbers over many years, including when systems are refurbished and replaced?

To answer such questions, WG4 has looked to existing verification regimes, which offer many valuable lessons and good practices. WG4 analyzed verification mechanisms of the International Atomic Energy Agency (IAEA), as well as relevant security agreements and treaties.[1] The study of all the instruments and models used by the existing regimes has, to varying degrees, contributed to understanding the complex challenges and solutions connected to the verification of nuclear weapons declarations. At the same time, the subject of verification of the declaration of nuclear weapons has not previously been studied in depth, and raises its own unique set of requirements, conditions, point-in-time dynamics, and complications. Thus, although the analysis of existing verification regimes has certainly aided in WG4's endeavors, these models are not directly transferable to the verification of nuclear weapons declarations, but they do contain important lessons and employable experiences.

[1] WG4 consulted the Treaty on Conventional Armed Forces in Europe (CFE), Chemical Weapons Convention (CWC), Brazilian-Argentine Agency for Accounting and Control (ABACC), and the START (Strategic Arms Reduction Treaties) family of treaties.

Defining the Term "Nuclear Weapons"

We began by defining what WG4 means when we refer to nuclear weapons. In the literature, items defined as nuclear weapons can refer to both an individual nuclear explosive device (NED) or a delivery system with one or more NEDs inside. Because the IPNDV is looking at verification through the dismantlement and disposition of nuclear weapons and their associated materials, it made most sense to make the item of account to be the NED. Consideration can then be given to each individual NED from being deployed (possibly within a missile or other delivery system) through to its dismantlement.

In its effort to identify and account for every NED in a State, WG4 in each of its published papers has used the term "nuclear weapon" to refer to any NED. Hence, a delivery vehicle could contain multiple NEDs or nuclear weapons. In principle, nuclear weapons may be categorized in multiple ways according to weapon technology, intended use, means of delivery, and operational status.[2] As part of its declaration, a State will declare how many nuclear weapons it holds, and during inspections such items will be identified to inspectors. These are then designated as items declared as weapons (IDWs)[3] because it is likely that inspectors will have no other knowledge of what these items are and cannot know for certain they are indeed nuclear weapons. Once declared as nuclear weapons, inspectors will treat them as treaty accountable items (TAIs). As there are no technical measurements that completely confirm an item is a nuclear weapon, all items will remain IDWs throughout the verification process.

Disarmament Context

The scope, subject, and modalities of any verification arrangement depend heavily on the context and contents of the agreement that is to be verified. Thus, to be able to elaborate realistic options for the verification of nuclear weapons declarations, the applicable disarmament scenario should be clarified. The IPNDV considers four broad disarmament categories that provide representative characteristics for possible disarmament scenarios of a single State or among several States. These categories are (1) reductions in nuclear weapons numbers, (2) limitations on nuclear weapons numbers, (3) reaching global zero, and (4) maintaining global zero.

The role of nuclear weapons declarations in a **reduction scenario** would focus on verifying the relevant information, activities, material, and locations as declared by the inspected State. Because this category consists of scenarios in which a given number of nuclear weapons will be dismantled, this category would not need full stockpile numbers as a whole, only those nuclear weapons or weapon components to be dismantled or destroyed. Initial declarations for a Step 1–14 dismantlement scenario must include the numbers and types of nuclear weapons to be dismantled/reduced, the deployment site or storage facility, the transportation method, the transport of the dismantled components, and the monitored storage facilities. Also important is

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[2] An exploration of different categories of nuclear weapons is in WG4 Deliverable Part IV, in this document.

[3] Further explanations on the concept of IDW are in WG4 Deliverable Part II, in this document.

the location of the deployment site, the dismantlement facility, and the disposition site. Reduction scenarios that cover only Steps 6–10 will not need information about deployment sites or storage facilities. In addition, the conditions (storage, access, administration, etc.) for the monitored storage facilities, as well as the safety and security requirements are important.

Under a **limitation scenario**, the verifying entity must be able to determine a total or maximum number of nuclear weapons in a State. At a minimum, an initial declaration for a limitation scenario must include the total number of existing nuclear weapons and the number of weapons assigned for dismantlement, including their location and operative status. Depending of the operative status, information about the location would include the deployment, storage, or production site. A key assumption is that the 14 steps of the dismantlement process are verifiable. A key objective of a limitation scenario would also be to verify that there is no undeclared production of TAI, which means at a minimum, weapons production facilities would have to be included in State declarations. These facilities and the production of any new TAI would have to be accounted for in declarations.

In a scenario of **reaching global zero** (or full elimination of nuclear weapons), the assumption is that all nuclear weapons have been declared as TAIs and that States will remove all their nuclear weapons from deployment in order to dismantle and destroy them. A minimum requirement for an initial baseline declaration must include timely information about the number of remaining nuclear weapons to be dismantled, including nuclear-capable delivery systems. Additionally, the facilities/locations of the entire nuclear weapons cycle must be declared. This would also include the dismantlement or conversion of the remaining deployment/storage sites. A verification aim would be to ensure no further production of nuclear weapons is possible or feasible without significant risk of early detection. This would be aided by the eventual dismantlement of all the production and assembly sites. The dismantlement or conversion of nuclear weapons deployment/storage sites will require the development of specific inspection procedures to allow for verification of their status as long as these sites exist. A remaining problem is the nuclear weapons knowledge within former nuclear weapons States, but prospects for preventing States re-arming may need to rely on a sufficiently rigorous multilateral verification and enforcement regime.

The **full civilian nuclear fuel** cycle becomes increasingly important as we approach global zero. The size and capacity of a country's civilian nuclear infrastructure will determine its break-out time. Possible clandestine nuclear weapon activities or permitted non-weapon nuclear-related activities for military purposes (e.g., naval propulsion) can also provide the basis for a potential or real break-out option. Complete safeguards for the civilian nuclear cycle, and any permitted nuclear-related military activities, must be established and effectively maintained. But these can be built on rich experiences from earlier disarmament phases and the IAEA safeguards system, including the Additional Protocol, and regional safeguards systems, such as Brazilian-Argentine Agency for Accounting and Control (ABACC) and Euratom.

Once all nuclear weapons have been eliminated, **maintaining global zero** requires continuing verification of remaining infrastructure that might contain proliferation-relevant fissile material, production capabilities, and knowledge. Existing knowledge of how to build or produce nuclear weapons cannot be verified, but research institutions or development facilities can be notified or monitored (perhaps with lessons learned from the Organization for the Prohibition of Chemical Weapons (OPCW) monitoring of commercial institutions). The main verification objective is to ensure that no State, including the former nuclear possessor States, can use clandestine or nuclear infrastructure to produce a nuclear weapon. Although nuclear weapons may have been eliminated, much of the former nuclear weapons-relevant infrastructure, potentially containing proliferation-sensitive information, will initially remain in some countries. In these scenarios, it should be determined which verification options are required in former nuclear possessor States beyond conventional safeguards, or indeed, if extra verification measures beyond the current safeguards would be required in all States.

Applicable IPNDV Principles

The principles of verification that were elaborated by IPNDV Working Group 1 apply *mutatis mutandis* to the work of WG4.[4] The following principles are especially relevant in relation to nuclear weapons declarations:

Effectiveness. The objective of the verification of nuclear weapons declarations should provide parties sufficient levels of assurance regarding the number of weapons in the inspected State. Although absolute certainty will not be possible due to the requirement for information barriers to prevent the release of proliferation- or security-sensitive information, sufficient confidence may be achieved through a monitoring and inspection process that is robust enough to deter cheating. In discussing verification options for nuclear weapons numbers, WG4 has contemplated what it considers as significant diversions from the nuclear weapons declaration, and in which timeframe such a defection must be determined. Such margins of error vary with the applicable disarmament scenario.

Confidence-building. Providing certain types of information—for example relating to national security reviews, public doctrines, capabilities, in addition to the information that is to be verified—can signal a willingness to provide transparency and may increase mutual confidence regarding the correctness and completeness of the nuclear weapons declaration. WG4 has considered, under various verification options, to what degree should such types of information be included in a nuclear weapons declaration, and to what degree these types of information can be verified. In addition, the implementation of a verification regime will, over time, contribute to increased confidence among the parties to an agreement.

Non-interference and Non-proliferation. Declarations must seek a balance between achieving verification objectives, minimizing the burden of verification on the inspected party, and achieving the objectives of the inspected party. In this particular context, considerations of national security and safety, including the ability to maintain effective deterrence, and to

[4] See IPNDV Phase 1 Deliverable 1, https://www.ipndv.org/reports-analysis/deliverable-one-principles-nuclear-disarmament-verification-key-steps-process-dismantling-nuclear-weapons-14-step-diagram/.

prevent non-proliferation will be important, and can inform the planning and conduct of inspections.

Cost-efficiency. When assessing options relating to the verification of the number of nuclear weapons in a State, options must be feasible in relation to the amount of time, the number of personnel, and the level of resources they would entail. WG4 has, in its deliberations, considered which limits this places on nuclear weapons declarations and the information therein that is to be verified.

Objectives of Declarations and the Role of Transparency

The principle of effectiveness dictates that the primary objective of declarations is to "offer information that provides the basis for the effective implementation of disarmament agreements and to facilitate the detection of non-compliance by establishing the baseline of declared activities and informing specific monitoring/inspection procedures."

Apart from this "core objective," declarations also function to aid verification and the implementation of arms control agreements in various supplementary ways, for example, by:

- Building trust through increased transparency, both between parties to an agreement and more widely within the international community;
- Establishing credibility and data consistency over time, and thereby increasing confidence that Parties are implementing an agreement in good faith;
- Facilitating nuclear material accountancy, including the process of creating an accurate as possible verification baseline of past nuclear weapon related activities on the part of parties to an agreement, and, as agreed, supporting the assessments made by a multilateral verification entity that could be created as part of a future monitoring/inspection regime;
- Facilitating "nuclear cultural anthropology,"[5] that is, helping to understand the ways in which different countries with nuclear weapons undertake their activities and operations across the nuclear weapon lifecycle (from production to disposition) and thereby informing the development of the monitoring and verification regime of specific nuclear disarmament agreements, for example, by compiling over time a more comprehensive "map" of nuclear weapon activities against which it would be easier to detect anomalous behavior or undeclared activities; and
- Providing experience in cooperation that builds trust and increases the prospects for further disarmament agreements between the parties.

The fact that declarations serve multiple primary and secondary verification objectives also means that the different types of information that may be included in such declarations are not

[5] "Nuclear cultural anthropology" is further explained in WG4 Deliverable Part IV, in this document.

necessarily verified with equal levels of scrutiny or intensity; certain types of information may not be verified at all.[6]

Transparency plays an essential role in supporting verification of a declaration by increasing confidence that declared information is credible. Transparency measures result in greater predictability regarding the intentions and capabilities of States, thus facilitating mutual understanding, easing tensions, and reducing misperceptions.

Transparency will also influence the design of a verification regime. The degree of transparency provided by parties to an agreement reflects the level of trust between them. Low levels of trust are likely to result in fewer transparency measures, and more rigorous and intrusive processes for verification. However, over time and with experience in the implementation of an agreement, increasing trust between the parties can result in the parties accepting less than the full scope of information obligated in an agreement, and an increase in informal or voluntary exchanges of information related to a State's nuclear weapons enterprise.

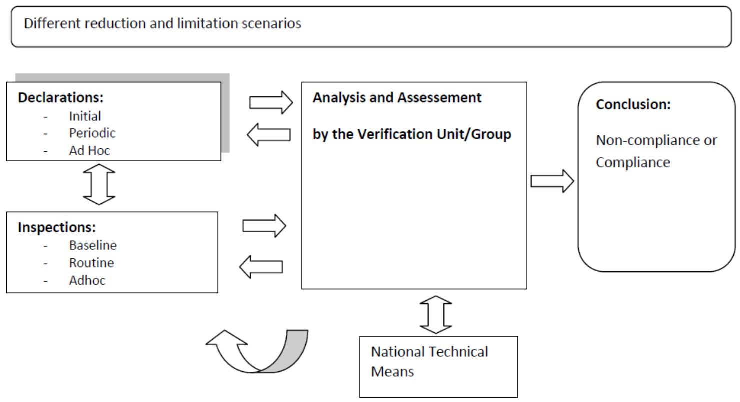
Declarations as They Apply to Verification

"Verification" is the iterative and deliberative processes of gathering, analyzing, and assessing information to enable a determination of whether a State party is in compliance with the provisions of an international treaty or agreement.[7] In the context of the work of WG4, the goal of this hypothetical verification process or mechanism is to enable one or more States party to an agreement to determine the number of nuclear weapons present in another State—or, possibly, in any given part of that State's territory.

WG4 has focused on declarations and inspections as the main sources of information used in the process of verification of nuclear weapons numbers. These sources of information are interlinked in several ways: the data provided in declarations are often confirmed by inspections, or serve to enable or facilitate inspections; conversely, the information yielded through inspections may prompt subsequent declarations (see Figure I-1).

[6] This distinction is further elaborated in WG4 Deliverable Part IV, Paper 2, in this document.
[7] IPDNV Phase I Deliverable 1, *A Framework Document with Terms and Definitions, Principles, and Good Practices*, p. 12.

Figure I-1. Verification Process Diagram with Data Flow



There are different types of declarations and inspections. Although these go by various designations depending on the regime of which they are part, general distinctions can be made between initial declarations, which are intended to establish baseline information, and periodic declarations and updates, which are time- and incident-driven, respectively.[8] Similarly, inspections will differ in terms of nature, frequency, and intensity. IPNDV Working Group 2 identified three types of inspections: initial, ad hoc, and inspections carried out under managed access arrangements. In the context of the work of WG4, so-called "challenge" inspections aimed at undeclared locations, for example as included in the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CWC) and Conventional Forces Europe (CFE) Treaty regimes, also have a significant role.

Types of Declarations

A declaration is a formal provision of information required under the terms of a negotiated disarmament agreement after entry-into-force. The content of declarations depends on whether a disarmament treaty has unilateral, bilateral, or multilateral obligations. The most important objective of a declaration is to establish a baseline of data that can contain numerical, locational, or technical information based on the agreed requirements for future inspections and other activities such as surveillance, dismantlement, conversion, etc. This information can include photographs of inspection objects, site diagrams, or technical drawings. The documentation forms the basis of inspection activities to monitor treaty

[8] The New START verification regime, for example, obliges the States parties to provide data current as to the entry into force of the treaty (initial/baseline); periodic data after the expiration of every six-month period following the entry into force of the treaty (periodic); and five days after the occurrence of certain changes in the relevant data (updates).

compliance with high confidence. Additionally, elaborated declaration documents can be used to contain special or advanced data. The IAEA has developed expertise concerning site declarations, as have the U.S. and Russia through bilateral treaty arrangements. Depending on the specific scenario, other categories could include special declarations about delivery systems or the operational status of nuclear weapons.

A key aspect is the use of declarations over time, which determines the scope, frequency, intensity, and monitoring to build high confidence and to reach the treaty objectives. This is important for inspection procedures such as managed access, monitoring, surveillance, etc. The first part of an agreed verification cycle is always an initial declaration that obliges the States parties to provide baseline data, such as the number of nuclear weapons or the location of relevant sites containing IDWs. Baseline inspections are activities conducted by States parties to confirm exchanged baseline data of a treaty-limited item. During a defined period (weekly, annually, etc.) regular or routine inspections are aimed to verify the baseline data to reach the inspection objectives. Updates are possible during a defined period. The New START Verification regime is based on this model. Challenge inspections, which are aimed at undeclared sites, have been introduced by the CWC and the CFE Treaty where agreement has been reached on the absence or limited presence of Treaty-accountable items or activities. During latter stages of the disarmament process, ad hoc inspections can be introduced regarding the conversion of storage or production facilities.

The objects and locations earmarked for inspections are also important (see Table I-1). Information to fulfill the verification objectives must be clearly defined, well-structured, and applicable for the IPNDV verification principles. Not all information provided by the inspected party is to be verified with the same level of scrutiny. The level of scrutiny necessary will be related to the level of assurance required to fulfil verification objectives within the overarching disarmament scenario.

Table I-1. Types of Declarations and Inspections and Required Data[9]

Type of Declarations	Trigger	Inspections	Provided Data
Initial	Conclusion of Agreement	Baseline Inspections	Baseline data
Periodic	Time-Driven Declaration	Routine Inspections	Periodic updates of required data
Ad hoc	Incident-Driven Declarations	Ad hoc inspections	Notification of changes in inventory, locations, etc.

[9] WG4 Deliverable Part II expands on these suggested declaration types, including under certain scenarios the need to distinguish between initial and baseline declarations and inspections.

Disarmament Scenario Used by Working Group 4

To aid its work on the verification of declarations, WG4 identified a specific nuclear disarmament scenario in which a possessor State declares its full stockpile of weapons in preparation for further disarmament steps. The primary focus of this scenario is to explore verification of a baseline declaration and the evolution of confidence over time.

In this scenario, State “A” has declared all of the nuclear weapons in its stockpile and agreed to keep its total stockpile below an agreed number.

The declaration was considered to be the first action by State “A”’ in a process that would lead to significant reductions and eventual disarmament. This process would be lengthy and hence robust and efficient verification would be required to monitor the total number of weapons in the State.

To develop a full range of potential verification options, it was important to ensure the scenario encompassed all locations within the State where nuclear weapons may sensibly exist. As such, State “A” was envisaged to have some weapons deployed at sea on naval submarines, in fixed ground-launched silos, on road mobile launchers, and in storage for deployment by land-based aircraft. Further systems were located in central storage and at a production and dismantlement site. The replacement or refurbishment of old systems was possible; however, the total number in the State would not exceed the set value at any time.

Consistent with the Partnership’s key judgement from Phase I regarding multilateral verification,[10] the verification process in this scenario involves a multilateral group comprising members from both nuclear possessor States and non-possessor States. Although not prescribing how this group formed, WG4 will examine issues such as the group’s resourcing, capabilities, and equipment, as well as mandate, logistics, and ability to resolve ambiguities, with a view to contributing to future discussions and recommendations on the organization of the verification body.

Frequently Used Terms

Following is a short list of terms frequently used by WG4. This list is to aid the reader in understanding the terminology used in these Deliverable papers published by WG4 as part of Phase II of the IPNDV. This list is not intended for use beyond these papers.

Declaration. The formal provision of information required under the terms of a disarmament agreement.

[10] See Phase I Summary Report: Creating the Verification Building Blocks for Future Nuclear Disarmament, www.ipndv.org/reports-analysis/phase-1-summary/.

IDW (Item Declared as Weapon). Any object that is declared by a nuclear weapon possessing State as a nuclear weapon or treaty-accountable item for reasons of establishing an initial potential maximum baseline declaration.

NED (nuclear explosive device). A generic term for an otherwise undefined object containing special fissionable material and high explosives.

Nuclear cultural anthropology. The study of culture (practices and protocols) within nuclear enterprises. These cultures may have some variability within a State, depending on the mission of the site and roles and responsibilities of its assigned workers. Nuclear culture may also be influenced by a State's unique cultural perspectives on safety, security, responsibility, accountability, and authority structure.

Site. A specified geographical area delimited by a State party to an international treaty or agreement according to the provisions of that agreement's verification regime.

State-wide verification. A verification mechanism, which covers the entire territory of a State (minus the parts that are not under its control or jurisdiction) but also any dependent territories, areas under its de facto control, surface ships, submarines, or overseas military bases.

TAI (Treaty Accountable Item). The subject of an arms control treaty.

UID (unique identifier). A distinct sequence of characters, bar code, or other identifying feature applied to track an individual item limited by a treaty or agreement, or a unique feature of that item.

Verification. The iterative and deliberative processes of gathering, analyzing, and assessing information to enable a determination of whether a State party is in compliance with the provisions of an international treaty or agreement.

Working Group 4 Deliverable
Part II. Potential Options for Declarations on Nuclear Weapons

Working Group 4: Verification of Nuclear Weapons Declarations

Abstract

Declarations are essential to arms control/reduction agreements. The most important objective is to establish a baseline of data such as numerical and locational as well as technical characteristics, photographs, and site diagrams for accountable items that can be used to monitor holdings and progress in reductions to agreed limits.

Based on lessons learned from other regimes as well as Working Group 4 discussions and papers, this deliverable contains potential options for declarations on nuclear weapons as well as information that may be included therein.

Finally, this paper explores several topics, articulating specific considerations deemed pertinent to a future multinational arms control verification regime.

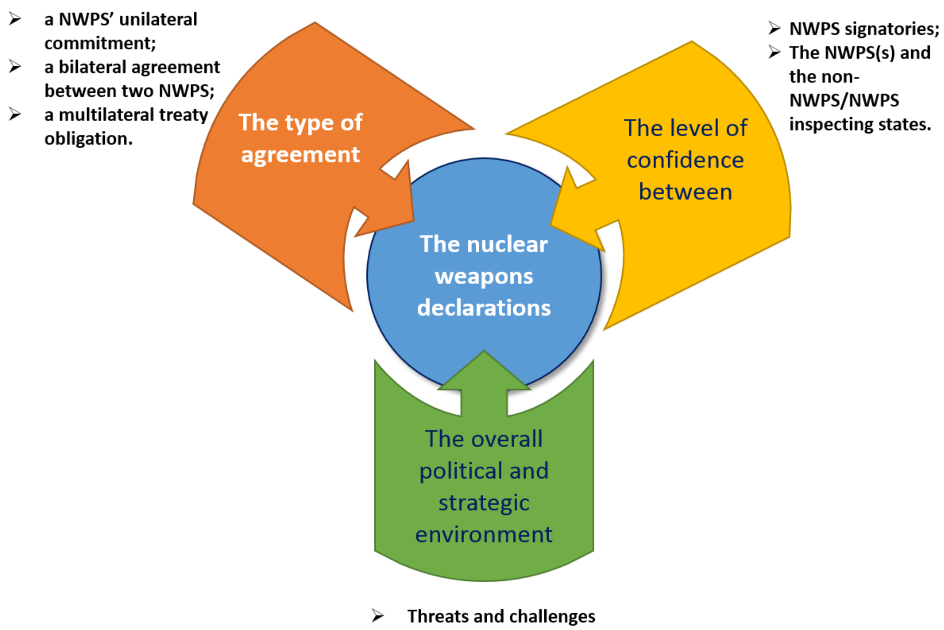
Introduction

During the discussion conducted by Working Group 4 (WG4) on objectives and subjects of nuclear weapon declarations, multiple factors that could influence their final determination were pointed out (see Figure II-1). The nature and content of declarations will largely depend on:

- Whether it is a State's unilateral commitment, a bilateral agreement, or a multilateral Treaty obligation;

- The level of trust between States party to the agreement;
- The overall political and strategic environment.

Figure II-1. Factors That Influence Nuclear Weapons Declarations



Note: NWPS is a nuclear weapon possessor State

For this reason and sake of simplification, WG4 adopted one main scenario for further considerations of objectives and subjects of nuclear weapons declarations:[11]

- **A disarmament scenario.** All nuclear weapons, irrespective of their operational status, will have to be declared. Verification should then rely on two principles:

  (1) Verifying that there are no nuclear weapons in a State that have not been declared as "items declared as weapons" (IDWs); and

  (2) No IDWs exist outside these declared locations. By verifying that there are no NEDs that are not declared as IDWs, either in declared locations or other relevant locations, it is possible to establish a maximum number of NEDs.

Some basic questions arise in relation to this scenario:

- What types of information should be included in a State's declaration?
- How is that information verified?
- How to keep track of numbers over the years?

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[11] See IPNDV Phase 1 Deliverable 1, https://www.ipndv.org/reports-analysis/deliverable-one-principles-nuclear-disarmament-verification-key-steps-process-dismantling-nuclear-weapons-14-step-diagram/.

- How to deal with weapons that are being refurbished or replaced?

Subject of Declaration and Its Verification

An important question to be resolved by WG4 was related to the subject of the declaration. According to the IPNDV terms and definitions, a "nuclear weapon" is a "weapon assembly that is capable of producing an explosion and massive damage and destruction by the sudden release of energy instantaneously released from self-sustaining nuclear fission and/or fusion."[12]

Alternative options would be a nuclear warhead, a "military device consisting of high explosives and nuclear material in a configuration capable of producing a nuclear yield" or a NED, a generic term for an object containing special nuclear material and high explosives that is capable of producing a nuclear yield.

This paper, however, proposes another idea, which is to leave the subject of the declaration undefined for now, to not pre-empt definitional issues in a future agreement. Instead, **nuclear weapons declarations could be based on the concept of "items declared as weapons" (IDWs)**.

A key characteristic of this approach is that the exact nature of the IDW remains unknown to the verifying entity, although it may be confirmed at some point during the dismantlement process. When it comes to verifying the number of nuclear weapons in a State, or in any given location, there would then be only two options: either an object is an IDW, which requires solely its designation as such by the possessor State, or it is not.

By foregoing the verification of a State's IDW declaration—in other words, by not verifying whether or not IDWs are, in fact, nuclear weapons, nuclear warheads, or NEDs—the difficult issue of non-proliferation concerns involved in measurements on NEDs would be at least partially sidestepped. Verification should rely on two key principles:

- Establishing a closed-off "IDW balance area," consisting of locations and sites where IDWs are present, and verifying that no IDW leaves this area unnoticed by the inspecting entity; and
- Verifying that there are no NEDs in a State/location that have not been declared as an IDW.

This would entail "measuring absence," which has as a benefit that—unless the inspected State cheats—there is a smaller risk of transferring proliferation-sensitive information, because the objects measured should *not* be NEDs. Especially in locations that would not be part of the IDW balance area, this may mean that more technologies could be used for verification purposes. This does not foreclose the options of taking some measurements on certain, perhaps randomly selected, IDWs. Measurements could include for example checking for the presence of nuclear material, and/or the quality or quantity of such material. This may build confidence the items are worth inspectors tracking, and to raise the bar so States are discouraged from

[12] See IPNDV Phase 1 Deliverable 1, https://www.ipndv.org/reports-analysis/deliverable-one-principles-nuclear-disarmament-verification-key-steps-process-dismantling-nuclear-weapons-14-step-diagram/.

cheating. However, such measurements cannot confirm an item is a nuclear weapon, and as such, the items remain IDW throughout the process.

Lessons from Other Regimes

From the beginning of the work carried out under the IPNDV, an important activity was the exploration of existing arms control regimes (including those not related to nuclear weapons) in terms of selecting elements that can be used in the process of nuclear disarmament. In this context, WG4 has reviewed the lessons learned from the Conventional Forces Europe (CFE) Treaty, Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CWC), Strategic Arms Reduction Treaty (START), and Brazilian-Argentine Agency for Accounting and Control (ABACC) in terms of the declarations and information provided in the framework of these agreements. Despite the fact that the agreements concern various areas in both the weapons of mass destruction (WMD) and the conventional sphere, a similar approach to the scope of declarations, other related information, and procedures for submitting declarations can be found.

Conceptual Background on Declarations

Declarations are essential to arms control/reduction agreements. The most important objective is to establish a baseline of data, such as numerical, locational, and technical characteristics, as well as photographs and site diagrams for accountable items that can be used to monitor holdings and progress in reductions to agreed limits.

Both the scope of an agreement, its provisions or limitations, and the definitions of certain terms are likely to be agreed prior to the exchange of declarations. The declarations and the data that they contain flow from and are related to the provisions or limits agreed in an agreement. The declarations will incorporate the treaty-accountable items and data about those items, including numbers, types, and locations that, combined with a regime of notifications and inspection activities, will allow parties to monitor treaty compliance and track progress in reaching treaty limits.

Initial Declarations

Initial declarations have previously been provided mainly before the entry into force of the agreement or contained in the text of the agreement itself (e.g., Strategic Arms Reduction Treaty (START) Treaty). These declarations referred directly to the most important data related to the accountable items and includes information on:

- Reduction liabilities;
- Current holdings or possession of the accountable item;
- Technical characteristics and photographs

Baseline Declarations

Baseline declarations were provided in most cases immediately after the entry into force of the agreement. These declarations referred directly to the most important data necessary to prepare for and conduct verification activities:

- Updated version of initial declarations;
- Locations of accountable items as well as the production, storage, and maintenance facilities associated with these items;
- Site diagrams;
- Locations of reduction sites.

Periodic Updates

To be effective in monitoring compliance or progress toward agreed limits, declarations cannot be a one-time occurrence. As time passes, the information in the declarations requires updates to reflect the new information. For example, if the status of an accountable item changes through its movement to a different facility or to a different location within the same facility, its elimination, production of a new item, or when a new type of accountable item is added, the change in the status of that item should be notified in an update.

Updates to data declarations are made through an agreed notification system that uses agreed formats and content or by periodic (annual) information exchange. Passing periodic updates enables more effective monitoring and easier tracking of changes.

Ad Hoc Declarations

Information that may affect the verification of the correctness of delivered declarations and characterized by high dynamics of changes, is transmitted using appropriate ad hoc declaration systems in a short interval from the change taking place.

Different types of declarations covering data updates relate mostly to movement, conversion, or elimination of agreement-accountable items.

Verification of Baseline Declarations

Although parties are responsible for ensuring the accuracy and completeness of the declarations/data that they provide, confidence comes from the ability to confirm that the exchanged data are correct.

Baseline inspections (e.g., START, CFE) represent the most useful method to determine accuracy and completeness of the data in the initial exchange. The initial period, after the entry into force of the agreement, is characterized by a large number of inspections as compared to a further period of “normal” functioning of the agreement. Confirmation of the accuracy of the information obtained during inspections conducted in the initial phase plays an important role in building mutual trust between the parties to the agreement.

However, because of inspection cost and intrusiveness concerns, it is not possible to verify 100 percent of the information provided in a short period and instead a selection of a reasonable sample is used to confirm the declared data. The parties simply agreed on the number of allowed inspections for any one type of inspection based on what they believed would allow for effective monitoring activities, verification, and a deterrent to cheating; something that will also have to be taken into account in any future nuclear disarmament/dismantlement treaty.

Another important aspect in the initial phase is an exhibition. Exhibitions of accountable items and facilities and a chance to view their distinguishing characteristics allow parties to conduct more efficient inspections and accurately confirm the items of inspection as different, but similar, types of weapons and delivery systems.

Exhibitions could include treaty-accountable items existing at the time of entry into force of a treaty/agreement and new types of accountable items and new facilities introduced afterward.

Options for Declaration Elements

Types of Declarations

In general, verification mechanisms entail different types of declarations to be made by the inspected party. Although more detailed analysis of existing mechanisms is necessary, at this point we can roughly distinguish four types of declarations/notifications:

Initial declarations. An initial declaration mainly contains the data needed in the negotiation process to determine the necessary parameters of the agreement.

Baseline declarations. A baseline declaration by a State to the verification entity sets out plans and data necessary to prepare for and conduct verification activities.

Periodic. Time-driven declarations. At least annually a State provides an update of its declarations to the verification entity. Such periodic declarations facilitate the allocation of resources and planning of inspections by the verification entity.

Ad hoc declarations. Incident-driven declarations. Reflecting the changes that have occurred in the relevant data.

Note that ensuing inspections may differ in nature, frequency, and intensity. Discussions of the CFE and CWC Treaties by WG4 also reflected the importance of challenge inspections, which would be aimed at undeclared locations.

Verification "Layers" and Categorizing Information in Declarations

Lumping together all possible types of information would be rather unworkable for analytical purposes. Not all information provided by the inspected party is to be verified with the same level of scrutiny. This would mean that for some types of information, the level of assurance that is required is higher, necessitating more rigorous verification and a different inspection regime, than for others.

For analytical and discussion purposes, we can distinguish three "layers" of verification:

- A "**core**" system is a layer of verification formed by the most sensitive information and involving the highest level of scrutiny. The verification of this information provides a high level of assurance, for example by being subject to a system that keeps track of numbers of declared items within declared locations.
- **Complementary** information forms a second layer around this core, increasing the level of assurance of non-diversion. This kind of information does not have to be mechanically or systematically verified, for example, the IAEA Additional Protocol and its complementary access provisions.
- **The outer layer** is formed by all other types of information, for example open-source information that may be considered relevant, because it helps to establish a better picture of a State's capacities or policies as a whole.

Note that not all information will, or should, be treated equally in terms of corresponding verification effort. For instance, some of this information may be required only in the case of suspected non-compliance. This links to the principles of efficiency and non-interference but also effectiveness—the notion that verification consists of cumulative efforts that may yield varying levels of assurance on their own.

Therefore, WG4 suggests categorizing the information to be included in nuclear weapons declarations, as illustrated in Figure II-2.

Figure II-2. Recommended Categories of Nuclear Weapons Declarations

Category of information	Basis for	Possible example
Core	Accounting system	Number of declared nuclear weapons; location of declared nuclear weapons
Complementary	Complementary access	Information on locations and roles of relevant facilities
The outer layer	Confidence-building on State level	Role of nuclear weapons in military doctrines

Information to Be Included in Nuclear Weapons Declarations

Based on lessons learned from other regimes as well as WG4 discussions and papers, Table II-1 sets out an inventory of information that may be included in a nuclear weapons declaration. It also distinguishes between the different categories this information may belong to, as well as the different declarations (initial, periodic, updates).

The elements listed thereafter are indicative. Their possible inclusion in a declaration will largely depend on the type of agreement (limitation, reduction, elimination).

Table II-1. Possible Inventory Information to Include in a Nuclear Weapons Declaration

Information	Category	Declarations Featured
Locations/designation/diagrams of nuclear facilities • **Production/refurbishment** • **Storage** • **Military bases (air, naval, ground, mobile)**	CORE	Baseline, periodic, updates
Sites of interest[13]	COMPLEMENTARY	Baseline, updates
Nuclear sites within facilities • **Storage** • **Process facility** • **Hangers/docks** • **Reactor facilities**	CORE	Initial, baseline, updates
Non-nuclear sites within facilities • **Workshops** • **Administration** • **Non-nuclear storage** • **Former nuclear facilities**	COMPLEMENTARY	Baseline, updates
Nuclear weapons numbers on territory, in jurisdiction, and under control	CORE	Initial, baseline, periodic, updates
Number of IDW	CORE	Initial, baseline, periodic, updates

[13] Voluntary presentation of information on sites where infrastructure may allow for nuclear weapons storage (e.g., former military sites, auxiliary military bases/storage sites).

Total aggregate/per location **Deployed/non-deployed; active/inactive stockpile** **Types (see WG4 Deliverable Part IV)** **Reserve/maintenance** **In storage prior to dismantlement** **Dismantled**		
Movement of IDW	CORE	Periodic, updates
IDW reduction liability	OUTER LAYER	Updates
Upkeep/modernization/refurbishment programs	OUTER LAYER	Periodic, updates
Unique identifying characteristics (subject to limits set by need to protect proliferation-sensitive and other classified information) **Type (fission/fusion)** **Serial numbers** **Names, model designations** **Size, shapes**	CORE/ COMPLEMENTARY	Baseline, periodic, updates
Delivery systems	CORE	Initial, baseline, periodic, updates
Reduction/dismantlement sites	CORE	Baseline, updates
Reduction/dismantlement procedures	CORE	Periodic, updates
Past production of weapons and materials	OUTER LAYER	Baseline
Nuclear anthropology (see WG4 Deliverable Part IV)	OUTER LAYER	Baseline, periodic
Nuclear-related R&D facilities	COMPLEMENTARY	Baseline, periodic, updates
Nuclear-related R&D activities (ongoing, planned, ceased)	COMPLEMENTARY	Baseline, periodic, updates
Equipment (possibly) related to production of nuclear weapons; import/export thereof	COMPLEMENTARY	Baseline, periodic, updates

Sites/materials covered by other verification arrangements (IAEA safeguards, CTBT, FMCT, etc.)	OUTER LAYER	Baseline, updates
National policy on nuclear disarmament	OUTER LAYER	Periodic, updates
Nuclear doctrine	OUTER LAYER	Periodic, updates

Challenges and Possible Solutions for Verification during an Inspection

When considering developing a verification regime, additional issues should be considered to assure a regime that takes into account the differing needs and perspectives of each treaty partner. These concerns include complex specific issues such as safety and security requirements based upon the unique requirements of each site and the broader influence of the country's national and regional cultural history, weapon-specific issues and concerns, as well as key lessons from other regimes that have similar applications or context. This paper explores several such topics, articulating specific considerations deemed pertinent to a future arms control verification regime.

A comprehensive understanding of the unique operational cultures and the corresponding perspectives on safety and security, allowable or unallowable work practices, and behavioral and performance expectation of a country's nuclear weapons workers across different sites and different States will be important to developing a successful verification regime. This is discussed further in WG4 Deliverable Part IV, Paper 4. Nuclear Cultural Anthropology.

Different sites may host differing safety and security environments depending on the function of each site and the overall culture of that facility. Additionally, national or regional culture may also influence decisions regarding where facilities are established, who works in those facilities, and decisions regarding the overall design and distribution of a State's nuclear infrastructure.

Finally, lessons from previous successful treaty regimes may help define how a future, multinational arms control verification regime could be structured, and provide process elements that could be leveraged and adapted. This paper is based in part on key lessons taken from the CFE Treaty and considers applying those lessons to the development of a future arms control verification regime. The CFE Treaty is discussed in further detail in WG4 Deliverable Part V.

Deployed Items Not Present

One or more road mobile missiles and submarine missiles may be routinely deployed outside their bases at any given time and therefore not be available for inspection. Confidence building must then take place over time because new inspections will verify different subsets of the total number of IDWs. Reliable unique identifiers on each IDW would make it possible to trace them all over time; however, this may not be practicable for all weapon types. Further confidence may be created, for example, by also making it possible to identify each of the missiles, as well as any transporter-erector-launchers (TELs)[14] or submarines. If there are no unknown delivery vehicles, then unknown, unaccounted for weapons cannot be deployed.

Limited Inspection Time

Verifying that an IDW indeed satisfies the declared criteria for a specific nuclear weapon will most likely require several hours of work for inspectors. Obviously, verifying the actual presence of a large number of nuclear weapons may take days or weeks to carry out, that is, much longer than the fairly short inspection visits permitted under other relevant treaties. Just visiting all relevant buildings and facilities at a base may exceed the time limit.

It is not possible to see, let alone measure, everything everywhere during an inspection visit. However, much may be achieved by collecting information over time through repeated visits. Over time, inspections would naturally move from questioning everything to looking for anomalies. Furthermore, one may choose to randomly select a low number of missiles for verification and build confidence based on statistical analysis.[15] In any case, nuclear disarmament treaties may have to allocate more time to verification inspections than has been customary under other treaties. It is not preferable to spend several years performing a baseline verification; if necessary, other inspections—for example to monitor the dismantlement of weapons—may need to be carried out simultaneously.

Monitoring Delivery Vehicles

Monitoring IDWs over many years is not straightforward because in general different weapons may be deployed, and therefore missing from the base, at different visits. The necessary checks and balances may be easier to achieve by also keeping track of the delivery vehicles and which IDW(s) are at any given time associated with each delivery vehicle. Because deployed weapons may not be inspected and their existence therefore not verified, adding information about delivery vehicles is a confidence-building measure that to begin with may appear to have little added value, but that over time should provide the inspectors with a better overview and thereby make it increasingly harder for the inspected State to cheat.

Safety and Security

Both safety and security issues may seriously complicate the work of the inspection team. Health and safety regulations are generally strict regarding radiation and explosive hazards, and they are not negotiable. This may limit physical access, tools, and methods available to the inspectors. Ideally, some inspectors should have the necessary training and certification to work under such hazardous conditions.

Proliferation security is another obviously non-negotiable obstacle, but also various national security issues may complicate the verification process. For example, some areas or some

[14] TELs are road mobile vehicles from which missiles may be launched.
[15] See WG4 Deliverable Part IV, Paper 1. Evaluating Confidence in Compliance for further details on the statistical approach.

equipment may be considered too sensitive to be seen by the inspecting team under a confidentiality agreement. Furthermore, just the process of getting access to sensitive sites and sensitive facilities may be very complicated and time-consuming as demonstrated, for instance, by the IPNDV NuDiVe exercise.[16] Some security issues may be addressed in the treaty and the relevant protocol(s) governing the work of the inspectors. For example, select non-proliferative information not available to the public might still be shared with the inspection team.

Both safety and security issues generally lead to more elaborate processes, which in turn will reduce the amount of time available for the actual inspection work. It is important that the inspectors receive as much information as possible about any restrictions early in the process, for example as part of an advance "familiarization visit" to the site where the activities to be inspected will take place.

Rules and Restrictions for Inspections under New START

Provisions and restrictions under the CFE Treaty are discussed in detail in WG4 Deliverable Part V. It is also relevant to study the inspection rules under New START, which is a bilateral treaty between the Russian Federation and the United States limiting the number of strategic nuclear weapons in the two States.

New START permits 10 "Type One" inspections per year at intercontinental ballistic (ICBM)/ submarine-launched ballistic missile (SLBM)/air bases to confirm accuracy of the declared data on deployed and non-deployed items and to confirm that converted items have not been re-converted. The Treaty further permits eight "Type Two" inspections per year at declared and formerly declared facilities to confirm declared data on non-deployed items and conversions and eliminations.

The general rules for carrying out a Type One inspection are as follows:

- Party declares intent to conduct inspection with at least 32 hours' notice before arrival.
- Inspection team enters through an east or west Point of Entry of other country.
- Inspection team declares type of inspection and inspection site within four hours of arrival at Point of Entry—pre-inspection restrictions at the designated inspection site start one hour later.
- Host informs inspection team of currently deployed fraction of weapons at site within two hours. If less than 50 percent of deployed ICBMs based at a base are present, less than 30 percent of deployed SLBMs contained in SLBM launchers are present, OR less than 70 percent of the deployed heavy bombers based at the air base are present, the inspection team has the option to (1) continue with the inspection, (2) designate another inspection site, or (3) decline to inspect and leave (note: if the inspecting party chooses to decline the inspection, then the inspection will not count in the total of annual inspections).

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[16] See https://www.ipndv.org/news/ipndv-experts-gather-in-julich-germany-for-nuclear-disarmament-verification-nudive-exercise/.

- Inspection team transported to inspection site within 24 hours of arrival at Point of Entry.
- Host provides pre-brief updating site deployment information and site diagrams.
- Inspection team designates precise items to be inspected within one hour of arrival.
- Host transports inspection team to the items for inspection within three to 12 hours depending on item.
- Inspection time limits range from 12 to 30 hours depending on the activities to be completed.

In addition, for Type One inspections, the following rules apply:

- At ICBM bases, the inspection team can inspect one loaded launcher to confirm number of warheads, one empty launcher or fixed structure to confirm it is empty, and the maintenance facility.
- At submarine bases, the inspection team can inspect one loaded launcher to confirm number of warheads, one empty launcher to confirm it is empty, converted launchers, and the inspection site within boundaries.
- At air bases, the inspection team can inspect three designated deployed heavy bombers to confirm the number of nuclear armaments loaded on them, heavy bombers equipped for non-nuclear armaments, and structures declared not to contain a heavy bomber.
- Inspection team can read the UIDs on all designated items.

For Type Two inspections, these rules apply:

- At loading, storage, repair, and training facilities and test ranges, the inspection team can inspect non-deployed ICBMs and SLBMs, first stages, and launchers to confirm number and type.
- At formerly declared facilities, the inspection team confirms disuse for purposes inconsistent with the Treaty.
- At ICBM and SLBM bases, the inspection team confirms declared eliminations were performed.
- At conversion or elimination facilities for ICBMs, SLBMs, and mobile launchers, the inspection team confirms declared eliminations were performed.
- At conversion or elimination facilities for heavy bombers, the inspection team confirms declared conversions were performed.
- At storage facilities for heavy bombers, the inspection team confirms number and type and number of nuclear armaments located on heavy bombers.

Confirmation of non-nuclear status of objects is carried out by using radiation detection equipment:

- Measurements are made in coordination with the host at the request of the inspecting party using the inspecting party's radiation detection equipment.

The Treaty includes observation periods for use of National Technical Means (NTM) to confirm some conversions and eliminations and prohibits parties from interfering with the use of NTM.

There is an opportunity for a sequential inspection either immediately after the conclusion of an inspection or at Point of Entry.

New START includes detailed counting rules for the number of launchers, heavy bombers, and warheads. Regarding warheads, Article III specifies that "for ICBMs and SLBMs, the number of warheads shall be the number of reentry vehicles emplaced on deployed ICBMs and on deployed SLBMs and that one nuclear warhead shall be counted for each deployed heavy bomber."

One may note that under New START, the parties keep track of the missiles and heavy bombers and verify the number of IDWs on each of them by randomly selecting a few delivery vehicles. Nuclear disarmament verification will require keeping track of each individual IDW.

Confirmation of Absence

Nuclear disarmament inspectors will likely need to verify the absence of nuclear weapons in several situations, such as when inspecting an item that is *not* declared to be an IDW, or when inspecting buildings, areas, and entire sites declared *not* to contain IDWs or nuclear material. The challenge has two aspects. First, measuring a quantity of zero is practically and philosophically impossible, but the measurements may establish an upper limit for the amount of nuclear material present. Second, the number of items and the areas of interest may be far too large to permit proper measurements of them all.

Verifying the absence of nuclear weapons at undeclared locations, that is, outside all sites covered by the formal declaration of the host party, in the State as a whole, is discussed in WG4 Deliverable Part III.

Any item that is not an IDW and that does not contain proliferation-sensitive materials may in principle be inspected in detail with radiation detection equipment and other relevant tools. It is therefore fairly straightforward to verify that such an item is indeed *not* a nuclear weapon. However, there may be many such objects and not sufficient time available to examine them all. As discussed earlier, it may then be necessary to randomly select a few objects for further study and collect information over several inspections. Statistical analysis may assist in deciding how many items should be investigated (further elaborated in WG4 Deliverable Part IV). Note that several items in a closed space may be inspected collectively by determining the absence of certain radiation from the room as such instead of from each item separately.

When it comes to verifying that no nuclear weapons exist within large areas of a base, or at locations outside of declared bases, the inspectors are left with a similar approach. That is, selecting items or buildings to inspect at selected areas. The selection process may be random or guided by the inspectors' knowledge, suspicion, and intuition.

The general rule would be to intelligently select objects for inspection, while holding "everything at risk" in all areas of interest.

Conclusion and Recommendations

This paper presents and discusses different types of declarations and some of the challenges involved in verifying nuclear disarmament declarations. Some key points:

- There is much to be learned from existing verification regimes, including non-nuclear related arms control treaties. Specific techniques and procedures from these regimes will in general have to be modified—including from previous nuclear treaties (e.g., START) because the treaty-accountable item is now the weapon itself, not just the delivery vehicle.
- Verifying and monitoring delivery vehicles still remain very important tools for keeping track of the weapons as they are moved around over time.
- Any regime for verification of disarmament of nuclear weapons will likely have to depend on statistical methods. Even though some work has been done in this area (see WG4 Deliverable Part IV), this topic needs further exploration.
- Nuclear disarmament verification inspectors must be well prepared for their important work. To assist in their preparations, it is recommended to carry out early familiarization visits to the sites that will later be inspected. This should include understanding the physical layout of the sites as well as the activities undertaken and safety and security requirements. Some existing regimes have also demonstrated the benefits of special exhibitions of weapons, tools, etc.
- Confirmation of the absence of nuclear weapons becomes more important as a State is approaching zero nuclear weapons (see WG4 Deliverables Part III and Part V).

Further, detailed elaboration related to some of these key points are found in WG4 Deliverable Part IV, which contains four papers:

- Paper 1. Categorization of Nuclear Weapons
- Paper 2. Evaluating Confidence in Compliance: Methods to Evaluate Random Selection Approaches and Confidence-Building Statistics
- Paper 3. How to Resolve Inspection Ambiguities
- Paper 4. Nuclear Cultural Anthropology: An Exploration of the Influence of Cultural Norms and Changing Cultural Behaviors on Nuclear Cultures

WG4 notes the usefulness of scenario-based studies of nuclear disarmament verification and recommends this approach, when possible, for future work in the field.

Working Group 4 Deliverable
Part III. State-Wide Verification of Absence of Undeclared Weapons

Working Group 4: Verification of Nuclear Weapons Declarations

December 2019

Abstract

This paper contains an exploration of the concept of verifying the absence of nuclear weapons at undeclared locations in the State as a whole. This requires the inspecting entity to (1) determine that there are no undeclared nuclear weapon-related facilities and (2) reach a conclusion regarding the absence of nuclear weapons at any other sites. Questions regarding the significance of diversions becomes pertinent in a State-wide setting, especially as arsenal sizes decrease over time. This paper explores some major challenges in terms of verifying State-wide absence of nuclear weapons. These are first related to the size of the inspected area versus that of the subject of inspection, which implies a near-endless range of possible locations are subject to verification. This, in turn, creates very real complications in terms of potential inspection burdens, effectiveness, and the interests of the inspected State, which could be addressed by innovative ways of looking at inspection regimes. Second, the vast range of potential sites of interest means that State-wide verification will involve plenty of site-specific inspection challenges that warrant further research and analysis. Notwithstanding these complications, this paper concludes that State-wide verification of the absence of nuclear weapons at undeclared locations in the context of nuclear disarmament is conceptually and hypothetically possible and sets out recommendations for further work.

Introduction

This paper focuses on the verification of the absence of nuclear weapons at undeclared locations in a possessor State as a whole. It provides an overview of the relevant discussions on this issue in Working Group 4 (WG4), focusing on useful generally applicable concepts and the main challenges involved. Although there was only enough time to scratch the surface of this complicated matter, this paper does attempt—where possible—to set out the general direction in which solutions could be sought. The paper concludes by outlining some general reflections on this issue and sets out guidance and suggestions for further work, either inside or outside the context of the IPNDV.

In the scenario considered, a State has declared all of the nuclear weapons in its stockpile and agreed to keep its total stockpile below an agreed number.[17] This declaration could be the first action by that State in a process leading to significant reductions and disarmament. The State in question is envisaged to have some weapons deployed at sea on naval submarines, in fixed ground launched silos, on road mobile launchers as well as in storage for deployment by land-based aircraft. Further systems may be located on central storage and/or production, refurbishment, and dismantlement sites.

It was assumed that when more than one nuclear weapon possessor State is involved in the disarmament process, that a number of States—both possessor and non-possessor States—are involved in the inspection process, and that any successful verification mechanism would have to be a cooperative arrangement. The concept of reciprocity between participating possessor States plays an important role, because these States will have to make decisions between transparency allowed within their own States and their confidence in other possessor State compliance. Finding effective and efficient solutions will also be essential given the significant efforts and costs that may reasonably be expected to be involved in such State-wide verification efforts.

Lessons from Other Verification Regimes

The issue of verifying the absence of nuclear weapons at undeclared locations on a State-wide scale has not been explored before. In discussing this issue, WG4 considered the applicability of various other verification regimes such as the International Atomic Energy Agency (IAEA), the Organization for the Prohibition of Chemical Weapons (OPCW), the Conventional Forces Europe (CFE) and the Strategic Arms Reduction Treaty (START) Treaties. Discussions of existing regimes have helped to clarify some useful concepts related to scope, inspection parameters, and flexibility in verification efforts for different types of information. An example is the CFE, where a number of individual concepts were found to form a useful starting point for analysis.[18] However, none of these regimes would be directly suitable for application to the verification of

[17] See WG4 Deliverable Part I, Disarmament Scenario Used by Working Group 4.
[18] For more information, see WG4 Deliverable Part V.

nuclear weapons; the mechanisms for the detection of undeclared locations and items, in particular, are not transferable.

Scope of "State-Wide" Verification

The IAEA, in its safeguards conclusions, makes a distinction between its ability to conclude that all of a State's declared nuclear material remains in peaceful activities (correctness), and that there are no undeclared materials or activities in a State (completeness). This terminology, although logical in IAEA-context due to the particular development of its safeguards system, has proven less useful during discussions in WG4, which has instead made a distinction between the verification of declarations pertaining to nuclear bases and the verification of State-wide nuclear weapons declarations.

Existing disarmament regimes provided some guidance as to what should be considered as "State-wide" in terms of geographical scope. The obligations of the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CWC), for example, apply to "any place under its jurisdiction or control." The concept of "State-wide" verification therefore does not assess the State as a geographical entity but as an international legal actor. That means that WG4 included in its deliberations not just the territory of a State (minus the parts that are not under its control or jurisdiction) but also any dependent territories, areas under its de facto control, surface ships, submarines, or overseas military bases.

At the same time, WG4 considered potential complications for scenarios in which the area to be verified is a defined geographical area that does not comprise an entire State, but only a delineated part thereof. This may be necessary in disarmament agreements that only focus on a certain area.

Inspection Parameters

Several other verification regimes contain provisions to inspect undeclared locations in a State. Although it is unlikely that any of these will be directly applicable to the problem at hand, it is worth noting certain concepts and ideas within them.

The IAEA may make use of special inspections, based on its model comprehensive safeguards agreement (CSA), to inspect any location in a State—including undeclared ones.[19] The procedure concerning such inspection involves consultations and agreements with the State involved.[20] According to the related articles of the CSA, in urgent cases, the Board of Governors can get involved. In practice, requests by the IAEA for special inspections have normally led to involvement of the Board of Governors and risk escalating the situation. The Board concluded in 1992 that special inspections should occur only on "rare occasions"; the last formal request to undertake such an inspection was in 1993.

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[19] International Atomic Energy Agency, The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons (INFCIRC/153), paragraph 73.
[20] See WG4 Deliverable Part IV, Paper 3. How to Resolve Inspection Ambiguities.

Under the CWC, States parties can request challenge inspections of undeclared locations in other States.[21] This means that the initiative for the inspection in question lies with other States, not with the verifying body itself. The idea was that this would be a more cooperative way to deal with inspection of undeclared locations, because States are expected to try to resolve any ambiguities through extensive consultations prior to requesting a challenge inspection. Moreover, the CWC contains several clauses that are designed to prevent abuse of the challenge inspection procedures by, for example, asking for inspections for the purpose of hampering the normal operations of locations of facilities. However, challenge inspections have never been used since the CWC came into force, suggesting that the political cost of requesting them is too high to make them an effective verification tool.

In general terms, it emerged from discussions in WG4 that elements of the CFE system of quotas for inspections at undeclared locations may be the most useful mechanism in this context. Under the CFE treaty, States parties have an annual quota of challenge inspections of undeclared sites.[22] These are inspections of any territorial area, not to exceed 65 square kilometers; no access or entry onto any declared site is allowed. The inspected State has the right of refusal, and the number of challenge inspections is limited to a percentage of the quota of inspections for declared sites in the State.

Flexible Verification Efforts

As discussed in Part II, WG4 recognized that not all information will, or should, be treated equally in terms of corresponding verification effort.[23] This links to the principles of cost-efficiency and non-interference but also effectiveness—the notion that verification consists of cumulative efforts that may yield varying levels of assurance on their own.[24]

Thus, not all information provided by the inspected party is normally verified with the same level of scrutiny. Certain types of information require a higher level of assurance, entailing more rigorous verification and a stricter inspection regime than others, which may not have to be mechanically or systematically verified (e.g., former nuclear weapons storage sites); whereas yet other types may not be verified at all and simply serve as background or additional information (for example, historical nuclear weapon numbers or fissile material production numbers).

Verification Objectives

The State-wide verification of the absence of nuclear weapons at undeclared locations requires the inspecting entity to (1) determine that there are no undeclared nuclear weapon-related

[21] See WG4 Deliverable Part IV, Paper 3. How to Resolve Inspection Ambiguities.
[22] See, for example, Nuclear Threat Initiative, "CFE overview," www.nti.org; see also WG4 Deliverable Part V.
[23] See WG4 Deliverable Part II.
[24] See WG4 Deliverable Part I; see also IPNDV Working Group 1 Deliverable 1.

facilities and (2) reach a conclusion regarding the absence of nuclear weapons at any other sites.

The verification objective is to deter and detect violations of the underlying nuclear disarmament agreement through diversion of treaty-accountable items at undeclared locations before these violations can become significant. The idea is that the regime in question cannot only detect such violations but also deter cheating because it can detect violations. The regime also deters cheating by making the pathways for cheating costly. The regime must be robust enough in terms of access and numbers of inspections to meet these goals, which will imply a trade-off between effectiveness versus intrusiveness and cost of inspections. The concept of confidence over time will likely play an important role by providing increased assurance that a party to the agreement abides by its obligations.

The question of the strategic significance of diversions in a State-wide setting becomes more pertinent as arsenal sizes decrease over time and small numbers become more significant. IPNDV Working Group 1 Deliverable 1 (2017) relates the principle of effective verification to the concepts of “timeliness” and “significant quantities” as introduced by the IAEA. Whether or not States will have confidence in a verification mechanism depends, among others, on the question, “What are the potential implications of non-compliance with the relevant agreement, and what are the possibilities for adequate individual or collective responses?”

These questions become very relevant on a State-wide scale because it is highly unlikely that any State could be provided with absolute certainty that another State has not hidden a single weapon or a small cache of weapons somewhere at a secret location. Rather than discuss which numbers constitute a significant diversion (which should be left to future negotiators), it is important to determine when a diversion would allow for a significant strategic advantage.

Whether or not a diversion of one or two weapons is strategically significant depends on context, such as the location of the weapon located, and how far it is from being operational and deliverable. This would suggest that State-wide verification of the absence of nuclear weapons at undeclared locations would imply a scenario in which there exists some parallel form of control of delivery systems and other nuclear-military infrastructure. The State-wide verification of the absence of nuclear weapons at undeclared locations also requires some form of monitoring for, or prevention of, the undeclared reconstruction of weapons. This may be a cut-off for the production of nuclear weapons and their components, or some form of control thereof. This may also imply control on the means of delivery, but this will not be considered further here.

Based on these considerations, WG4 observed that sufficient assurance of absence of non-declared items on a State-wide level would be attained only in combination with other verification arrangements. However, more work on the concept of strategic significance in this particular context is necessary.

Challenges

Scope of Verification

In comparison to the size of a State, or even to the treaty-accountable items of the CFE, nuclear weapons are relatively small. This means that the range of locations in which a weapon could be—in theory—stored would be near limitless. In practice, of course, regard for safety/security/environmental norms will put significant limits on the number of potential locations. Under normal circumstances, only a limited amount of locations are connected to a State's nuclear weapons infrastructure. That could change if potential (strategically significant) gains of defecting from a disarmament agreement are high enough. This will also depend on the sort of government involved, and its regard for abovementioned norms.[25] If the stakes are high enough, however, a State could theoretically apply all necessary resources to turn nearly any location into, for example, a hidden weapon storage.

That means that, in order to deter diversion from the underlying disarmament agreement, all locations in a State would, in theory, have to be placed at risk of inspection in one way or another.[26] Such a scope is not unprecedented: as was pointed out in Lessons from Other Verification Regimes above, neither the IAEA, CWC, nor the CFE exclude any type of location from any and all possibility of being inspected. The goal behind this approach is not to inspect all these locations; that would be inefficient, overly intrusive, unacceptable to inspected States, and most likely highly counterproductive. Instead, the aim would be to provide for the option to inspect any location in a State, should that need arise, to avoid creating locations outside the legal purview of the verifying entity.

The point, therefore, is not to create a system of "anytime, anywhere" inspections but to ensure that no location on the territory or under jurisdiction/control of a State is formally exempted from control. The problem with this approach is that it could allow for deliberately disruptive inspections at places such as government offices, military facilities or even schools and hospitals. Yet even such locations cannot be formally excluded from some form of control—even if only to confirm that they are indeed government offices or hospitals as declared. Another challenge is posed by the potential issue of access to privately owned locations.

There are possible ways to address these complications. Under existing regimes, procedural and legal safeguards were designed to protect States from inspections that are frivolous or intended to be exceedingly disruptive. The CWC, for example, requires some form of information or evidence to be shared before a challenge inspection can be held, requiring the State requesting the inspection to prove that this inspection is indeed necessary. Quota systems may also be effective: if a State only has a limited number of inspections available, it might think twice before using them in a manner that will not provide any assurances regarding

[25] This was, for example, an underlying assumption under the work that was carried out by UNSCOM in Iraq in the 1990s.
[26] See WG4 Deliverable Part IV, Paper 2. Evaluating Confidence in Compliance, as well as WG4 Deliverable V.

non-diversion. Another option is to offer the inspected State to block an inspection in a limited amount of cases, for example, *force majeure*.[27]

The consequence of applying the "everything at risk" concept is that verification options must be defined for a virtually limitless range of locations. Naturally, this does not imply that every location in a State will be inspected regularly—or even at all. The applicable underlying concept is that the mere *risk* of inspection deters a State from diverting weapons to undeclared locations, thereby providing assurance to all parties involved. To avoid unrealistic inspection burdens, one option is to distinguish between less and more "likely" locations for diverting weapons toward (non-nuclear military bases, former storage sites, explosive storage sites, etc.). Parameters that could apply are:

- Presence of security infrastructure;
- Location/remoteness;
- Proximity to military bases; proximity to deployment locations with means of delivery (such as silo launchers for ICBMS.)
- Logistical infrastructure;
- Suitable storage (e.g. hardened shelters for blast containment);
- Availability of security personnel;
- Accessibility;
- Health and safety expertise and capacities on site;
- Emergency response procedures;
- Indications of nuclear accident preparedness;
- Power consumption; and
- Presence of suitable canisters for transport and storage of weapons or delivery systems.

Building on the categorization and corresponding inspection burdens in WG4 Deliverable II, different quotas/inspection burdens could apply to different categories of locations. A quota system of inspections at undeclared locations, based on the CFE verification mechanism, seems to work best as it de-politicizes the process (in comparison with, for example, the IAEA's special inspections and the CWC's challenge inspections). Although no type or category of locations should have an inspection quota of 0 or 1, inspections quotas—also depending on the size and

[27] Under bilateral verification regimes, moreover, additional protection against disruptive inspections will be afforded by the concept of reciprocity: States would have an incentive not to pursue unduly disruptive inspections in another State because the latter can always retaliate in kind.

infrastructure of a State—cannot be so high that they go largely unfilled or they constitute severe potential disruption of the inspected State's activities.

During discussions in WG4, it has become clear that State-wide verification of the absence of nuclear weapons at undeclared locations will not be practicable or feasible without significant help from unilateral means of monitoring. National technical measures will be necessary to supplant information yielded by declarations and inspections. Satellite imagery, open source analysis, and big data analysis could help direct inspection activities. Environmental sampling and radio-isotope detection seem, at first sight, less promising because even if there are nuclear weapons on the site, unless there has been processing activities there may be little-to-no environmental signatures to detect.[28] Certain sites may also not allow such sampling to protect unrelated or historic activities, or have radioactive signatures that confuse or mask detection capabilities. However, it is still worthwhile pursuing further study on these and other means of broad-spectrum data-gathering, as coupled with information barriers these may still hold non-compliant activities at risk.

The IAEA has further built on its existing safeguards system by developing the "State-level concept," which looks at the State as a whole. This includes assessments of so-called "acquisition paths," which help the IAEA direct its verification/inspection efforts.[29] Procedures akin to the "acquisition path analysis" could not only help assess the data gathered by the inspecting entity; they could also provide useful insights and pointers regarding which undeclared location warrants closer attention.[30] The IAEA uses a wide array of publicly available information to get a clearer picture of a State as a whole, which may in turn help with the efficient implementation of safeguards in that State.[31] Although the State-level concept has no direct application to nuclear disarmament verification, some of the underlying analytical models have been relevant to the discussions of WG4.

Site-Specific Challenges

Once a site has been selected for inspection for undeclared weapons, the challenge of verifying the absence of nuclear weapons at that particular site could begin. In general, this involves

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[28] Radio-isotope detection and environmental sampling could be useful for determining that a site is not an undeclared facility. However, they could show presence of a military activity that is not constrained by a treaty regime; States cannot be sure of preventing cross-contamination from stored items (or even peaceful nuclear activities), given the detection threshold of these techniques is so low, down to the individual particle level. Therefore, its use in determining that a suspect site is an undeclared facility containing nuclear weapons could be problematic. Radio-isotope detection and environmental sampling at a formerly declared facility may only confirm that nuclear weapons were located at the site without providing information on whether or not they are still at the site.

[29] For more information on the APA, see IAEA, "Supplementary Document to the Report on the Conceptualization and Development of Safeguards Implementation at the State Level," document GOV/2013/38.

[30] See WG4 Deliverable Part IV, Paper 2. Evaluating Confidence in Compliance.

[31] See WG4 Deliverable Part IV, Paper 4. Nuclear Cultural Anthropology, for more information that may be pertinent in this context.

questions of procedure and technology, starting with negotiating access with the State in question.

Credible procedures and arrangements would have to be in place for a large range of different types of locations and terrains (determination of size of sites, transport, observation methods, technology, etc.). It may be worth looking at established CFE procedures in this regard.[32] The next question is how to determine what inspectors would actually do when they get to the area/site they have chosen to inspect, and what (practical, logistical, and other) challenges they would face, such as how to choose what buildings to enter and what to look for. In this context, there could be possible lessons from CWC challenge inspection training, which focuses on medical facilities, health and safety documentation, and explosives areas. Other options could be to ascertain radiation signatures or swipe sampling, discussions/interviews with staff, or assessment of security arrangements.

Solutions have to be found for specific locations, such as overseas military bases and surface ships, including military ships and civilian vessels.

When inspections are to be carried out in a contiguous geographical area, it is important that some form of "lockdown" can be applied in the time between the announcement of the inspection and the inspection itself, meaning that certain restrictions will apply in terms of moving certain items within or outside the location.[33]

There is also a need for further research into useful technologies for conducting inspections on sites. If a team is inspecting an undeclared site, what type of detection methods could be used? These will be different for highly enriched uranium (HEU) and plutonium sources. The usefulness and feasibility of the collection of radiation and/or heat signatures should be discussed further to assess what the chances are of detecting undeclared weapons in a location. As the inspecting entity should not, in fact, encounter nuclear weapons while verifying the absence of undeclared items, in most cases there should be few limits to the type of measurements that can be arranged.[34] Conversely, when establishing the absence of undeclared weapons in a wider area, radiation signatures from any weapons present may be weak, especially at a distance and with varying level of shielding. For large areas, good survey technology is not available, meaning that locations identified for inspection should be as small as possible.

However, other considerations of safety, security, and information protection would still apply. There will be many sites in a State that are of a highly sensitive nature, whether for military, national-security, or other reasons; at such sites, access and measurements by inspectors could be restricted.

[32] WG4 Deliverable Part V.

[33] Compare New START, which includes pre-inspection restrictions in terms of weapons-related activities on sites that have been selected for inspection.

[34] Exceptions may be for facilities with very specific purposes, such as producing highly enriched uranium or low-enriched uranium fuel for naval reactors.

The sheer range of sites that may come into play when verifying State-wide absence of undeclared nuclear weapons at undeclared locations makes it difficult to list all the site-specific challenges that could surface in this context. Although these issues were certainly examined during discussions in WG4, discussions were not exhaustive due to time constraints. Key issues include the following:

- Some sites may host sensitive military-related activities that cannot be accessed by an inspection team made up of foreign personnel;
- Facilities associated with the Naval Reactor Program (fuel fabrication, reactors, etc.) may not be open to inspections;
- Techniques, like environmental sampling may not be available at certain sites (e.g., former weapons sites) or would not be conclusive (nuclear sites in general), although they could be useful for absence measurements at other sites;
- Presence of explosive materials at certain sites; and
- Possible presence of depleted uranium.

Conclusion and Recommendations

Having discussed the concepts, objectives, and challenges involved with the State-wide verification of the absence of nuclear weapons at undeclared locations, and conducted a table-top exercise based on a simplified version of the CFE verification mechanism,[35] WG4 made the following general observations:

- It should be possible to credibly, practically, and effectively verify the absence of undeclared items or activities in a State as a whole, without compromising State sovereignty.
- Sufficient assurance of absence of non-declared items on a State-wide level would be attained only in combination with other pre-negotiated verification arrangements.
- The complications caused by the relatively small size of items declared as warheads[36] in combination with the large number of potential undeclared locations in a State should be addressed through the “everything at risk at all times” approach.
- Existing verification mechanisms may form a useful starting point for analysis, but must be adapted to suit the different requirements involved.
- Verification of State-wide completeness will only be possible with the right procedures and technologies, including unilateral means of monitoring.

[35] See WG4 Deliverable Part V, Report of the CFE Table-Top Exercise.
[36] See WG4 Deliverable Part II, Paper 1, Categorization of Nuclear Weapons.

There was a general convergence of opinion among WG4 members that State-wide verification of the absence of nuclear weapons at undeclared locations in the context of nuclear disarmament is conceptually and hypothetically possible. Of course, whether and how any such mechanism could be set up to be practically viable, without compromising State sovereignty, is a question that can only be answered through more research and analysis.

In general, further effort is needed to work on a general conceptual framework of inspection types and numbers, focused on the "everything at risk" approach.[37] Such a framework should take into account the necessity to protect States from unnecessary or overly intrusive inspections. Existing verification mechanisms such as those of the Comprehensive Nuclear-Test-Ban Treaty (CTBT), CFE, and Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CWC), as well as relevant past experiences, would form a good starting point for such work.

It is very likely that scenario-based work would benefit our understanding of the challenges and solutions connected to State-wide verification of the absence of nuclear weapons at undeclared locations. More detailed scenarios and simulations based on the concepts in WG4 Deliverable Part IV Paper 2, including work on acquisition path analysis and table-top exercises, could be helpful in gathering useful insights regarding what types of locations would be most relevant to a State-wide verification effort, which parameters would likely be relevant for finding such locations, or under what circumstances diversions or irregularities would be most strategically or militarily significant.

More research is needed on the question of which types of information are needed for State-wide verification of the absence of nuclear weapons at undeclared locations, including the technologies to acquire that information. The matrix in WG4 Deliverable Part II is a useful starting point for such work. It would also be useful to gain a better understanding of the possible role for National Technical Means (NTMs) as used in existing and previous verification such as the START and CFE treaties. The concepts, processes and data used by the IAEA to form a State-level picture of States' nuclear activities, as well as to direct its verification efforts, should also be taken into account.

Finally, the site-specific challenges outlined above merit further attention, both in terms of procedure and technology.

[37] See WG4 Deliverable Part IV, Paper 2. Evaluating Confidence in Compliance for more details on statistical approaches.

Working Group 4 Deliverable
Part IV. Detailed Analyses of Various Aspects of Verification of Declarations

Paper 1. Categorization of Nuclear Weapons

Paper 2. Evaluating Confidence in Compliance: Methods to Evaluate Random Selection Approaches and Confidence Building Statistics

Paper 3. How to Resolve Inspection Ambiguities

Paper 4. Nuclear Cultural Anthropology: An Exploration of the Influence of Cultural Norms and Changing Cultural Behaviors on Nuclear Cultures

Paper 1. Categorization of Nuclear Weapons

Working Group 4: Verification of Nuclear Weapons Declarations

June 2019

Abstract

This paper presents how nuclear weapons may be categorized according to

- Weapons technology;
- Intended use;
- Means of delivery;
- Operational status; or
- Names or model designations.

The relevance for nuclear disarmament verification of each method of categorization is discussed.

Introduction

Many different ways and many different terms are used to characterize nuclear weapons. Some may be relevant to nuclear disarmament verification, others most likely not. Some characteristics may be impossible to verify due to proliferation concerns. This paper provides a short overview of the terminology.

In Phase I of the IPNDV, a "nuclear explosive device" was defined simply as a device containing both weapons usable fissile materials and high explosives. For Phase II, the official P5 definition may be more appropriate: A "nuclear weapon" is a "weapon assembly that is capable of producing an explosion and massive damage and destruction by the sudden release of energy instantaneously released from self-sustaining nuclear fission and/or fusion."[38]

Nuclear weapons may be categorized in multiple ways according to weapons technology, intended use, means of delivery, and operational status, as well as by their actual names or model designations. This is discussed below.

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[38] P5 Working Group on the Glossary of Key Nuclear Terms: *P5 Glossary of Key Nuclear Terms*, China Atomic Energy Press, Beijing, April 2015, https://2009-2017.state.gov/documents/organization/243293.pdf.

How an inspector can be become confident that the system being verified is indeed of a specific, uniquely identified type, is a further question beyond the scope of this paper. Verifying that two systems are of the same type, based on measurable characteristics and supporting information as described throughout the paper, is more straightforward to accomplish.

Categorization According to Weapons Technology

Basic nuclear physics describes two different ways of releasing energy from atomic nuclei: "fission" (splitting) of heavy nuclei or "fusion" (merging) of light nuclei.

The early nuclear weapons were all fission weapons in which the fissile material, that is, uranium and/or plutonium of suitable quality, undergoes a very rapid fission chain reaction. Fissile material emits alpha and gamma radiation, the former is stopped by any kind of casing and is therefore irrelevant for nuclear disarmament verification, but the latter, especially gamma radiation from plutonium, will get through substantial layers of material and may therefore be of interest to disarmament verification inspectors.

There are two different types of nuclear weapons making use of fission: gun-type assemblies and implosion weapons. The type used in a given weapon may affect how and where the inspectors make their measurements.

Fusion weapons are also known as thermonuclear weapons. The fusion process requires large amounts of energy to begin, which is provided by first setting off a fission charge. Fusion weapons are therefore often referred to as two-stage weapons because each weapon contains two charges, a primary (fission) stage and a secondary (fusion) stage. The primary stage will contain fissile material as described above and may be of use for nuclear disarmament verification inspectors. Very little official information about the secondary stage has been made available to the public.

Basic nuclear physics limits the yield (the released energy) of a fission weapon, while in principle the yield of a fusion weapon is almost unlimited. The physical characteristics of nuclear weapons will, to some extent, depend on the technology used in a given weapon. However, this is hard to generalize because weight and shape also depends heavily on intended use of the weapon, engineering sophistication, yield, etc. Some weapons have been several meters long and weighed several tons, whereas other weapons could be launched by artillery guns.

Some knowledge of the technology applied in a given weapon is essential for nuclear disarmament verification purposes because this determines what possible radiation may be detected and which methods may or must be used in the verification process. Physical characteristics such as shape and dimensions of the outer casing may provide supporting verification information. Relevant technical information can only be provided by the weapons owner, for example as part of the declaration process.

Categorization According to Intended Use

This categorization divides all nuclear weapons into one of two possible categories: strategic nuclear weapons and non-strategic nuclear weapons. The dividing line between the categories is rather fuzzy. As the names imply, strategic weapons are intended to play a role in the bigger picture with deterrence and power balance, whereas non-strategic nuclear weapons may play a more operative role. Depending on their deployment, the same weapon systems could in many cases have either a strategic or a non-strategic function. Furthermore, for one State, strategic balance may be measured relative to its neighbor, while for another State, global balance may be the most important.

Several definitions exist of strategic and non-strategic nuclear weapons. However, the only usable definition seems to be the simple one stating that a strategic nuclear weapon is any weapon covered by a strategic arms control treaty. This definition applies only between the United States and Russia, although China also considers its longer-range weapons to be strategic nuclear weapons. Other States possessing nuclear weapons may have different views on what constitutes a "strategic weapon"; for example, if a nuclear weapon is capable of hitting the territory of a given State, the States in question may consider that weapon to be strategic regardless of its range.

"Non-strategic nuclear weapons" are often referred to by numerous other names such as "tactical nuclear weapons," "sub-strategic nuclear weapons," "battlefield nuclear weapons," or "theater nuclear weapons." There are no strict definitions of these terms; they could refer to yield, delivery vehicle, intended use, or other criteria, but again very similar systems in different States are likely to be defined differently. For example, in the United States, there is a differentiation between battlefield or tactical nuclear weapons and theater nuclear weapons, which are related to both range and intended use.

Whether a specific nuclear weapon is considered strategic or not should be of little or no importance to nuclear disarmament verification because the tools and procedures applied would be largely independent of the intended use of the weapon.

Categorization According to Means of Delivery

Many ways exist for delivering nuclear weapons to their intended point of detonation. At the highest level, all nuclear weapons would fall into one of three general categories classified by where the delivery systems are based: ground-launched, sea-launched, or air-launched/air-delivered. Space-based nuclear weapons, although possible, are not considered in this paper because they are prohibited by the widely accepted Outer Space Treaty,[39] which entered into force in 1967.

Ground-launched nuclear weapons include ground launched ballistic missiles (GLBMs) and ground launched cruise missiles (GLCMs) as well as artillery shells and landmines with nuclear charges. Many different types of ballistic missiles have been developed for different purposes. They have been designed to carry different weights over different ranges, and they use different propellants. They are often subcategorized according to range, for example as shown in the Table IV-1-1 below:

Table IV-1-1. Missile Subcategories and Ranges

Subcategory	Acronym	Range
Close range ballistic missile	CRBM	Less than 300 km
Short-range ballistic missile[a]	SRBM	300–1000 km
Medium-range ballistic missile[a]	MRBM	1,000–3,000 km
Intermediate-range ballistic missile	IRBM	3,000–5,500 km
Long-range ballistic missile	LRBM	
Intercontinental ballistic missile	ICBM	Greater than 5,500 km

[a] SRBM and MRBM may be combined to the term "theatre ballistic missile" (TBM) (range between 300 km and 3,000 km).

As an example of the lack of standardization of these terms, one may observe that the 1987 Intermediate-Range Nuclear Forces Treaty (INF Treaty)[40] defines an "intermediate-range missile" to have a range of 1,000–5,500 km and a "shorter-range missile" to have a range of 500–1,000 km. (This remains a non-standard definition of short range, however; the MTCR[41] definition of 300 km as the lower limit appears to have gained greater credence.)

Both GLBMs and GLCMs may be launched from fixed launchers (such as missile silos) or from mobile, land-based transporter-erector-launchers (TELs).

Many ballistic missiles are equipped with multiple re-entry vehicles (MRVs) or multiple independently targetable re-entry vehicles (MIRVs); thereby each containing several nuclear warheads. The term "nuclear warhead" is therefore often used for general bookkeeping purposes instead of the term "nuclear weapon," even though the term "warhead" is defined conventionally as referring only to the explosive elements delivered by a missile.

Sea-launched nuclear weapons include ballistic missiles and cruise missiles as well as torpedoes, depth charges, and mines equipped with nuclear charges. These weapons may be launched

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[39] Formally known as the *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html.

[40] Formally known as the *Treaty between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles*, https://www.state.gov/inf.

[41] MTCR is short for Missile Technology Control Regime, which is a multilateral export control regime for missile technology.

from surface vessels or submarines. The terms “SLBM” and “SLCM” are used somewhat ambiguously. They are often taken to mean submarine-launched ballistic missile and submarine-launched cruise missile, respectively, but “SL” could also be read as “sea-launched” or “ship-launched.” For example, the United States generally uses SLCM to mean a sea-launched cruise missile regardless of whether it is launched from a ship or from a submarine. However, sometimes the term “ShLCM” has been used to specify a “ship-launched cruise missile.” Sea-launched ballistic missiles may be further subcategorized according to range as described above for ground-launched ballistic missiles.

Air-launched nuclear weapons include air-launched ballistic missiles (ALBMs) and air-launched cruise missiles (ALCMs). Torpedoes may also be launched from aircraft. Air-delivered nuclear weapons are nuclear bombs that are dropped close to the intended point of detonation. Traditionally, these were unguided bombs, also known as gravity bombs, but modern bombs may be precision-guided bombs, also referred to as smart bombs, which include tail kits to improve the accuracy of the bomb.

The term “nuclear triad” is used when discussing nuclear weapon possessor States that deploy (strategic) nuclear weapons in all three general basing modes, that is, ground-launched ballistic missiles, submarine-launched ballistic missiles, and nuclear capable aircraft.

As far as nuclear disarmament verification goes, the techniques and technologies applied would be the same regardless of means of delivery. One useful aspect of describing systems this way, however, is that it provides inspectors with an approximate idea of what they are likely to encounter in the field. Consistency with regard to delivery vehicle, location, certain characteristics, etc. may help build confidence.

Access requirements to sites with different categories of nuclear weapons may vary, and hence the verification procedures will depend somewhat on the type of site the systems are on (naval bases, silos, mobile launchers, etc.). In summary, some information on means of delivery may be important regarding the practicalities of nuclear disarmament verification, but may not provide sufficient information on its own to identify weapon systems or individual weapons or warheads.

Categorization According to Operational Status

This categorization may be carried out in multiple ways. The discussion below first follows the approach used by the Status of World Nuclear Forces, a commonly quoted non-governmental organization (NGO)[42] and then presents the system used in the United States. Other nuclear weapon possessing states probably have similar categories for weapons in their stockpiles.

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[42] Hans M. Kristensen and Robert S. Norris, *Status of World Nuclear Forces*, Federation of American Scientists, Washington, https://fas.org/issues/nuclear-weapons/status-world-nuclear-forces/.

At the top level in the NGO categorization, all nuclear warheads are either part of the military stockpile, that is, they are in military custody earmarked for military use, or they are awaiting dismantlement, that is, retired, but still intact. In late 2018, roughly one-third of all warheads fell in the latter category.

The warheads in the military stockpile may be further subdivided into those that are deployed with operational forces and those that are non-deployed. According to the same NGO source, in late 2018, about 40 percent of the nuclear warheads in the military stockpiles were deployed. The deployed warheads may be subdivided into those that are on high alert (ready to be used on short notice) and those that are not.

Non-deployed weapons may be awaiting deployment, undergoing maintenance, or be kept in long-term reserve. Reasons for keeping a substantial number of nuclear weapons in reserve may be to ensure that the State can meet possible future geopolitical challenges and/or to safeguard against potential technical problems due to an aging arsenal.

In the U.S. categorization, all nuclear warheads are part of the military stockpile. This stockpile can be further divided into the active stockpile and the inactive stockpile. Weapons in the active stockpile are maintained to ensure that the military requirements for operational warheads are met. The inactive stockpile is composed of warheads retained in a non-operational status and can provide augmentation or replacement warheads to the active stockpile. These two categories can be further broken down into subcategories.

There are three subcategories in the U.S. active stockpile: active ready, active hedge, and active logistics. Active ready consists of warheads available for wartime employment planning. Active ready warheads can be loaded onto missiles or made available for use on aircraft within required timelines. Active hedge warheads are retained for deployment to manage technological risks in the active ready stockpile or to augment the active ready stockpile in response to geopolitical developments. Active logistics warheads are used to facilitate workflow and sustain the operational status of active ready or active hedge quantities. They may be in various stages of assembly.

The inactive stockpile is composed of inactive hedge, inactive logistics, and inactive reserve. The inactive hedge consists of warheads retained for deployment to manage technological risks in the active ready stockpile or to augment the active ready stockpile in response to geopolitical developments. Inactive logistics warheads are used for logistical and surveillance purposes; these warheads may be in various stages of disassembly. Inactive reserve warheads are retained to provide long-term risk mitigation. Warheads in this category are exempt from future refurbishment modifications or alterations.[43]

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[43] *U.S. Nuclear Warhead Stockpile*, briefing presented to the International Partnership for Nuclear Disarmament Verification, March 19, 2015.

Warheads in some of the different categories may have different characteristics, but these would not be directly observable to the nuclear disarmament verification inspectors. Different categories of warheads may be stored in different locations.

In and of themselves the above categories do not add much verification value unless they are accompanied by further information as to what this means for the physical location or state of the warhead. If a deployed system refers to the system being mated with a delivery vehicle, this would be verifiable, and similarly if it refers to the system being at a specific location. The nuclear disarmament verification inspectors would most likely prefer to meet the warhead that is to be dismantled as close to its end of deployment as possible. This will increase their confidence that the device that they are introduced to really is the warhead that it is claimed to be.

Categorization According to Names or Model Designations

This form of categorization is quite obvious and straightforward. All types of nuclear warheads and nuclear weapons have a name (for example, Little Boy or Blue Danube) and/or an alphanumeric model designation (for example, B61, Mk53, W78, or WE177). Warheads of the same general model may also have different modifications that can further differentiate the warhead or bomb. For example, the B61 gravity bomb has appeared in several different modifications to enable different uses or to increase its safety, security, and reliability (identified as B61-1, B61-2, etc.). The differences represented by the modifications may or may not be observable for a nuclear disarmament verification inspector.

Furthermore, one would expect each individual warhead or bomb to be identified by a unique serial number.

In the field of nuclear disarmament verification, these designations are important for bookkeeping purposes. It is important to uniquely identify each object under verification in ways that are meaningful to all participating parties.

Conclusion

In this paper, we have presented five independent ways of categorizing nuclear weapons according to:

(1) Weapons technology;

(2) Intended use;

(3) Means of delivery;

(4) Operational status; and

(5) Names or model designations.

In principle, any nuclear weapons may be described by terms from all of these five categorization systems. In the earlier sections of this paper, we have discussed the relevance of each of the different systems to nuclear disarmament verification.

Paper 2. Evaluating Confidence in Compliance: Methods to Evaluate Random Selection Approaches and Confidence Building Statistics

Working Group 4: Verification of Nuclear Weapons Declarations

September 2019

Abstract

The measurement or quantification of confidence is a complex problem; first because confidence is a perception and as such is subjective by nature, indicating that even with the pertinent information, confidence may differ between evaluators; and second, because although one may want to collect all information, the practicalities of the real life limitations of resource constraints (number of inspectors that are both available and trained), time (the amount of time that is agreed in the treaty for the inspector's access to the sites), access constraints (host safety or security restrictions that limit access or restrict inspection activities in specific environments), and ultimately the cost of conducting an inspection overall. Because of these things, it is necessary to layer various different tools to not prove confidence, but instead provide evidence that can be used by assessors to bolster their perception of confidence. The existence of these real-life limitations suggests that although the inspectorate might want all to collect all information to provide enough confidence, realistically, the reality of those limitations make it such that random selection poses a more reasonable option.

Although random selection is a strong measure by itself, mechanisms exist to augment it by identifying tools and applications that, when applied to random selection, can create an effective and efficient approach for evaluating confidence. The three main levels at which confidence can be assessed are as follows: The first is at the single-item level: how confident can an inspector be about the compliance assessment of an item or its application given the current inspection tools? The second is at the multi-item level: how confident can an inspector be about a suite of tools or applications given the subset of items or the environments being inspected? The third and final level is at the systems level: across a site or a State, how confident can an inspector be about compliance across the entire regime based on the subset of inspection tools, applications sites, items inspected, based upon the known facilities and processes of a State? Because of subjectivity, mechanisms used to evaluate confidence must do so using very prescribed and consistent processes, designed in such a way to reduce the influence of personal perception to the greatest degree possible. Proposed approaches and their associated technical elements within a random selection regime can objectively produce

numerical data, creating quantitative tools to determine random selection inspection effectiveness in relation to the expected verification environment.

Using Random Selection

Although the constraints of reality indicate that random selection may be more realistic than measuring every item, it does not prevent everything from being "at risk" of inspection. In fact, the holding of everything at risk until such a time that the inspectorate determines which specific location and items will be inspected on that visit is an important tool to deter cheating. Limitations of random selection and the possibility that a treaty, such as the Conventional Forces Europe (CFE), may allow a number of items to be in temporarily deployed status but not have to be reported as transferred from that facility. Because of this, random selection decisions may be limited in nature to selecting a site and then pre-planning the number or percentage of items for visual and radiation detection inspections, while leaving the complete item selection until that actual serial number inventory and their status' are available. At this point, the available inventory can be held at risk through random selection, thus maintaining deterrence to cheating at the site level.

As mentioned previously, confidence is subjective, thus a single random selection verification inspection is not likely to deliver complete confidence from the inspectorate that they understand the host's processes and believe that the host is 100 percent compliant across the regime. Instead, evidence of consistency can be collected through multiple layers of statistical evaluations that provide evidence to support the growth of confidence over time and as each layer matures. Repeated random selection inspections also serve to help develop a growing body of evidence which over time, increases the inspectorate's perception of confidence. Over time, the ability to observe consistency in behaviors, processes, and documentation lends more credence to the host's claim of compliance through openness and transparency.

There may be a correlation between the inspectorate's desired level of confidence and the consequences of non-compliance. For example, if any evidence of non-compliance is detected, this could undermine the fundamental security relationships between States party to an agreement. A lower level of confidence in any sampling process might therefore be acceptable as the inspected State would have strong disincentives to cheat. On the contrary, if there are limited consequences to non-compliance, an inspecting entity may wish a greater rate of sampling to increase the confidence level.

Tools for Evaluating Random Selection Approaches

Not all tools and mechanisms are created equal. It is important to understand that in many cases, both in the design and implementation of evaluation, there are spaces in evaluation where subjectivity and perception retain roots. When constructing the data sheets for a technology, for example, technologists have certain perceptions of their technology's capabilities and performance that may not be repeatable in all environments. Additionally, in evaluation, there is subjectivity in the weighting scheme based upon the evaluator's perception of the environment. Last, there is subjectivity in the determination of what value product is necessary to deliver confidence (x=confidence). Because of this subjectivity, there is not necessarily a one-size-fits-all means for evaluating confidence. However, there are numerous different mechanisms that could be used to measure elements of a compliance regime and provide quantifiable data on the effectiveness of those elements in a single application, even though quantification of overall confidence may still be elusive.

> Although there is no universally accepted definition of verification, there is a common understanding of its meaning as "an activity whose purpose is to establish the degree of compliance with, or violation of, the specific terms of an agreement." Verification encompasses the technical elements of monitoring and inspection as well as information processing and evaluation. The aim of verification is to increase confidence that an agreement is being fully implemented by providing parties with the opportunity to convincingly demonstrate their compliance and to detect non-compliance, thereby deterring parties which may be tempted to cheat.[44]

This section discusses briefly several methods that could be used to evaluate random selection compliance approaches to verification. Within this paper we will discuss three layers of statistical approaches: For technology and application comparison, hybrid qualitative/quantitative approaches include The Arms Control Evaluation Criteria (ACEC), the Analysis of Alternatives (AoA) Methodology, and the Analytical Hierarchy Process (AHP). For combined technology suites or applications, we discuss mathematical approaches to assessing compliance like the statistical rule-of-three or estimates of probability. For the higher-level systems-level obligation assessments, tools such as Acquisition Pathway Analysis (State Level Concept), Discrete Event Simulation (DES) and Game Theory might be most applicable. Although these may not be the full breadth of all approaches that could be used, others very likely include elements or evolutions of these methods.

Informing Direct Comparison Activities

Hybrid Qualitative/Quantitative Approaches

When considering hybrid qualitative/quantitative approaches, application of the hybrid methods is applied differently than the individual qualitative or quantitative approach independently. Because each of these approaches still provides for inserting subjective perspectives that can influence the overall outcome, it is important to limit such influences through a direct and concise set of evaluation questions that both limit subjectivity and require proof of validity in the response. Confidence in each of the following approaches results from an amalgamation of results associated with each of the independent elements of the random

[44] N. Zarimpas, *Transparency in Nuclear Warheads and Materials: The Political and Technical Dimensions* (Oxford University Press, 2003).

selection regime and the quantified effectiveness that each element provides in delivering accurate results. These tools will help the inspection parties determine which technologies or approaches will be most effective in delivering the confidence levels expected based upon the effectiveness of their internal approach elements.

The Arms Control Evaluation Criteria

The ACEC is used to objectively assess and compare technologies and technology design features for effectiveness in meeting the verification needs for specific applications. The ACEC evaluation approach provides an easy-to-use methodology for the objective comparison of treaty verification technologies. Although this tool could potentially be used to compare entire suites of technologies within a hypothetical arms control agreement, its primary intent is to compare individual technologies that fulfill a specific monitoring objective (e.g., tamper indicating seals applied to secure equipment or rooms, which may be examined later to verify integrity of the item secured). The ACEC contains a detailed hierarchical structure of the two evaluation Criteria Suites (CS), which contain a total of six Evaluation Criteria (EC) that are used to assess competing technology options. EC are numbered according to their hierarchy, with the CS number listed first, followed by the evaluation criterion number. Inspected State-only criteria/considerations are indicated by an asterisk and should be examined with respect to inspected State-only perspectives; all other criteria/considerations should be jointly examined from both inspected State and inspecting entity perspectives. The user tool is a web-based tool that can capture and depict the resulting comparison.

The two CSs and corresponding six EC are summarized below:

- CS 1: Ability to demonstrate or verify compliance
  - EC 1.1 Confidence in the ability to meet the end-use application
  - EC 1.2 Confidence in the accuracy of information
- CS 2: Ability to be deployed in host facility
  - EC 2.1: Sensitive information protection*
  - EC 2.2: Hazard level
  - EC 2.3: Cost
  - EC 2.4: Deployment readiness

Several elements of this approach rely on subjective inputs to provide the data that are used to identify technologies that meet the needed criteria: how the criteria are weighted and what elements are prioritized or restricted. It does, however, provide a mechanism for both the host and inspector to evaluate technologies from their differing perspectives and to weight the criteria based upon the two different knowledge bases. Additionally, the ACEC allows for the user to adjust weighting of criteria based upon their perception of the criteria’s importance to the regime. This adjustability of weighting criteria allows the evaluation process to be customized.

Analysis of Alternatives (AoA)

AoA is an analytical comparison used by the U.S. Department of Defense (DoD) to assess operational effectiveness, costs, and risks of alternative approaches to operations.[45] The AoA is different from the ACEC in that it is designed to compare multiple technologies at the same time, eliminating the need to perform multiple pair-wise or "head-to-head" comparisons. However, like the ACEC, the AoA relies on potentially subjective information of technical capability. It is critical to the AoA to have consistent and complete technical information to accurately evaluate technologies and reduce the likelihood of unverified inputs from subject matter experts being used for decision-making.

Additionally, the AoA method and associated tools (e.g., Microsoft Excel) provide a user-friendly evaluation rationale clearly depicting results with coded bullets (e.g., ++, +, =, -, --) to identify pros and cons for each option, and the scaling system for the AoA makes it easy to understand the meaning of the option's overall score (e.g., red, yellow, green stoplight-style chart). Using criteria considerations (CC) offers the flexibility to support multiple different tool evaluations. The ability to use CCs instead of independent criteria reduces unnecessary evaluation complexity. The AoA tools include two Excel components: the first defines and evaluates the value of that criterion, and assesses the technologies performance against those criteria, whereas the second describes the rationale for the weighting and documents pros and cons of each technology in comparison. Examples of the AoA assessment sheets are illustrated in Tables IV-2-1 and IV-2-2.

Table IV-2-1. Example Analysis of Alternatives Excel Tool: Values and Weighted Scores

Analyses of Alternatives Excel Tool: Values
Directions: Users of this criteria evaluation Excel tool should identify the end-use application, technologies to be examined, pertinent technology information, and criteria weighting before proceeding. This "Values" sheet should be where users specify the end-use application, technology names, and varied weight fractions. Users may also input technology scores for each criterion in this sheet after identifying rationale on the Rationale sheet. All user inputs should be made in the shaded Excel cells.

End-Use Application:	

	Technologies Examined

[45] Office of Aerospace Studies, *Analysis of Alternatives Handbook: A Practical Guide to the Analysis of Alternatives* (Kirkland AFB, New Mexico, 2016).

Criteria	Equal Weights	Varied Weights	Tech1	Tech2	Tech3	Tech4	Tech5
Confidence in the ability to meet the end-use application	0.1667						
Confidence in the accuracy of information	0.1667						
Sensitive information protection	0.1667						
Hazard Level	0.1667						
Costs	0.1667						
Deployment Readiness	0.1667						
TOTAL SCORE (Equal Weights):			0.00	0.00	0.00	0.00	0.00
TOTAL SCORE (Varied Weights):			0.00	0.00	0.00	0.00	0.00

Table IV-2-2. Example Analysis of Alternatives Excel Tool: Rationale

Analyses of Alternatives Excel Tool: Rationale
Directions: Describe the rationale driving the scores on the Values sheet. Enter the rationale for each technology in the shaded boxes. Additional notes not affecting scores on the Values sheet may also be made in the additional note section of this sheet. Use the following system to identify positive/neutral/negative rationale: ++ Very Positive Feature + Positive Feature = Neutral Feature - Negative Feature -- Very Negative Feature

End-Use Application:	

	Technologies Examined				
Criteria	Tech1	Tech2	Tech3	Tech4	Tech5
Confidence in the ability to meet the end-use application					

Confidence in the accuracy of information					
Sensitive information protection					
Hazard Level					
Costs					
Deployment Readiness					
Additional Notes					

The Analytical Hierarchy Process (AHP)

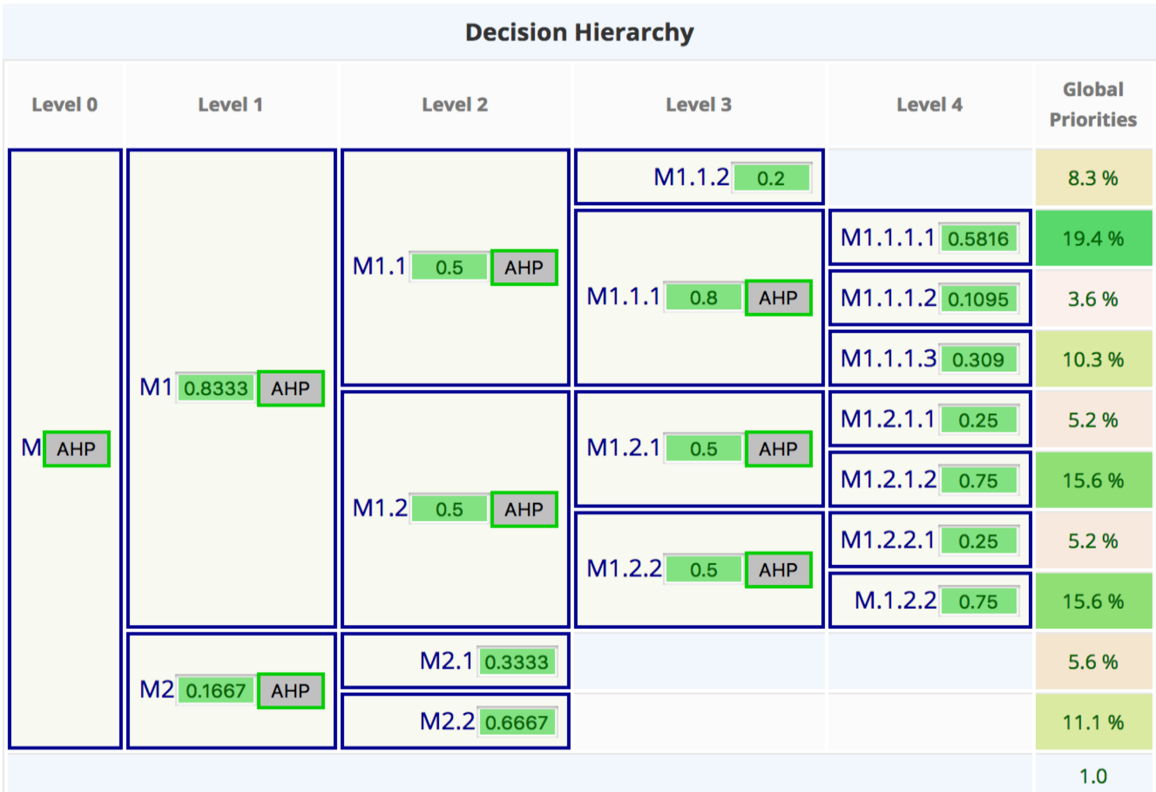
AHP is a rigorous decision-making tool that uses a set of values and perceived relationships between values, to help the user determine priorities and ultimately make the best decision between options based upon both subjective and objective inputs. Created by Thomas Saalty in 1980, AHP uses pairwise relative evaluations of both the criteria and the options provided by the user, to make the best decision determination. "The computations made by the AHP are always guided by the decision maker's experience, and the AHP can thus be considered as a tool that is able to translate the evaluations (both qualitative and quantitative) made by the decision maker into a multicriteria ranking." Using the AHP is simple because there is no need for a complex tool to capture expert knowledge. However, every criterion is necessarily compared for every pair of alternative tools considered, with a weighting vector to determine the importance of each individual criterion relative to the others (see Figure IV-2-1). For example, tool A is compared to tools B and C, and then tool B is compared to tool C, repeating for all criteria considered.

It follows, then, that "the number of pairwise comparisons grows quadratically with the number of criteria and options. For instance, when comparing 10 alternatives on 4 criteria, (4 x 3)/2 = 6 comparisons are requested to build the weight vector, and 4 x ((10 x 9)/2) = 180 pairwise comparisons are needed to build the score matrix."[46] To simplify the use of AHP, automation may be necessary, especially in the case of larger numbers of comparisons. Automated tools exist to compute the results after the input is provided, which reduce the overall magnitude of time needed to conduct the pairwise comparisons.

As an example of the magnitude of these pairwise comparisons, where a comparison is performed between seven tamper indicating seals, the AHP comparative approach would require 21 pair-wise comparisons to make an option determination. The decision-making process of the AHP requires a weighted decision-making hierarchy, which is then ultimately depicted in a comparison diagram in Excel.

[46] T.L. Saalty, *The Analytic Hierarchy Process* (New York: McGraw-Hill, 1980).

Figure IV-2-1. AHP Decision Hierarchy



Assessing Combinations of Technologies and Approaches for Evaluating Compliance

Mathematical Approaches

The various elements of verification all contribute to confidence in compliance, but it is problematic to combine them to mathematically gauge a single absolute measure of confidence. The element of inspections may come closest through statistical confidence measures that can be derived from the resulting inspection data. Inspections offer the opportunity to directly examine weapons via direct observations, measurements, and tests using various technologies.[47] With this, an inspection could determine if a weapon is compliant or not with its declared attributes. Ideally, such inspections could examine every documented weapon that is under the treaty and this would offer a definitive statement on the site being compliant or not. However, for various reasons (e.g., time and resource constraints, access limitations, and especially cost), it is typically not practical to inspect all weapons at a site.

[47] N. Zarimpas, *Transparency in Nuclear Warheads and Materials: The Political and Technical Dimensions* (Oxford University Press, 2003).

Rather a subset of the weapons determined via random selection is inspected and from this a statistical statement is formed that provides a confidence measure in compliance.

The same approach can be used when comparing suites of technology for effectiveness in delivering the measure of compliance needed to provide confidence that a specific activity or set of activities is being performed as expected and without deviation from the understood processes.

Statistical Rule of Three

A simple statistical rule in this regard is called "the-rule-of-three," which provides that if no "defects" are found in a batch of n items, then with 95 percent confidence there will be fewer than 3/n defects in all of the items.[48] So if a batch of 30 weapons are inspected and no defects—in this example, noncompliant weapons—are found, then with 95 percent confidence one could claim there are fewer than 3/30 or 1/10 noncompliant weapons overall at the site. This notion can be extended to other confidence levels such as 2/n, which would yield 86.5 percent confidence that there are fewer than 2/30 or 1/15 noncompliant weapons. Alternatively, using 5/n would yield 99.3 percent confidence that there are less 5/30 or 1/6 noncompliant weapons. In this case, there is a high degree of confidence in the stated numbers, but the potential of 1/6 noncompliant weapons are likely far from ideal in forming a statement about the overall confidence in an inspected State's declared nuclear weapons being compliant.

The only way to overcome this is by inspecting more weapons. For example, using 3/n again, if instead 300 weapons were inspected with no defects, one could state with 95 percent confidence that there are fewer than 1/100 noncompliant weapons at the site. Note that the above discussion assumes that inspectors can randomly sample any of the weapons at the site with equal likelihood (i.e., the site does not limit access to certain potentially noncompliant weapons). If this likelihood criteria is not met, other verification elements may act to further support an overall confidence claim.

Estimating Probability of Noncompliance

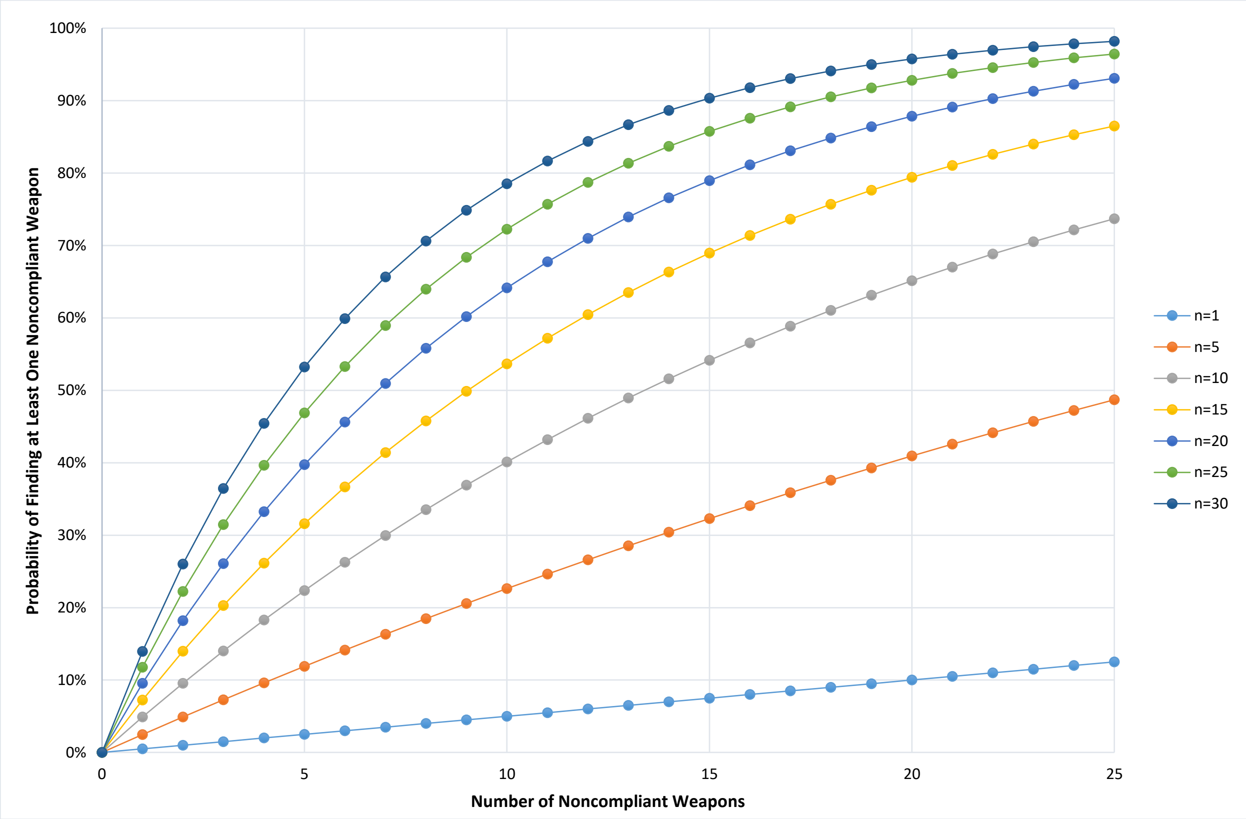
Another view of confidence comes from estimating the probability of identifying at least one noncompliant weapon as related to an assumed noncompliant weapon fraction at a site. If there are more noncompliant weapons, the inspector is more likely to find at least one, and more likely still if many weapons are inspected. For instance, Figure IV-2-2 shows a plot of the probability of finding at least one noncompliant weapon versus the assumed number of noncompliant weapons at a site as a function of the number of weapons randomly inspected. For convenience, we consider a site having 200 weapons, where the noncompliant fraction is used to determine the number of noncompliant weapons. For a site having a significant number of weapons (e.g., more than 50), the formula that provides an approximate probability for this

[48] Tony Gojanovic, *Zero Defect Sampling,* November 2007, http://asq.org/quality-progress/2007/11/basic-quality/zero-defect-sampling.html.

is P = 1 – (1 – F)n where F is the noncompliant fraction and n is again the number of weapons inspected.[49]

From this plot, one can see the trade-offs in dealing with confidence. For example, if one assumes a significant level of noncompliant weapons at a site (e.g., 10 percent noncompliance or 20 noncompliant weapons) and say 15 of the weapons (from the total pool of 200) are randomly inspected, there is about an 80 percent chance that at least one of the noncompliant weapons will be discovered. Hence, if no noncompliant weapons were found, although there is not a quantitative confidence level that can be assigned, one would have pretty good confidence that the site is compliant. However, if there is only 1 percent noncompliance (2 noncompliant weapons) at a site and 15 of the weapons are again randomly sampled, there is now only a 14 percent chance of finding at least 1 of the noncompliant weapons. So even though no discrepancies were identified, one's confidence in the site being compliant would not be as great in this case because the likelihood of discovering a noncompliant weapon was low.

Figure IV-2-2. Probability of Finding at Least One Noncompliant Weapon at a Site with 200 Weapons (n is the number of weapons randomly inspected)



[49] N. Zarimpas, *Transparency in Nuclear Warheads and Materials: The Political and Technical Dimensions* (Oxford University Press, 2003).

The essential challenge then is knowing the degree of noncompliance at a site, which obviously cannot be ascertained with certainty. However, if some past historical data are available, one can use this to potentially gauge where a site might fall in its level of compliance and then use this to support a confidence claim from the inspection results. It is also noted that a treaty partner could use this same sort of analysis to realize that if they only had one or two noncompliant weapons at their site, the probability that one of these would be detected via random sampling is relatively small. Although this is where the notion of deterrence comes into play, that is, by conducting the inspections and randomly selecting which weapons to inspect, the hope is that treaty partner(s) would be less inclined to cheat.

Furthermore, inspectors can keep track of which weapons have been previously inspected at a site so that these are not included in the next pool of weapons to be randomly inspected. This means that the fraction of noncompliant weapons in the remaining pool of weapons would increase, and in turn this would increase the probability that at least one noncompliant weapon is detected in the next round of inspections.

Finally, we note that this same approach (as well as the rule-of-three) could also be applied at a more detailed level of fidelity that considers specific weapon system types or specific technology suites used at a site for specific functions. Alternatively, the approach could be used to assess an entire regime, where each site is now treated as compliant or noncompliant and then a probability of identifying at least one noncompliant site via random sampling of sites across the regime could also be calculated, providing evidence for a confidence judgement in the overall regime.

Defining and Assessing Systems Level Obligations

Defining and assessing obligations occurs at a systems level. Each method for assessing compliance provides an estimate of confidence given current inspection parameters and measurements but can be re-framed to define obligations given a goal confidence level set by a given treaty. However, the compliance methods outlined do not consider the variability across sites, weapons, and facility types that may be encountered in a system in a cohesive way. Confidence in final compliance assessments relies on where in the weapons-pathway the assessment occurs; the methods in this section are designed first and foremost to identify potential areas where noncompliance can occur and best implement inspections to deter and detect it.

Acquisition Pathway Analysis (APA) IAEA State Level Concept

Although the APA in its original form is not designed to suit the needs of a weapons verification treaty, some tenets of weapons verification share commonalities with elements of the APA approach. The APA, as designed, estimates the time necessary to complete plausible routes to weapons-usable material based on all information available on a State. To more fully understand the breadth of a weapons disarmament treaty environment and determine which inspections and timings would be most effectively implemented as part of random selection, it would be essential to gain a similar understanding of the weapon's lifecycle behaviors across the State and what interactions exist between sites. Would one site expect to see storage primarily, with little transportation involved, whereas another sees limited storage or staging but significant transportation? When considering those transportation interactions, what modes of transportation would that site expect to see and where would weapons enter and depart?

Even in the IAEA APA approach, it is assumed that there will be areas of high-field inspection and low-field inspection activities.[50] This would also be a reasonable expectation in a random select application for weapon treaty compliance verification. Specific areas of priority would be selected because of what is known and assumed about the weapon's lifecycle behaviors, and then discrete numbers of random selection verifications chosen based upon predetermined inspection percentages, availability of inspection resources (people on the ground), time, and level of effort required. As mentioned in the beginning of this paper, the key to successful random selection is that everything should always be held at risk, until a final decision is made regarding the application of the random selection plan. Increased confidence in this case would result from the combination of lifecycle and behavior knowledge, witnessed or verified behaviors, and random selection verification measures.

Discrete Event Simulation (DES)

DES is an analytical "method of simulating the behaviors and performance of a real-life process, facility or system."[51] The rationale for using a discrete event simulation approach is that it does not rely on complex mathematical models, but instead attempts to recreate real world systems using logic and event-driven activities. DES codifies the behavior of a complex system as an ordered sequence of well-defined events. The strengths of DES include handling systems characterized by high variability, constrained or limited resources, and complex dynamic interactions. Processes include both those of the weapons enterprise and the monitoring system. For example, enterprise processes may include changes in the weapon lifecycle state, transportation to other sites, or maintenance activities. Monitoring system processes incorporate activities defined by Concepts of Operation (CONOPS). Likewise, enterprise resources and constraints, for example, include storage capacities and dismantlement bay availability. Example monitoring system resources are inspectors and monitoring system equipment.

PNNL developed such a DES that seeks to capture all processes and decision points associated with the progressions of virtual weapons through the monitoring system from initialization

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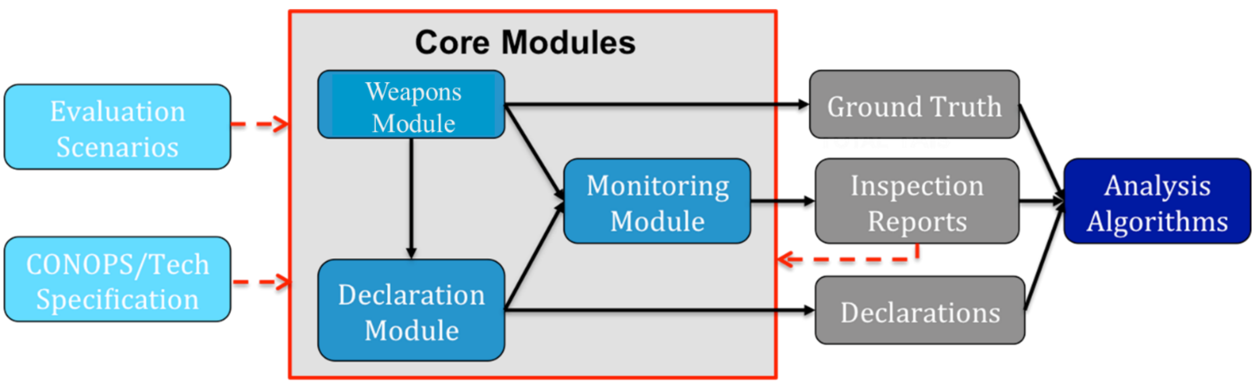
[50] Lance K. Kim, Guido Renda, and Giacomo G. M. Cojazzi, "Methodological Aspects of the IAEA State Level Concept and Acquisition Path Analysis: A State's Nuclear Fuel Cycle, Related Capabilities, and the Quantification of Acquisition Paths," *ESARDA Bulletin,* no. 53 (2015).

[51] E. Staton, G. Cates, R. Finn, K. M. Altino, K. L., Burns, and M. D. Watson, "Use of DES Modeling for Determining Launch Availability for SLS," AIAA Space Operations Conference (Pasadena, California, May 2014).

through dismantlement.[52] The simulation updates weapon progression (simulated physical movements and state changes at appropriate points) over the item lifecycle and up until dismantlement (see Figure IV-2-3). Simulation of weapon lifecycles provides the basis for assessing how the order, frequency, and combination of functions in the CONOPS affect system performance. In addition to being a suitable framework for warhead monitoring activities, a DES approach also allows for a long-term view of the entire weapon monitoring process over a treaty regime. Once the DES framework is established and associated simulation parameters and logic (rules) are established, the simulation can be run over any desired period (from months to years to decades). A discrete event simulation approach can directly output metrics of concern to evaluate overall system performance. In this case such metrics might be related to overall confidence in the warhead monitoring declaration by a treaty partner as a function of the rules, CONOPS, and monitoring technologies that might be deployed.

Beyond providing insights related to warhead monitoring, a DES approach also enables analysis of warhead monitoring inspection effectiveness/confidence under various inspection paradigms (random, targeted, etc.) along with specific evaluations and sensitivity assessments of associated sampling plans.

Figure IV-2-3. DES Simulation Framework



Because future treaties related to arms control will likely include multilateral treaty partners and non-nuclear weapons States, the use of declarations as a confidence building measure is a good first step to engage these new treaty partners in the future. Moreover, these declarations will also form a knowledgebase for information pertaining to a treaty partner's nuclear weapons enterprise. False declarations could lead to a partner's ability to subvert a weapon-monitoring regime. Methods such as DES have been proposed to quantify that level of risk, improve the ability to detect false declarations and associated uncertainty, and characterize if and how much deterrence can help reduce that risk by a system that can identify false declarations. Ultimately, this capability can be used to inform a treaty negotiator and the results could also apply to the IAEA and the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) because declarations could be valuable verification elements of the State's NPT

[52] C. Perkins, et al., "Using Simulation to Evaluate Warhead Monitoring System Effectiveness," Institute of Nuclear Materials Management 56th Annual Meeting, 2015 (Indian Wells, California, July 2015).

obligations, if applicable under country specific safeguards agreements. This analysis could potentially be used to increase confidence in these declarations, which the IAEA uses to determine compliance.

Game Theoretic Methods

Within the game theory field, inspection games have been developed to model the relationship between an inspector and host to ascertain the host's compliance with respect to a treaty or agreement.[53] An inspection game can account for the specific requirements of a treaty, practical limitations on inspector resources, and the host's potential interest in violation. In a simple two-player non-cooperative game, an inspector's goal is to deter any violations, and detect with high probability any violations that may occur. A host has the choice to violate the agreement or not, and if they violate, their goal is to avoid detection (assuming there is some negative consequence to a violation). In the random sampling inspection framework, game theoretic methods can be used to assess optimal inspection parameters such as sample size (i.e., number of items or sites inspected) as well as optimal political "punishment" to deter a violation. The results of game theory implementation directly inform best inspection practices, such as number of items to be inspected to maximize noncompliant item detection.

As in the previous sections, a major challenge is identifying the approximate noncompliance level of a site or State. In addition, game theoretic frameworks also require some knowledge of a host's interest in violation as related to interest in compliance. In quantifying these aspects, subjectivity does affect the game formulation and resulting confidence in inspection results. However, incorporating historic data to inform violation probability and the corresponding number of potentially noncompliant items, or even worst-case estimates, can moderate subjectivity's role and increase confidence in an inspection regime's detection capabilities. Recent advances[54] in safeguards game theory include quantifying advantage to a State for noncompliance using quantity and attractiveness of material/item obtained by violation, with attractiveness increasing the closer a material is to weapons-usable (see Table IV-2-3). This adds complication to the game theory model, as it includes an extra simulation step to generate these quantities, making it primarily applicable at the site level rather than system level, but removes subjectivity from the final analysis of the game as well. Overall, game theory models provide increased confidence that current and future inspection methods best implement finite resources to minimize the payoff of noncompliance for a host, and thus maximize deterrence and noncompliance detection. We believe game theoretic methods are a useful approach and will continue to see increased interest in use in both the arms control and disarmament and the safeguards domains.

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[53] R. Avenhaus, "Inspection Games in Arms Control," *European Journal of Operational Research* 90 (1996).
[54] R.M. Ward and E.A. Schneider, "A Game Theoretic Approach to Nuclear Safeguards Selection and Optimization," *Science & Global Security* (2016).

Table IV-2-3. Example Game Table for Inspector/Host Relationship Assuming Inspection Is Synonymous with Detection (C is physical cost of inspection—reflects practical constraints)

Inspector\host	Compliance	Violation
Inspection	-C/0	1/-1
No Inspection	0/0	-1/1

Conclusion

In closing, it is important to remember that confidence is not necessarily something that one can quantify immediately due to the subjectivity and the reality of what is required to verify compliance. It may not be possible to collect all information that would be necessary to deliver complete confidence because of limitations of resources (number of inspectors that are both available and trained), time (the amount of time that is agreed in the treaty for the inspector's access to the sites), access constraints (host safety or security restrictions that limit access or restrict inspection activities in specific environments), and ultimately the cost of conducting an inspection. Instead it may be more realistic to understand that confidence is achieved through layers of evidence that ultimately deliver more complete perceptions through platforms that include direct comparative analytics tools, tools that can compare suites of tools or approaches and groups of activities, and systems level analysis that provides a higher level understanding of both what is required for compliance at the highest level and which things are most important. The addition of random selection approaches demonstrates evidence over time of behaviors, processes, and procedures that can, through consistency, demonstrate compliance with the treaty obligations.

When measuring the confidence of different random selection approaches, it is important to remember that not all tools and mechanisms are created equal. In many cases, there are spaces where subjectivity and perception retain roots. Additionally, there may be different types of random selection needs depending upon the circumstances or objectives of the verification. The random selection of items/weapons at a site verifies presence of declared numbers of items whereas the random selection of sites/facilities verifies the absence of declarable items/weapons. Because of these differences, the effectiveness of assessment tools may also differ, based upon the overall verification objective (verification of absence at declared or undeclared sites or presence of declared numbers of items). Statistical approaches, for example, might be appropriate for the assessing approaches that look to determine presence of declared numbers of items, whereas the examples of the IAEA APA, the DES, and game theoretic methods may be more effective for verification of absence at declared or undeclared sites assessments and provide a level of confidence that material is not being diverted clandestinely to weapons programs. In turn, methods like the ACEC, the AoA, and the AHP provide a level of confidence that the tools in use provide adequate information for program assessments for both verification of absence at declared or undeclared sites and presence of declared numbers of items objectives.

Paper 3. How to Resolve Inspection Ambiguities

Working Group 4: Verification of Nuclear Weapons Declarations

November 2019

Abstract

This paper addresses ways to resolve ambiguities, that is, uncertainties about the compliance of arms control/disarmament and non-proliferation treaties, by presenting existing examples, including multilateral and bilateral arrangements. Examples include not only nuclear weapons' arrangements, but also chemical, biological, and conventional weapons because we can learn lessons from them as well. Each arrangement has its own mechanism to address/resolve such ambiguities, but we can see roughly four kinds of mechanisms: (1) internal consultation between inspected State personnel on-site and the inspecting entity, (2) additional-treaty mandated or agreed (and possibly more intrusive) inspections, (3) resolution in a standing compliance body, and (4) intervention of the United Nations, including that of the Secretary-General and a specific body established under Security Council resolutions. They are chosen according to circumstances such as numbers of contracting parties, their relations, and political circumstances surrounding contracting parties, and independence of an inspecting body.

Introduction

This paper concerns ways to resolve ambiguities, that is, uncertainties about the compliance of arms control/disarmament and non-proliferation treaties. In Phase I, Working Group 2 addressed "On-Site Inspections" based on lessons learned from existing treaties. Its Deliverables Four, Five, and Six mention ways to address disagreement or ambiguity: internal consultations between the inspected State and the inspection team; complete documentation of discrepancies or ambiguities in the Inspection Report, if the two parties are unable to resolve them; and roles of the compliance body in resolving discrepancies or ambiguities.

Although an ambiguity can be an indicator of cheating, it can also be something more innocent. An ambiguity can be a failure, for various reasons, to obtain the expected outcomes of agreed procedures. For example, the inspected party may not correctly take the required measurements of the accountable object during an inspection or the measurement procedure or a piece of equipment did not function properly. The object itself may vary in length or circumference more than the expected value because items are not always uniform in size. Or, the object may not be present at the time of the inspection because it has been moved to a different location and the notification of movement has not caught up.

This paper presents examples of measures to address ambiguities in relevant arms control/disarmament and non-proliferation regimes.

International Atomic Energy Agency Comprehensive Safeguards Agreement

The basic undertaking of the International Atomic Energy Agency (IAEA) Comprehensive Safeguards Agreement (CSA) under the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is to ensure that safeguards are applied on all source or special fissionable material in all peaceful activities within the territory of a State, under its jurisdiction, or carried out under its control anywhere, to verify that there are no indications of diversion of declared nuclear material and the basic undertaking of the Additional Protocol is to ensure that there are no indications of undeclared nuclear material or activities in a State as a whole from peaceful nuclear activities.

The IAEA pursues three generic safeguards objectives: (1) to detect any diversion of declared nuclear material at declared facilities, or locations outside facilities (LOFs), where nuclear material is customarily used; (2) to detect any undeclared production or processing of nuclear material at declared facilities or LOFs; and, (3) to detect any undeclared nuclear material or activities in a State as a whole. To this end, inspection is carried out.

The IAEA may carry out four types of inspections: ad hoc inspection, routine inspection, special inspection, and unannounced/short notice inspection. Under the CSA, if the IAEA considers that information made available by a State, including explanations from a State and information obtained from routine inspections, is not adequate for the IAEA to fulfill its responsibilities, the inspected State and the IAEA shall consult forthwith. As a result of such consultations, the IAEA may conduct special inspections in addition to routine inspection.[55] Special inspections have been rarely implemented by the IAEA and only in cases where there were serious suspicions of a breach of the obligations of a State with a Safeguards Agreement in force.

Any disagreement between the IAEA Secretariat and the State concerning the need for access to information or location in addition to that specified for ad hoc and routine inspection would be reported by Director-General to the Board of Governors. The Board could request the Director-General to initiate the procedure for carrying out such an inspection. If the State

[55] IAEA, *The Structure and Content of Agreements between the Agency and the States Required in the Connection with the Treaty on the Non-Proliferation of Nuclear Weapons* (INFCIRC/153 Article 77), https://www.iaea.org/publications/documents/infcircs/structure-and-content-agreements-between-agency-and-states-required-connection-treaty-non-proliferation-nuclear-weapons.

denies access or the IAEA to carry out the special inspection, the Boards may report the matter to the Security Council.

If the outcome of the special inspection is that undeclared facilities, locations, or materials are found that should have been declared under the safeguards agreement, it would be for the Board to determine what action should be taken to remedy the non-compliance in accordance with Article XII of the Statute.

If the outcome of the special inspection is that in view of the available evidence, the questions that gave rise to the inspection are not adequately resolved and the IAEA is unable to verify that there has been no diversion of nuclear material required to be safeguarded under the Agreement, the Board may, as provided for in CSA, make a report to the Member State, the Security Council and General Assembly or take the other measures provided for in Article XII C of the Statute, as appropriate.

Any questions arising out of the interpretation or application of the Agreement, the parties must, at the request of either, consult about it. Any dispute arising out of the interpretation or application of the Agreement may be submitted to an arbitral tribunal, whose decisions would be binding on both parties.[56]

The Treaty between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms

Ambiguities that arise during an inspection are recorded in an inspection report. Although the inspected party may offer a means to resolve the ambiguity, such as a different measurement or a different way to make a measurement, the inspecting party may not consider the ambiguity to be resolved.

Part Six of the New START Treaty establishes the Bilateral Consultative Commission (BCC). The authority of the BCC includes, inter alia, the resolution of issues regarding a party's compliance, the resolution of questions raised by a side, and the resolution of ambiguities that may arise during inspections. The BCC may also reach agreements on additional measures to increase the viability and effectiveness of the Treaty. This latter authority can be critical to the resolution of compliance issues. The Joint Compliance and Inspection Commission (JCIC) served the same purpose for the START Treaty.

A session of the BCC must be convened at the request of either party normally in Geneva, Switzerland, and no fewer than two sessions of the BCC must be convened each year, unless otherwise agreed.

[56] INFCIRC/153 Article 22.

The agenda for each session consists of the questions specified by the parties in their communications. Additionally, questions can be raised and discussed by the Commissioners in the intersessional period. Thus, if a party has documented ambiguities that occurred during an inspection (i.e., failure to obtain requested/required measurements of an accountable item, incorrect measurements, lack of access, etc.), these can become agenda items for the session. Additionally, if a party has questions about another party's compliance, they can raise this issue as a proposed agenda item.

Resolving ambiguities or compliance issues can take the form of promises to correct the behavior or activities that led to the ambiguity declaration. In some cases, it may be necessary to reach a new BCC agreement on procedures. For example, under the original START Treaty, access to a certain building that had been accessible on a previous inspection was denied due to an unannounced change in the entrance to the building. The parties eventually reach an agreement that resolved the issue.

Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction

The Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on their Destruction (CWC) has two mechanisms to resolve ambiguities regarding compliance of the Convention: the consultation mechanism (consultations and request for clarification,[57] and the Challenge Inspection.[58]

Without prejudice to the right of any State party to request a challenge inspection, State parties of the CWC should first make every effort to clarify and resolve, thorough exchange of information and consultations among themselves, any matter that may cause doubt about compliance with the Convention, or which gives rise to concerns about a related matter that may be considered ambiguous. In response to that, a State party that receives a request for clarification of any matter that the requesting State party believes causes such a doubt or concern is obliged to provide it, in any case not later than 10 days after the request, with information sufficient to answer the doubt or concern raised along with an explanation of how the information provided resolves the matter.[59]

Additionally, State parties can request an on-site challenge inspection of any facility or location in the territory or in any other place under jurisdiction or control of any other State party for

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[57] Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on their Destruction (CWC), Article IX, Subparagraphs 1–7, https://www.opcw.org/chemical-weapons-convention/articles/article-ix-consultations-cooperation-and-fact-finding.

[58] CWC, Article IX, Subparagraphs 8–25, https://www.opcw.org/chemical-weapons-convention/articles/article-ix-consultations-cooperation-and-fact-finding.

[59] CWC, Article IX, Subparagraph 2, https://www.opcw.org/chemical-weapons-convention/articles/article-ix-consultations-cooperation-and-fact-finding.

the sole purpose of clarifying and resolving questions concerning possible non-compliance with the provisions of the Convention, and to have this inspection conducted anywhere without delay by an inspection team designated by the Director-General of the Organization for the Prohibition of Chemical Weapons (OPCW) and in accordance with the Verification Annex. This challenge inspection mechanism has no limit on inspection target, and State parties have no veto. Conversely, the Convention has a system to avoid any abuse of this right, that is, if the Executive Council of the OPCW considers inspection request to be frivolous, abusive, or clearly beyond the scope of the Convention, it can decide by a three-quarter majority of all its members against carrying out the challenge inspection.[60]

With regard to the challenge inspection, the inspected State shall have (1) the rights and obligations to make every effort to demonstrate its compliance with this Convention and, to enable the inspection team to fulfil its mandate; (2) the obligation to provide access within the requested site for the sole purpose of establishing facts relevant to the concern regarding possible non-compliance; and (3) the right to take measures to protect sensitive installations, and to prevent disclosure of confidential information and data, not related to the Convention, and shall assist the inspection team throughout the challenge inspection and facilitate its task.[61]

The final report shall contain the factual findings as well as an assessment by the inspection team of the degree and nature of access and cooperation granted satisfactory implementation of the inspection, and the Executive Council reviews it and addresses any concern as to (1) whether any non-compliance occurred; (2) whether the request had been within the scope of this convention; and (3) whether the right to request a challenge inspection had been abused. If the Council concludes that further action may be necessary, it shall take the appropriate measures to redress the situation and to ensure compliance with the Convention.[62]

To date, the challenge inspection has never been requested and executed.

In the case of the destruction of Syria's chemical weapons, the OPCW Executive Council adopted decision EC-M-33/DEC.1, which was unanimously endorsed by the UN Security Council Resolution 2118. This decision requires Syria to allow inspectors the immediate and unfettered right to inspect any site identified as having been involved in the chemical weapons program.

Treaty on Conventional Armed Forces in Europe

Under the Treaty on Conventional Armed Forces in Europe (CFE), States parties shall, whenever possible, resolve during an inspection any ambiguities that arise regarding factual

[60] CWC, Article IX, Subparagraphs 8–9 and 14, https://www.opcw.org/chemical-weapons-convention/articles/article-ix-consultations-cooperation-and-fact-finding.
[61] CWC, Article IX, Subparagraphs 11 and 20, https://www.opcw.org/chemical-weapons-convention/articles/article-ix-consultations-cooperation-and-fact-finding.
[62] CWC, Article IX, Subparagraphs 21-23, https://www.opcw.org/chemical-weapons-convention/articles/article-ix-consultations-cooperation-and-fact-finding.

information.[63] Whenever inspectors request the escort team, a group of individuals assigned by an inspected State party, to clarify such an ambiguity, the escort team shall promptly provide the inspection team with clarifications.[64] If inspectors decide to document an unresolved ambiguity with photographs, the escort team shall cooperate with the inspection team's taking of appropriate photographs using a camera capable of producing instantly developed photographic prints. If an ambiguity cannot be resolved during the inspection, then the question, relevant clarifications, and any pertinent photographs shall be included in the inspection report.[65]

Inspectors shall have the right to take measurements to resolve ambiguities that might arise during inspections. Such measurements recorded during inspections shall be confirmed by a member of the inspection team and a member of the escort team immediately after they are taken. Such confirmed data shall be included in the inspection report.[66]

The inspection report may be, as a rule, made available to the Joint Consultative Group, which is a consultative body established in 1990 to resolve ambiguities in compliance of the Treaty. The group is composed of representatives designated by each State party, and if needed, alternates, advisors, and experts of a State party may take part in the proceedings. They meet for regular sessions to be held two times per year, in addition to that, at the request of one or more States parties additional sessions must be convened.[67]

Comprehensive Nuclear-Test-Ban Treaty

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) has not entered into force. It has its own verification regime to verify compliance with the Treaty: (1) an International Monitoring System (IMS), (2) consultation and clarification, (3) on-site inspection (OSI) and (4) confidence-building measures.[68] Although these mechanisms are not all used prior to entry into force, the IMS system is nearly complete and operating provisionally. It can and has been used to monitor activities. Information from the IMS is shared through the International Data Center with Signatories to the Treaty. OSIs cannot take place pending the entry into force of the Treaty, but various exercises have been done such as the Integrated Field Exercise in Jordan in 2014; as well, the manuals for conducting OSI are still being prepared so that once the Treaty is in force, full implementation of its provisions can proceed.

Verification activities must be based on objective information, must be limited to the subject matter of the Treaty, and must be carried out on the basis of full respect for the sovereignty of

[63] Treaty on Conventional Armed Forces in Europe, Section VI, Article 38.
[64] CFE, Section VI, Article 38.
[65] CFE, Section VI, Article 38.
[66] CFE, Section VI, Article 37.
[67] Protocol on the Joint Consultative Group Articles 1–4, https://fas.org/nuke/control/cfe/text/prot_jointcons.htm.
[68] Comprehensive Nuclear-Test-Ban Treaty (CTBT), Article IV, 1, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.

States parties and in the least intrusive manner possible consistent with the effective and timely accomplishment of their objectives. Each State party must refrain from any abuse of the right of verification.[69]

States parties should, whenever possible, first make every effort to clarify and resolve, among themselves or with or through the Comprehensive Nuclear-Test-Ban Treaty Organization, any matter that may cause concern about possible non-compliance with the basic obligations of the Treaty. This mechanism will not affect the right of any State party to request an OSI.[70] A State party that receives a request must provide the clarification to the requesting State party, as soon as possible, in any case no later than 48 hours after the request.[71] A State party shall have the right to request the Director-General to assist in clarifying any matter that may cause concern about possible non-compliance with the Treaty.[72] A State party also has the right to request the Executive Council to obtain clarification from another State party on any matter that may cause concern about possible non-compliance with the basic obligations of the Treaty.[73] In this case, the requested State party must provide the clarification to the Executive Council as soon as possible, but in any case no later than 48 hours after its receipt.[74] If the requesting State party deems the clarification to be inadequate, it has the right to request the Executive Council to obtain further clarification from the requested State party. If the requesting State party considers the clarification to be unsatisfactory, it has the right to request a meeting of the Executive Council. The Executive Council must consider the matter and may recommend any measure to redress a situation and to ensure compliance, including sanctions in accordance with the Article V, that is, restricting or suspending the State party from the exercise of its rights and privileges under this Treaty, recommending to State parties collective measures that conform with international law, and bringing the issue to the attention of the United Nations.

The sole purpose of an OSI is to clarify whether nuclear weapons test explosion or any other nuclear explosion has been carried out, and to the extent possible, to gather any facts that might assist in identifying any possible violator.[75] The requesting State party must present the OSI request to the Executive Council. The Executive Council must begin its consideration immediately upon receipt of the request, and take a decision on the request no later than 96 hours after receipt of the request.[76] The OSI request must include necessary information, including all data upon which the request is based and the result of a consultation and

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[69] CTBT, Article IV, 2, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.
[70] CTBT, Article IV, 29, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.
[71] CTBT, Article IV, 30, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.
[72] CTBT, Article IV, 31, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.
[73] CTBT, Article IV, 32, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.
[74] CTBT, Article IV, 32 (b) , https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.
[75] CTBT, Article IV, 35, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.
[76] CTBT, Article IV 38, 39 and 46, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.

clarification or explanation of the reasons why such a consultation and clarification process has not been carried out.[77]

The OSI will be conducted in the least intrusive manner possible, but then proceed to more intrusive procedures only as it deems necessary to collect sufficient information to clarify the concern about possible non-compliance with the Treaty.[78] Upon conclusion of the inspection, the inspection team shall meet with the representative of the inspected State party to review the preliminary findings of the inspection team and to clarify any ambiguities.[79]

The Director-General of the Technical Secretariat must promptly transmit the inspection report to the requesting State party, the inspected State party, the Executive Council and to all other States parties, after making draft inspection report available to the inspected State party.[80] The Executive Council must review the inspection report and address any concern as to whether any non-compliance with the Treaty has occurred and whether the right to request an OSI has been abused.[81] If the Executive Council reaches the conclusion that further action may be necessary, it must take appropriate measures in accordance with Article V.[82]

Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction

The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction (BWC) includes no verification mechanism, such as OSI, which enables State parties to this Convention to systematically find or resolve ambiguities. Yet there are two mechanisms to address this within the Convention.

The first one is consultation and co-operation within relevant State parties to this Convention. Article V of this Convention stipulates that the States parties undertake to consult one another and to co-operate in solving any problems that may arise in relation to the objective of, or in the application of the provisions of, the Convention. Consultation and Co-operation pursuant to this Article may also be undertaken through appropriate international procedures within the framework of the United Nations and in accordance with its charter.

The second one is lodging complaints with the Security Council of the United Nations. According to Article VI of this Article, if any State party to this Convention finds that any other State party is acting in breach of obligations deriving from the provisions of this Convention, it may lodge a

[77] Protocol, Part II, Article 41, , https://fas.org/nuke/control/cfe/text/prot_jointcons.htm.
[78] CTBT, Article IV, 58, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.
[79] Protocol Part II, Article 109, https://fas.org/nuke/control/cfe/text/prot_jointcons.htm.
[80] CTBT, Article IV, 58, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.
[81] CTBT, Article IV, 65, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.
[82] CTBT, Article IV, 66, https://www.ctbto.org/fileadmin/user_upload/legal/CTBT_English_withCover.pdf.

complaint with the Security Council. Such a complaint should include all possible evidence confirming its validity, as well as a request for its consideration by the Security Council. Each State party to this Convention undertakes to co-operate in carrying out any investigation that the Security Council may initiate. In accordance with the provisions of the Charter of the United Nations, on the basis of the complaint received by the Council, the Security Council shall inform the States parties to the Convention of the results of the investigation.

A further two measures have been established outside the convention to counter alleged use of bacterial (biological) and toxin weapons. The first is the investigation mechanism carried out by the Secretary-General of the United Nations, which was established by the Resolution 42/38 C of the United Nations General Assembly. The investigation is carried out in response to reports that may be brought to the Secretary-General's attention by any Member States concerning the possible use of bacteriological (biological) or toxin as well as chemical weapons in order to ascertain the facts of the matter, and to report promptly the results of any such investigation to all Member States.[83] The Secretary-General, with the assistance of qualified experts provided by interested Member States, develops further technical guidelines and procedures for the timely and efficient investigation of reports of the possible use of such weapons.[84] In order to conduct investigation, the Secretary-General (1) appoints experts to undertake investigation, (2) where appropriate, makes the necessary arrangements for experts to collect and examine evidence and undertake such testing as may be required, (3) seeks assistance as appropriate from Member States and the relevant international organizations.[85]

The BWC's mechanisms have never been used to date since they were introduced. Investigations by the Secretary-General have never applied to bacteriological (biological) and Toxin Weapons case, but mechanisms were put to use in chemical weapons cases in Syria and Iraq.

The second is investigation conducted by the Security Council based on its resolutions in specific cases of suspected use of WMD, including bacteriological (biological) weapons. In 1991 the Resolution 687 was adopted, which authorized the establishment of the United Nations Special Commission on Iraq and the United Nations Monitoring, Verification and Inspection Commission. Their mechanisms can be seen in the next section.

United Nations Special Commission on Iraq

The United Nations Special Commission (UNSCOM) on Iraq was created by the Security Council Resolution 687 of April 3, 1991. Its mandate was (1) to carry out immediate OSIs of Iraq's biological, chemical, and missile capabilities, (2) to take possession for destruction, removal, or rendering harmless of all chemical and biological weapons and all stocks of agents and all

[83] United Nations General Assembly, Resolution 42/38 C, paragraph 4, https://undocs.org/en/A/RES/42/38.
[84] United Nations General Assembly, Resolution 42/38 C, paragraph 5, https://undocs.org/en/A/RES/42/38.
[85] United Nations General Assembly, Resolution 42/38 C, paragraph 7, https://undocs.org/en/A/RES/42/38.

related sub-systems and components and all research, development, support, and manufacturing facilities, (3) to supervise the destruction by Iraq of all its ballistic missiles with a range greater than 150 km and related major parts, and repair and production facilities, (4) and to monitor and verify Iraq's compliance with its undertaking not to use, develop, construct, or acquire any of the items specified above. The Commission was also requested to assist the Director General of the IAEA, who was also requested to undertake activities similar to those of the Commission but specifically in the nuclear field. Further, the Commission was entrusted to designate for inspection any additional site necessary for ensuring the fulfillment of the mandates given to the Commission and the IAEA.

With regard to monitoring and verification, the Secretary-General and the IAEA Director-General submitted to the Security Council two separate but closely coordinated plans for compliance monitoring. Under its Resolution 715 of October 11, 1991, the Council mandated the Commission to implement the plan for ongoing monitoring and verification of permitted chemical, biological, and ballistic missile activities. The Council also requested the Commission to assist and cooperate with the IAEA in the implementation of the plan for ongoing monitoring and verification in the nuclear field.

Under the plans, Iraq was obliged to provide, on a regular basis, full, complete, correct, and timely information on activities, sites, facilities, material, or other items, both military and civilian, that might be used for purposes prohibited under relevant resolutions. Furthermore, the Commission and the IAEA had the right to carry out inspections, at any time and without hindrance, of any site, facility, activity, material, or other items in Iraq. They could conduct unannounced inspections and inspections at short notice and inspect on the ground or by aerial surveillance any number of declared or designated sites or facilities.

The resolution has no provision of the limitation on time and location of inspections, so it is understood that there was no need for further technical mechanisms to resolve ambiguities as inspectors could simply undertake further inspections and any outstanding issues could be dealt with directly at the political level.

The Commission's inspection and supervision activities covered multiple WMDs, including more than 40,000 chemical weapons and more than 800 scud missiles, and their destruction.

Conclusion

In the event of ambiguities we can see roughly four kinds of mechanisms to address/resolve them: (1) internal consultation between inspected state personnel on-site and the inspecting entity, (2) additional treaty mandated or agreed (and possibly more intrusive) inspections, (3) resolution in a standing compliance body, and (4) intervention of the United Nations, including by the Secretary-General and a specific body established under Security Council resolutions.

During internal consultation, different measures to address ambiguities could be offered, including inspection, ad hoc measurements, or procedures to be recorded, but this would not necessarily resolve the ambiguities. In such a case, solutions would be left to a political decision, not the inspecting entity.

In regard to compliance bodies, for multilateral treaties, they tend to be independent, for example, the IAEA for the NPT. For bilateral treaties such as START and New START, they are not independent but composed of representatives from both parties. In principle compliance bodies are used in case parties to an agreement are unable to resolve ambiguities and compliance issues at a lower level. However, ambiguities aren't usually resolved at lower levels but become agenda items for the work of their respective compliance bodies. At the compliance body, the parties should be prepared to explain what transpired during the inspection. This is usually documented in the inspection report itself but may need further explanation. In the case of questions regarding a party's compliance, the party raising the question must be able to provide some evidence to reinforce their questions or concerns.

As for the intervention of the United Nations, the examples cited above were created under unique circumstances, and careful study should be applied to whether they would be generally appropriate for future disarmament verification arrangements under a mutually agreed multilateral treaty.

These four mechanisms are chosen according to circumstances such as numbers of contracting parties, their relations and political circumstances surrounding contracting parties, and independence of an inspecting body. Also note that even when a treaty has a resolution mechanism, contracting parties may be reluctant to use it. Addressing such a challenge is important for future work toward global zero.

Paper 4. Nuclear Cultural Anthropology: An Exploration of the Influence of Cultural Norms and Changing Cultural Behaviors on Nuclear Cultures

Working Group 4: Verification of Nuclear Weapons Declarations

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Abstract

Cultural anthropology explores the influences of both shared cultural beliefs and practices, and social and cognitive cultural structures on societal behavioral norms and environments. This paper seeks to distill cultural anthropology even more narrowly, to explore the type of influences and manifestations of those beliefs, practices, and cultures within the nuclear culture and in the inverse, what influences the elements of nuclear culture may have on broader cultural and behavioral norms. The study of cultural anthropology is grounded in observation, thus the information provided by this paper will be revealed through the explication of Heuristic Inquiry to explain the lived experience of the nuclear cultural environment.[86] The one issue with any explorative inquiry, including heuristics, is the potential for behavioral misinterpretation as a result of the interpreter's cognitive bias. This bias is commonly described with the term "mirror-imaging," a practice through which a behavioral interpreter establishes perceptions of another party's actions or intentions based upon the interpreter's personal experiences and cultural norms. Because of this potential, heuristic inquirers must ensure that only facts are gathered, and that those facts are based upon open-ended and non-guiding questions and empirically validated, historic information. so that the resulting themes are grounded in fact.

The Importance of Understanding Nuclear Cultural Anthropology

Nuclear cultural anthropology helps to explain the social and cultural behaviors that influence how and why nuclear weapon possessor States undertake different actions and exhibit or foster behaviors that are inherent to their nuclear safety and security environment. Although some common anthropological themes exist across nuclear weapon possessor States, the influence of the nuclear culture may manifest itself differently depending upon the country's root culture. In very large and culturally diverse nuclear weapon possessor States, those manifestations may

[86] C. Moustakas, *Heuristic Research: Design, Methodology and Applications* (Newbury Park, California: Sage, 1990).

differ regionally as well because of internal cultural variability. An understanding of a nuclear weapon possessor State's nuclear cultural anthropology and regional variations could be very beneficial for treaty partners, especially when seeking to establish a common foundation from which to work.

The understanding of these cultural influences and how they manifest can serve to foster the development of greater trust between partner States. It can also serve as a mechanism to educate partners on information that could be shared to provide greater transparency and support future verification. Anthropological information may include such topics as what types of actions/behaviors are normal within a partner's nuclear weapons environment, (e.g., what safety/security behaviors and actions are inherent in the lifecycle and how are they applied, what types of elements are critically protected and why, and where there may be spaces to collaborate, which would allow for establishing/building trust and delivering provisions by which confidence can be developed), and how lifecycle elements are defined. Equally important is an understanding of the cultural and behavioral norms within that partner's overall culture, how they vary region by region, and why the different norms exist (history).

Understanding nuclear cultural anthropology as a construct will support the verification of specific nuclear disarmament agreements, for example, by creating over time a more comprehensive "map" of nuclear weapon activities/behaviors that are the "norm" or part of the culture and can be witnessed in regular interaction, against which it would be easier to detect anomalous behaviors, or behaviors that are outside that treaty party's cultural norms.

The United States: A Culture of Deterrence

The United States has a culture of deterrence, and although some might find this difficult to believe, that deterrence culture is not simply rooted in nuclear weapons or even in defense. Instead, within and emanating from the U.S. contexts, there are two root causes for deterrence. First, an internal or domestically constructed system of checks and balances; and second, the external deterrence dimension resulting from a matured self-perception of world political roles, post–Pearl Harbor. Therefore the U.S. deterrence culture is a double helix or dyad particular to the U.S. context and does not necessarily exist for other nuclear weapon possessors. As a result of this dyadic circumstance, deterrence is not simply an external response for the United States; instead, it is embedded in the make-up of its cultural norms holistically.

The U.S. domestic deterrence culture originated and matured from a rules- and laws-based foundation firmly established by the United States Constitution, its amendments, and the Bill of Rights. The U.S. Constitution identifies the levels and divisions of power, divided between the executive, legislative, and judiciary branches of the U.S. government. This division of power and authority also includes within each purview, the element of deterrence. The Bill of Rights and Amendments to the Constitution are used to establish specific inalienable rights that cannot be restricted or removed by those in authority without changing the constitutional amendment itself. This level of deterrence assures that leadership is prevented from establishing rules and laws that benefit leadership but injure the people.

This deterrence culture is firmly entrenched in many aspects of American life, spanning from education to law enforcement. In both education and law enforcement, the culture of deterrence demonstrates the thinking that deterrence needs not to simply defend against bad behavior, but should also instill significant enough punishment as to deter others from engaging in the same behavior.[87] In many cases precursory behaviors are deterred at a much more gentle level in the hopes that the threat of greater punishment, if that behavior persists will be sufficient to prevent its escalation. In the case that it is not successful, the United States has provided mechanisms to deliver enough punishment and publicity of that punishment through the guarantees of the first amendment and accessibility of journalists to information, to deter bad actors from following the same path that was punished.

The U.S. deterrence culture matured into something strategically actionable during World War II, with the deterrence processes, procedures, steps, and responses most broadly recognized afterward between the U.S and Russia in the Cold War. One can discern at this point because of the existence of a Russian nuclear weapons State with which the U.S. had to contend. Deterrence in the U.S.–Russian relationship has been described as a force/counterforce balancing agreement, used to prevent what is agreed by both parties as an "unacceptable level of damage," a term historically referring to the potential of catastrophic civilian casualties. It is perceived that only under the threat of such damage, would two parties with such a devastating destructive capability, agree to such balancing and prevent mutual destruction.

Although external deterrence is focused on whoever is determined to be the direct adversary, many internal cultural behaviors and functions exist that result from a deterrence culture and the need to ensure that the deterrence is credible (i.e., that it will function as expected if required, that the deterrer has the capability to act upon the threat, and that the threat can be communicated in such a way that it can be heard by the adversary).[88] The most pertinent of those cultural reflections includes risk aversion, resulting in heightened safety and security processes, procedures, and behaviors to protect the nuclear weapon, its environment, and personnel.

Behavioral Examples of the Deterrence Culture: Heightened Safety and Security Processes

In a deterrence culture the resulting heightened safety and security processes, procedures, and behaviors should be expected to include things like access control programs. In the United States, such programs assure that only personnel with the appropriate training and need-to-

[87] G.P. Shultz, S.D. Drell, and J. E., *Goodby Deterrence: It's Past and Future* (Hoover Institution Press: Stanford, California, 2010).
[88] Ibid; and Henry D. Sokolski and Robert Zarate, *Nuclear Heuristics: Selected Writings of Albert and Roberta Wohlstetter*, January 2009, https://publications.armywarcollege.edu/pubs/1985.pdf.

know have access to a nuclear weapon, and even with appropriate need-to-know, additional access requirements remain in place. The term “managed access” is commonly used in treaty-related discussions, but that same approach is also commonly applied to the employees of the weapon State as well. Different layers of access within sites and facilities prevent people without access approvals for getting near nuclear weapons operations. As each layer gets closer to the operation, the access requirement becomes more stringent.

For those afforded access to the operational areas, no lone person can have access to nuclear weapons regardless of their role or certifications. All nuclear weapons facilities require no fewer than two personnel to enter. Additionally, once in the facility, all personnel must be within visual line of sight of each other for general access and none can be within six feet of the weapon, alone. Along with this two-person concept is an additional safety/security operational function called “reader, worker, checker,” which is an approach to conducting operations that ensures that both personnel performing work are paying complete attention to everything going on in the conduct of that work, including the behaviors of their partner so that each step must be affirmed as being performed correctly and recorded complete, before a new step can be undertaken.

In maintenance configurations, additional access constraints are applied on top of the general constraints, which ensure that if any operations are ongoing, two people are required to be within six feet of the nuclear weapon, and that there is no additional unescorted access during those operations. Those two people allowed within the six feet must be certified in the Human Reliability (HRP) or Personnel Reliability Programs (PRP), have the appropriate clearance and training, and both be certified to conduct the actions required for the operation. To be approved in the HRP or PRP programs, personnel must be certified to be physically and mentally stable, and that stability is reverified annually unless circumstances require more frequent review. HRP/PRP employees undergo continuous behavioral observation to ensure that external issues cannot negatively influence safety and security judgements. Additional factors such as risky financial behaviors, addictive behaviors, some health conditions, and emotional control issues may be grounds for decertification from either program. HRP/PRP certification gives confidence that workers can be trusted to behave within the requirements of the environment.

In addition to these access control requirements, all processes and procedures are tightly engineered and approved through a verification mechanism to ensure that all information has been validated with a safety basis process. Employees are not permitted to deviate from those procedures, and anyone caught attempting to do so will face severe consequences. Tools and equipment are also scrutinized at this same level to ensure that nothing that has not already been thoroughly reviewed and assessed can contact the nuclear weapon. Transportation protocols also exist, which determine when items can be transferred and how that transference can be performed. Traffic controls requirements may be in place to ensure the best probability of safe travel, as well as specialized containers used to protect weapons from weather hazards in some environments.

Broader Cultural Context

Historically, anthropologists have consulted three schools of thought regarding the context of culture: the first, espoused by Schwartzman (1992) perceives culture on a national level, externally influencing behaviors from a national cultural perspective. The second, harkening back to the results of the Hawthorn Studies describes culture as something that has both formal and informal elements that depend on the needs, expectations, and requirements of the organization and have little to do with national culture; and the third considers culture to be rooted instead in the organizational processes both formal and informal, developing a separate subculture to which workers within the organization belong in addition to their national, or in our case also potentially regional, culture.[89]

This third description explains the cross-pollination of nuclear culture and social culture behavioral elements that are commonly found when comparing the cultural behaviors of nuclear weapons workers and non-nuclear weapons workers. In some cases, those new behaviors bleed into the broader community as well.

For example, in the United States citizens are taught what is perceived as right and wrong culturally. When applied to the nuclear weapons environment, that right and wrong become more distinctly honed for nuclear environment specific activities, providing a strongly reinforced set of cultural norms that drive and control behaviors. Those things commonly translate into social culture through the development or need for more process-driven actions within day-to-day external activities, heightened safety practices and teaming. History has demonstrated that when people work in these types of environments, a separate sense of cultural orientation emerges over time. There grows a perspective of community with the people with whom the environment is shared, people grow to recognize differently the topics of focus, responsibility, and accountability that exceed that of traditional social culture.

Conclusion

While these behaviors may be considered “right” in the U.S. nuclear enterprise, it does not mean that those same behaviors may be considered right for another party or may even be defined in the same manner. When viewed through a lens of U.S. nuclear culture, difficulties exist in interpreting the nuclear cultural norms of other countries as valid. They may not align with our own because they are blended from the social culture of that party and how they define their nuclear environment as a result. This does not mean that it is impossible to learn about another possessor State’s culture, only that because of cultural norms and perceptions, specific actions are necessary to develop an understanding of the differences between parties’ cultures and why those exist.

[89] Paul E. Bierly III and J.C. Spender, “Culture and High Reliability Organizations: The Case of the Nuclear Submarine,” *Journal of Management* 21, no. 4 (1995): 639–56.

In a disarmament context, this means that possessor states' understanding of each other's nuclear *Lebenswelt*[90] will be necessary to make progress. Although progress may be slow and constrained, the maturation of that understanding as a key aspect of the progress will ensure that a relationship can be built that may establish a foundation of trust upon which future collaborations may be built; spaces can be identified in which both, or in some cases multiple, parties may still feel safe; and the diverse cultures may not be invalidated. Without the development of trust, the potential for progress is tightly limited and true collaboration likely can never be reached.

[90] *Lebenswelt* is defined as the world of lived experience. Merriam-Webster, s.v. "Lebenswelt," https://www.merriam-webster.com/dictionary/Lebenswelt?utm_campaign=sd&utm_medium=serp&utm_source=jsonld.

Working Group 4 Deliverable
Part V. Report of the CFE Table-Top Exercise

Working Group 4: Verification of Nuclear Weapons Declarations

August 2019

Abstract

To learn as much as possible from previous verification regimes, and their applicability to the verification of nuclear weapons declarations, Working Group 4 (WG4) undertook a trial table-top walkthrough exercise on one specific treaty's verification regime: The Conventional Forces in Europe (CFE) Treaty. Such an exercise was aimed at exploring ideas and concepts from an existing monitoring and inspection regime and to test them against the requirements for verifying nuclear weapons declarations. It was not expected that verification mechanisms developed for conventional or chemical weapons regimes were exactly applicable in the nuclear case, but certain aspects and concepts could be transferable. By testing the existing mechanisms in an exercise-like format, we thought it would best identify relevant elements and concepts.

The Exercise

During the London IPNDV Plenary meeting in December 2018, Working Group 4 (WG4) undertook a one-day tabletop exercise to explore whether the verification aspects of the Conventional forces in Europe Treaty (CFE) could provide lessons for future nuclear disarmament verification.

After reviewing some of the existing verification regimes in previous meetings in Seoul and Stockholm, WG4 determined that the CFE declarations and verification mechanisms would be a good starting point. They are less complex than those found in the Strategic Arms Reduction Treaty (START) family of Treaties, yet focus on issues related to deployed and non-deployed weapon system of direct relevance to WG4, more than for example the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CWC), which has a greater focus on monitoring civilian industry and weapons destruction. WG4 also thought it was relatively obvious that START and New START would have transferable elements, and hence it would to be more instructive to see if a verification regime from a very different area—in this case a conventional arms control agreement—could indeed provide lessons for verification of nuclear disarmament.

Two background aspects were developed in order to conduct the exercise:

- A simplified version of the CFE declarations and verification mechanisms;
- A scenario and "fake State" to provide the context in which the declarations are made.

The aim was to look for transferable "concepts," not specific language or numerical limits. So when the CFE has restrictions on the numbers of inspections, or minimum sizes of buildings that could be inspected for example, it was the concept of having limits on these aspects we wished to explore, not whether the specific limits in the CFE were appropriate for future nuclear disarmament verification arrangements. Discussions focused on the implications of such limits, if they could apply in a future nuclear disarmament arrangement, if not then why not, and whether we could suggest different figures more appropriate for our case, or whether such details could only be determined during future negotiations.

The CFE concepts had to be modified and simplified to be applicable to nuclear weapons declarations. To aid discussions, the exercise focused on aspects applicable to the declaration of the total number of nuclear weapons in a single fake State. The participants were then asked to focus on how the verification concepts in the CFE would aid inspectors to gain confidence in both the initial declaration of nuclear weapons numbers and how this is maintained. For the purpose of the exercise, we did not differentiate between different types of nuclear weapons and concentrated only on the overall number of weapons declared. Also, for the exercise, and consistent with previous IPNDV work, WG4 defined a nuclear weapon as a container with weapons-grade nuclear and explosive material present. For delivery vehicles with multiple nuclear explosive devices present, each explosive device would be counted individually.

Two weeks prior to the exercise, all WG4 members were sent the simplified version of the CFE verification regime in order to familiarize themselves with it (see Annex 1). This included what declarations need to be made by the nuclear weapon possessor State, and when and how changes to initial declarations are made if weapons are moved, produced, or reduced. It also included the basis for where and when inspections can be called, notice periods, how long each inspection can be, and how many inspections can be undertaken each year. This included information for undertaking inspections of both declared and undeclared locations.

At the beginning of the exercise, WG4 members reviewed the initial declarations of our fake State, including weapons numbers, site diagrams, and photographs of delivery vehicles and weapon containers (see Annex 2). To add a sense of realism, all the photographs provided were of historic UK nuclear capable missiles and nuclear or military related facilities, except for a single photograph from a historic U.S. missile silo (which was advertised for public sale).

The exercise had two parts: The first reviewed the general Treaty concepts in light of the declaration of the State. During the first part, the group was guided using a presentation on CFE Treaty concepts and were asked a series of key questions at each stage of the process. The presentation and questions are in Annex 3. In the second part, the group split into four subgroups. Three subgroups examined in detail how an inspection could be undertaken at a specific weapon deployment site (naval, missile silo, and road mobile missile base), and looked at the practicalities and activities that could be undertaken to verify the declarations on that specific site. The subgroups examined actual aerial photographs of facilities (from historic UK sites; see Annex 4). The subgroups examined implications of both an initial visit and subsequent visits to consider the process of building confidence over time. The final subgroup considered the process and practicalities of undertaking inspections of undeclared locations under CFE rules, with a view to confirming the completeness of the declaration. This subgroup looked at the possible choices of sites that could be inspected, how to prioritize them, and what could be achieved in an inspection.

Information on the CFE mechanisms, the State facilities, and verification options were kept to a level so that they were easy to follow, to enable broad concepts to be evaluated yet not get trapped in details. Furthermore, to facilitate these subgroup discussions, three experts were present (one on each of the CFE, new START, and nuclear weapons) to which the subgroups could turn to for advice.

Following discussions, each subgroup presented their findings back to the main group for comparison. As with the initial discussion of the general arrangements, groups highlighted concepts most transferable to verification of nuclear weapons, concepts that could not be transferred, or how certain concepts might be modified so that they would be more applicable. In total the exercise took three two-hour sessions to complete.

Findings from Part One: The Initial Walkthrough

The list of questions in Annex 2 and the walkthrough presentation in Annex 3 set out what WG4 was asked to consider as part of the exercise. Discussions were not limited to these questions, but they provided the starting point for consideration of each concept, as set out below.

Concept 1. Initial Declarations and Information Exchange, Including Photographs of Items

CFE includes:

- Numbers of weapons in the State
- Photographs of delivery vehicles and containers

The group's initial reaction was that the photographs of items were too limited. Physical viewings and more technical data would be required, particularly if unique identifiers, tags, or seals would need to be applied to items or containers. The group also thought that it was difficult to say at this initial point exactly what would be required in such an information exchange, before the details of the inspections had been discussed. To answer this question would need much further work, including input from technical experts on information needed to ensure the successful use of technologies. It could certainly be helpful to include exhibitions of delivery vehicles and containers, but the group noted that physical trials of measurements or applying chain of custody technologies may be necessary, to ensure technology was fit for purpose and that inspections would run efficiently. WG4 identified this area for more study within the group and across the IPNDV.

Concept 2. Annual Data Exchange

CFE includes:

- Number of weapons at each site
- Notification of changes only above 10 percent changes
- Notifications five days after movements
- Site diagrams
- Temporary locations

An important aspect of the declaration on the overall holdings was the difference between this declaration and the Treaty agreed limit. In the exercise, the Treaty limit was 850 weapons within the State, the declaration was 800. The group noted that the closer the declaration to the limit, the more extensive inspections would need to be to have confidence in Treaty compliance, because smaller discrepancies would be of greater importance, with regard to remaining below the Treaty limit.

The group thought regular updates would be necessary; this could be annually but could be on other timescales as appropriate to the agreement, depending on expected changes in such numbers. The group also agreed that all changes and movements of items should be declared, not just changes over a certain level because of the relative importance of each item in a nuclear disarmament agreement as opposed to conventional armaments in the CFE.

WG4 thought post-notification was a necessary element, because for security reasons we believed disclosing prenotification and any further details of transport arrangements would be problematic. The group thought allowing five days to make such a notification was reasonable, although a slightly shorter or longer delay could also be acceptable, although not significantly longer.

The group agreed that the exercise site diagrams were too limited because they just provided a functional view of the site, including only major buildings in an approximate layout rather than a geographical plan. The group thought it necessary to require a more realistic geographical site diagram in order to plan efficient and effective inspections, because the smaller the nature of the items to monitor, the greater the range of buildings that may need to be inspected. Further information on the State as a whole would also be required so the relationship between different sites and to the points of entry to the State could be understood. Understanding what the IAEA requires in site declarations would be a useful addition, although recognition that information available on a civil nuclear State may be greater than on a military one because of security restrictions. WG4 also noted that site diagrams under New START only shows buildings which can be inspected, if all buildings can be inspected then potentially all buildings should appear on the site diagram.

The concept of a temporary location could only be understood in terms of a deployed nuclear weapon on board a submarine or road mobile delivery system. For security and defense reasons, inspected States would not reveal the exact location of such delivery systems. The weapons would still be associated with a particular base, with the number of weapons on temporary deployment declared to inspectors in their briefing at the base. This concept would need to be studied closely in the second part of the exercise, because these systems would not be available for counting, but more importantly would be for inspectors to convince themselves no extra systems could be included in such deployments, hence the declaration was accurate and the agreement was being complied with.

Concept 3. Inspections at Undeclared Locations

Although the CFE labels these as “challenge” inspections, they are routine occurrences of which each side gets a calculated number each year. The term “challenge” here refers to the fact they are at undeclared sites expected not to contain declared items.

CFE includes:

- Limit to area inspected 65 square kilometres
- Refusal to accept a “challenge” inspection

The group thought the routine nature of “challenge” inspections with a set number allowed each year was a significant benefit. Although a geographical limit of some kind would be required on such an inspection, other ways to limit such an inspection could also be considered rather than a set area. This could be a time limit rather than a geographical one, or if a specific site is chosen the bounds of that site may be more appropriate.

The concept of refusing an inspection was troubling to some members. However, the group realized that certain sites would have safety and security concerns, including military and industrial sites, or operational reasons for not being able to facilitate an intrusive inspection. Further work is required to see if rather than allowing a refusal, a delay with some kind of interim monitoring could be put in place for such inspections. Further study of this concept would be undertaken in the second part of the exercise.

Concept 4. Number of Inspections

CFE includes:

- Declared sites: 15 percent of sites can be visited per year
- Non-declared sites: one visit per year
- Baseline period with extra inspections allowed

WG4 agreed limits are required on the number of inspections per year for practical reasons and to allow normal activities at the sites. The CFE rules did not seem to be fit for purpose due to the likely much lower number of declared sites. A minimum of one visit per site per year at each declared site appears to be required to allow inspectors to build confidence over time, although the group noted that the START limit of a maximum of two visits in a year to any one site was a practical measure. Precise numbers of visits would need to reflect the exact nature of any agreement and the number of sites in each State.

Having more visits in an initial baseline period would appear to be a helpful concept. An alternative concept could be familiarization visits, which allow inspectors to become familiar with sites and items, hence being able to undertake effective inspections even on first inspections. Such familiarizations visits could be undertaken at mutually agreed times, allowing the inspected state a greater degree of preparation.

More than one “challenge” inspection would also be required if any significant degree of confidence was expected to be built. The subgroup was charged with exploring whether specific sorts of sites should be the focus of these inspections, specifically sites that would have the characteristics necessary to host nuclear weapons, and how to balance this with holding the entire State at risk of inspection, an important concept in of itself.

The group noted these inspections were only related to our focus of establishing confidence in the total number of weapons in the State. The numbers of inspections required for verifying other activities such as dismantlement would need to be related to the confidence required and activities involved.

Concept 5. Notification Periods and Points of Entry

CFE includes:

- 36-hour notice of an inspection
- Six-hour notice of the specific site
- Single or multiple points of entry

The group agreed the concept of having notice periods was necessary. The exact times would be a matter for negotiation, because site-specific aspects, including how long to make such sites safe and secure for inspections, would need to be considered. The shorter time the better for inspection purposes but practicalities would need to be allowed for.

Multiple points of entry would mean that only a part of the State or a set number of declared sites would then be possible to be chosen by the inspectors for the actual inspection. Hence normal operations could continue at other sites once the point of entry was known. Whether this is helpful or required would depend on the size of the State and number of declared sites. For New START, the United States and Russia each have two points of entry, with one associated with declared locations in the east or west of each State. This should be considered by negotiators, but there was no reason foreseen that either single or multiple points of entry would be problematic.

The group also considered concepts of whether any movement of items would be allowed after an inspection had been called or whether nearby systems would have to return to base. These are not concepts in the CFE but were included in the START treaty. Both of these would seem useful additions regarding delivery systems such as road mobile or submarines. Further study would be required to understand the implications for planned movements of non-deployed weapons not included in START.

Concept 6. Number of Inspectors and Inspection Duration

CFE includes:

- Limit of nine inspectors
- Limit of three subgroups
- 48 hours for an inspection including traveling time

The group recognized that a limit on numbers of inspectors and the duration of the visit at a nuclear weapons site would be required for cost and practical reasons. The exact numbers should be flexible and depend on the nature of the site and the activities to be undertaken. The group also recognized that only a limited number of inspection activities could be undertaken simultaneously on a nuclear weapons facility for safety and security reasons. However, allowing more inspectors and activities may be advantageous for inspected state facilities if this shortens the duration of the inspection. The numbers for CFE would appear to be low if any practical activities such as measurements would be needed. This would be explored in more detail in the second section of the exercise.

Concept 7. Equipment

- Host supplied equipment in sensitive areas

Although the CFE allows inspectors to bring certain equipment, in previous nuclear disarmament verification studies the need for host-supplied equipment in sensitive areas has been shown. As with previous IPNDV work, the need to ensure such equipment would still be trusted by inspectors is crucial, and further study on how this is achieved will be required. Inspectors will need their own IT to analyze any data received from such inspections, and the host will need to facilitate this in appropriate areas of the site or in an off-site location.

Concept 8. Overflights

WG4 recognized this would be problematic on many nuclear weapons sites, as most nuclear establishments, civil or military, do not allow overflights for safety as much as security reasons. Overflights would also be of little utility on small sites, where activities and objects of interest to inspectors are all within buildings. Using drones may be better, but would also have security and safety implications. This would be a site-specific issue, and we recognized it may not be allowed at all sites. Satellite imagery is a more likely source of such information, and how this could be used would be a matter for negotiations. Overflights or aerial imagery could have more utility, and less safety or security concerns, when looking for or at undeclared sites for absence confirmation purposes.

Concept 9. Rules to Discount Buildings and Objects to Inspect

CFE includes:

- No inspections of buildings with a less than two-meter entrance way
- No inspections of shrouded items less than two meters in diameter

WG4 thought that this concept was not one that translated to the nuclear weapons regime, given the small size of the TAI. Hence no building or item (shrouded or otherwise) should be off limits simply due to size alone. However, inspectors will need to decide how much time to spend looking at buildings that are unlikely to be used for weapons, such as offices and accommodation or recreational facilities as opposed to bunkers and shielded facilities. The group thought the ability of inspectors to hold all buildings and items at risk of inspection was an important concept, hence the importance of not having anything ruled out. WG4 thought this was particularly important when related to ensuring the absence of undeclared weapons at declared sites.

WG4 expected some security or otherwise sensitive items would be shrouded, but any such item if not declared as a weapon should be subject to confirmation measurements if inspectors require it. Questions for technical experts in IPNDV's Working Group 6 (WG6) came from this discussion on how much confidence that a shrouded or containerized item could be gained from a measurement. Is there a size beyond which an item could contain sufficient shielding that a measurement would not work? What other information or measurements could then help with this? Weighing the item if practical was one possible option.

Consideration and further work would be required to consider items that may be encountered at undeclared non-weapon facilities. This could then include items that have nuclear signatures that could not be opened for safety reasons. Could absence of explosives be used in these circumstances? The group suggested the possibility of weapon systems that contain radioactive signatures such as depleted uranium as a potentially particularly difficult problem to account for.

Concept 10. Video and Photography

WG4 thought that the use of video was unlikely to be acceptable within sensitive facilities unless it was very carefully host-controlled and in cases to ensure absence of activities. It was noted even in the CFE this was predominantly used to record initial briefings, so no information was missed. This may be allowable depending on the acceptance of the specific individuals involved. Photography would be expected to be widely used to record activities, unique identifiers, tags and seals, as well as any anomalies found. This is similar to CFE and START. Any such photography would be host controlled and images would be reviewed for security before releasing to inspectors. Chain of custody of equipment and data storage devices would be required to maintain confidence in such images.

Findings from Part Two: Site-Specific Inspections

The subgroups were only given two hours to discuss how they would verify declarations they were given at each site. Hence, the subgroups only expected they would be able to identify a few key challenges to using the CFE concepts, and not create any detailed inspection plans or arrangements. Each section below sets out the initial declarations subgroups were given for each site, any general observations made by the subgroups at the beginning of their discussions, the approaches the subgroups took to explore verification concepts, and the issues or questions they identified. The following sections are taken directly from the summaries made by the subgroups themselves. Key conclusions from both parts of the exercise are discussed at the end of this paper. Annex 2 also contains some key points and questions each subgroup was asked to consider as part of their deliberations.

Subgroup 1. Missile Silo Base

Initial declaration (as set out for exercise purposes):

- 100 weapons present on the site
- 50 weapons deployed on missiles located in 16 silos
- Each missile capable of carrying five weapons
- 50 weapons located in a separate storage area

General Observations

The silo subgroup found it important to demonstrate trust to the inspected State, and in this regard decided to focus first on the red-marked facilities (i.e., facilities declared to have nuclear weapons) on the site diagram (see Annex 2).

The subgroup also agreed that as many facilities as possible should be at least visually screened within the limited time, and that a handful blue-marked (indicating declared as no weapons present) facilities would undergo in-depth inspection.

Approach Discussed by the Subgroup

The subgroup tested if a team of 12 inspectors could gain sufficient confidence in the time allowed. They postulated that the inspectors would be split into three groups of four people. The first group to inspect the silo area, the second group to inspect the storage area and the base headquarters, and the third group to compile and analyze the data sent by the first two groups.

The first group would be split into two subgroups. On the first day of inspection, while the first subgroup conducts inspection of one of the red-marked silos, the second subgroup drives throughout the entire silo area and visually screens the authenticity of the red/blue (weapons present/not present) declaration.

On the second day of inspection, while the first subgroup conducts in-depth verification of a couple of blue-marked facilities, the second subgroup inspects the red-marked interim storage building located next to one of the silos.

The second team will spend a day-and-a-half inspecting the storage area and half a day inspecting the base headquarters. The second team would also be split into two subgroups to try to verify as many facilities as possible. Similar to the first group, it will visually screen all facilities, if possible, arbitrarily select a red-marked facility for in-depth verification and undergo same procedure for a blue-marked facility.

Issues or Questions Identified

If a silo contains a missile not loaded with a nuclear weapon, then it would be marked with blue. The inspectors decide whether to verify such a silo.

If the missile and the nuclear warhead are stored separately at the interim storage building next to the silo, then it would take less time to conduct verification. However, if the warhead is loaded on the missile, then it would take a longer time to verify.

As for the blue-marked facilities, if they are empty, then it would easy to screen visually. However, if there are objects similar to nuclear weapons containers, then this would delay the verification process and require additional time.

It was clear the CFE limit of 48 hours was too restrictive; the exact time required would depend on activities needed, although this would always be limited. A multinational inspection conducted under substantial time constraint would require sufficient prior training and coordination to ensure effectiveness.

Subgroup 2. Road Mobile Base

Initial declaration (as set out for exercise purposes):

- 100 weapons associated with the site
- 25 weapons temporarily on missiles on deployment
- Each missile capable of carrying one weapon
- 75 weapons located in a separate storage area

General Observations

The group quickly realized that it was not feasible to develop a comprehensive inspection plan, given the limited time and amount of information available. Instead, the group used the opportunity to discuss several aspects related to carrying out such inspections.

Approach Discussed by the Subgroup

Initially, one group of inspectors could check the site perimeter to ensure the overview of the site and check, for example, that suspicious items are not stored or hidden directly off the site perimeter.

At the same time, a second subgroup could start verifying the presence of declared warheads in the red structures. This task, limited to verifying the unique identifiers (such as serial numbers) on each warhead container, should be manageable for all 75 containers containing weapons.

Inspectors should never be left alone, so at least two inspectors should at any time be present in the inspectors' office where they can account for inspection activities and execute necessary compilation and analyze collected information.

When the perimeter has been inspected, the same subgroup may inspect some of the blue structures looking for any suspicious items or activities.

- It is not realistic to visit all buildings. Some will appear more relevant than others, and future visits to the same site may be used to inspect some of the buildings not visited earlier.
- In some locations, selected by the inspectors, the subgroup should carry out absence measurements by looking for weapons-related radiation. Sufficient time should be allocated to make several such measurements as long as no suspicious radiation is detected.

One subgroup should, if possible, collect information about the whereabouts of the warheads, such as the unique identifiers associated with the deployed weapons.

- It is important for confidence-building to be able to follow the weapons over time. Documents do not prove anything, but consistency over many years is difficult to fake.

The inspecting group is assumed to be able to confirm the presence of nuclear weapons by performing certain measurements. Because measuring one weapon takes half a day, realistically, the group would therefore be expected to verify only one or two weapons by actual measurements in any one visit.

- These weapons must be selected by the inspectors.
- Confidence must be built over time as new inspections are carried out and new weapons are measured.

Issues or Questions Identified

The given CFE-based frequency of inspections is not satisfactory for nuclear disarmament verification. Just carrying out the verification of the initial baseline declaration would take several years and verifying the movements of individual weapons over time would be almost impossible.

The CFE-based rule of excluding structures with a door width less than two meters is not applicable to nuclear disarmament verification. Missiles are large, but nuclear weapons may be much smaller than two meters even if they are placed in a container.

- Nuclear disarmament verification may therefore call for much more comprehensive inspections than those performed under existing treaties.

The limited duration of inspections as in the case of this exercise, albeit meaningful from a practical perspective, comes as a detriment to the reliability and accuracy of the inspection and hence the credibility of the verification regime. This is due to the fact that a single nuclear weapon can be highly relevant strategically, as opposed to a small number of conventional weapons (for instance a tank under the CFE Treaty). Given the complexity of nuclear disarmament verification activities, such activities will need significantly greater resources in terms of personnel, logistics, and budgets than verification activities under the CFE treaty.

Subgroup 3. Naval Base

Initial declaration (as set out for exercise purposes):

- 100 weapons associated with the site
- 50 weapons temporarily on submarines
- Each missile capable of carrying three weapons
- 50 weapons located in a separate storage area

General Observations

Importance of prior information, including on the submarines, included the number of boats, the number of launch tubes on each boat, how to uniquely identify each boat, as well as serial numbers or other unique identifiers (UIDs) for the missiles and the weapons. This would be essential to ensure confidence on the total numbers of weapons that could be gained over multiple visits. Given half of the weapons are not present on the initial visit limited any potential confidence that could be gained.

If possible, intrinsic UIDs would help increase confidence over time because these would always be directly associated with the items (weapons, missiles, boats), rather than attached tags or seals, or printed serial numbers.

Approach Discussed by the Subgroup

The group gave priorities to identifying and counting the declared weapons present on the site, including physically checking the stores and ensuring unique identification of the items present. The group preferred to make a measurement on a randomly selected item to ensure it was a real weapon system.

If a boat was present during the inspection, the group would check the number of tubes and how the boat is uniquely identified; this is important for subsequent visits to ensure there are no extra boats. The group would need a declaration of how many launch tubes contain missiles and how many weapons were on each missile. The group would choose to inspect one tube declared as empty, and one missile to count the number of weapons (these would be shrouded so just “lumps”) attached. The group would take measurements of any “lumps” declared not to be weapons. Much of this could replicate procedures from START baring any State-specific differences.

The group would perform a visual inspection of any other boats or vessels and buildings. Everywhere should be available for inspection, and the inspectors would use a random selection process to choose which areas to physically inspect to check for absence of weapons.

Issues or Questions Identified

Based on CFE inspection rules, it could be a very long time before all boats would have been seen by inspectors. The group determined that more work is required into how much confidence could be gained that all weapons were being counted. Statistical methods should be looked at to assess the reliability of random selection as a methodology and how to optimize it to gain most confidence.

Considering how to make random selection most effective would allow a better estimate of how many inspections would be required to gain sufficient confidence in the declarations, and how long each inspection would need to be.

Subgroup 4. State-Wide Completeness Considering Undeclared Locations

General Observations

Based on the discussions on applicability of CFE verification rules to the given scenario, a convergence of opinion emerged that it should be, in principle, possible to verify the absence of undeclared items or activities in a State as a whole with sufficient levels of assurance.

NTMs would likely play a very large role in State-wide completeness verification efforts.

Approach Discussed by the Subgroup

In the context of State-wide verification of completeness, it is most promising to further look into the "holding everything at risk" concept of the CFE Treaty.

That means *all* undeclared locations should, in principle, be at risk of being inspected. In other words, no location on the territory or under jurisdiction/control of a State should be exempted, although safeguards against frivolous or excessively disruptive inspections are required (in addition to the possible deterrent effect of reciprocity).

The wide scope of a State-wide inspection regime could perhaps be made more manageable by distinguishing between different types of locations (less or more suitable for undeclared items/activities) and allocating different types of inspection regimes to the different categories.

Locations especially suitable for undeclared items or activities (e.g., because of security, military nature, accessibility, remoteness, proximity to military facilities with delivery vehicles) would receive higher inspection quotas than other locations.

Even so, credible procedures/arrangements would have to be in place for a large range of different types of locations and terrains (determination of size of sites, transport, observation methods, technology, etc.).

Issues or Questions Identified

It is highly unlikely that any State could be provided with absolute certainty that another State has not hidden a single or small batch of warheads; however, this uncertainty should be offset by other checks and verification regimes, for example, on delivery systems and fissile materials.

Adequate verification of absence of undeclared items in a State-wide context will require a highly cooperative setting or an extremely high verification burden. Unless a minimum of confidence exists between parties and they actively cooperate to reassure others of their compliance, verification of State-wide completeness will likely be too cost-intensive to be feasible. Exceptions could be joint efforts to verify disarmament in a single (smaller) State.

Conclusion

Many concepts could be used from the CFE. Although comprehensive verification solutions could not be developed in the timescale of this exercise, no reasons were found why sufficient confidence could not be gained with a relatively similar approach to the CFE, modified for the practicalities of nuclear weapons and facilities.

The details would likely need to change in each concept (number of inspections, inspectors, subgroups, time, etc.), but the principles involved would be the same. Future negotiators would be taking the same considerations (confidence, intrusiveness, efficiency) to decide such details, which relate directly to the principles the IPNDV developed in Phase 1.

Further details developed in START and New START would also be directly relevant and would provide the basis for many of the activities to count deployed declared items. However, site-specific issues in different States may require different solutions.

The exercise showed the importance of detailed information on sites, delivery vehicles, and containers prior to inspections. The more detailed information provided, the more efficient and effective inspection could be. Prior information would include not just written information and data, but visits to sites, exhibitions of missiles and delivery vehicles, and establishment of how measurements and unique identification would work, including trials. This would also be in the inspected State’s interest to ensure inspections could be as efficient as possible and hence spend less time physically on their sites.

WG4 also noted the need to identify and be able to account for delivery vehicles, even when it is the nuclear weapons that are the items of account. Accounting for delivery vehicles provides the most effective way of being able to account for weapons on deployment, and by ensuring no extra delivery vehicles exist provides confidence in no excess weapons.

The routine application of “challenge” inspections was a very useful concept to build confidence in the absence of weapons in non-declared locations. This was an aspect not included in the START Treaties. WG4 thought much further work is required in building how verification of absence could be most effectively undertaken during inspections both at declared and non-declared locations.

The importance of random selection and holding "everything" at risk of inspection was demonstrated. Further study of methods to assess the effectiveness of statistical approaches to verification should be undertaken. This will particularly aid the understanding of how best to build confidence in the absence of declared items in undeclared locations based on random selection of inspections.

WG4 identified two immediate points during this phase of the IPNDV:

- Coordination with technical experts in WG6 is required on how to make effective and efficient measurements to indicate the absence of a weapon in containers or under shrouds.
- Coordination with technical experts in WG6 is required on unique identification, particularly intrinsic features, to enable re-identification of items on subsequent visits. Because items can legitimately move between inspections, and not all items will be available for counting on each inspection (on deployment), sealing items in containers may not provide a benefit in many cases. Need to ensure items can still be identified, and hence avoid "double accountancy."

These questions could also be taken up by technical experts beyond IPNDV.

Overall, as with previous work by the IPNDV, participants thought although there was still much work to do, that this exercise built further confidence that verification could be successfully accomplished for nuclear disarmament in the future.

Working Group 4 Deliverable
Annex: Exercise Documentation

Annex 1. WG4 Walkthrough Exercise on Declarations: CFE Treaty Case Study

Annex 2. Exercise Handouts: Initial Declaration, Site Diagrams, and Photographs

Annex 3. Walkthrough Presentation

Annex 4. Aerial Photographs of Facilities

Annex 1. WG4 Walkthrough Exercise on Declarations: CFE Treaty Case Study

Reference Material: A Simplified Version of the CFE Treaty

INITIAL DECLARATIONS

Each State Party shall provide at the signature of this Treaty notification to all other States Parties of the maximum levels for its holdings of **NUCLEAR WARHEADS**.

Technical Data and Photographs

Technical data together with photographs (**WEAPON CONTANERS/DELIVERY VEHICLES)** shall be provided by each State Party to all other States Parties at the signature of the Treaty.

NOTIFICATIONS AND EXCHANGE OF INFORMATION

Annual Exchange of Information

- Information on the overall holdings **(NUCLEAR WARHEADS)**;
- Information on the location, numbers, and types of **NUCLEAR WARHEADS** not in service with Armed Forces (exp. research and development facilities, etc.);
- Information on **DECLARED FACILITIES**;
- Points of Entry/Exit;
- Information on the location of sites from which **NUCLEAR WARHEADS** have been withdrawn (the locations of these sites shall be notified for three years following such withdrawal).

Operational Notifications

- Any change of 10 percent or more in number of **NUCLEAR WARHEADS** assigned to any location. Such notification shall be given no later than five days after such change occurs, indicating actual holdings after the notified change.

VERIFICATION (INSPECTIONS)

General Obligations

- No more than one inspection team conducting an inspection may be present at the same time at any one inspection site.
- Each State Party shall be obliged to receive a number of inspections pursuant to not to exceed its passive **DECLARED FACILITIES** inspection quota for each specified time period:
  - During the first 120 days after entry into force of the Treaty—20 percent of **DECLARED FACILITIES**;
  - Each year, commencing after completion of the 120 days after entry into force of the Treaty, for the duration of the Treaty—15 percent of **DECLARED FACILITIES**.
- Each State Party with territory within the area of application shall be obliged to accept challenge inspections as follows:
  - During the baseline validation period, up to 15 percent of the number of inspections of **DECLARED FACILITIES** which that State Party is obliged to receive on its territory;
  - During each year of the residual period, up to 23 percent of the number of inspections of **DECLARED FACILITIES** which that State Party is obliged to receive on its territory.
- Notwithstanding any other limitations, each State Party shall be obliged to accept a minimum of one inspection each year of its **DECLARED FACILITIES**, and each State Party with territory within the area of application shall be obliged to accept a minimum of one inspection each year within a specified area.
  - An inspection team's in-country period shall not exceed the 48 hours for the inspection of a **DECLARED FACILITIES** or within a specified area;
- An inspection team conducting an inspection shall spend no more than 48 hours at a **DECLARED FACILITIES** and no more than 24 hours in inspection within a specified area.
- The inspected State Party shall ensure that the inspection team travels to an inspection site by the most expeditious means available. Time between completion of the inspection conducted by an inspection team on the territory of the State Party where an inspection is carried out and the arrival of that inspection team at the point of Entry/Exit does not exceed nine hours. Excess time shall not count against that inspection team's in-country period.

Notification of Intent of Inspection

The inspecting State Party shall notify the inspected State Party of its intention to carry out an inspection, such notifications shall be made **no less than 36 hours in advance of the estimated time of arrival** of the inspection team at the point of Entry/Exit and shall include:

(A) The point of Entry/Exit to be used;

(B) The estimated time of arrival at the point of Entry/Exit;

(C) The means of arrival at the point of Entry/Exit;

(D) A statement of whether the first inspection shall be conducted as a **DECLARED FACILITIES** or challenge inspection and whether the inspection will be conducted on foot, by cross-country vehicle, by helicopter, or by any combination of these;

(E) The time interval between the arrival at the point of Entry/Exit and the designation of the first inspection site;

(F) The likely number of sequential inspections.

The inspected State Party shall acknowledge receipt of notification within three hours.

Procedures upon Arrival at Point of Entry/Exit

- The escort team shall meet the inspection team and transport crew members at the point of Entry/Exit upon their arrival.
- Equipment and supplies that the inspecting State Party brings into the territory of the State Party where an inspection is to be carried out shall be subject to examination each time they are brought into that territory. This examination shall be completed prior to the departure of the inspection team from the point of Entry/Exit to the inspection site. Such equipment and supplies shall be examined by the escort team in the presence of the inspection team members.

GENERAL RULES FOR CONDUCTING INSPECTIONS

- An inspection team shall consist of up to nine inspectors and may divide itself into up to three sub-teams.
- The inspection team shall be permitted to bring such documents as needed to conduct the inspection, in particular its own maps and charts. Inspectors shall be permitted to bring and use portable passive night vision devices, binoculars, video and still cameras, Dictaphones, tape measures, flashlights, magnetic compasses, and laptop computers. The inspectors shall be permitted to use other equipment, subject to the approval of the inspected State Party.

- The inspection team shall specify on each occasion it designates the **DECLARED FACILITIES** to be inspected whether the inspection will be conducted on foot, by cross-country vehicle, by helicopter, or by any combination of these.
- The inspection team shall have the right to conduct helicopter overflights of the **DECLARED FACILITIES**, using a helicopter provided and operated by the inspected State Party. The duration of such helicopter overflights at an inspection site shall not exceed a cumulative total of one hour.
- The inspected State Party shall not be obliged to provide a helicopter at any **DECLARED FACILITIES** that are less than 20 square kilometers in area.
- During an inspection of a **DECLARED FACILITIES** or within a specified area, inspectors shall be permitted access, entry, and unobstructed inspection:
    - In the case of a specified area, within the entire specified area; or
    - Inspectors shall not have the right to enter other structures or areas within structures the entry points to which are physically accessible only by personnel doors not exceeding two meters in width and to which access is denied by the escort team.
- The inspected State Party shall have the right to shroud individual sensitive items of equipment.
- The escort team shall have the right to deny access to sensitive points, the number and extent of which should be as limited as possible, to shrouded objects and to containers any dimension (width, height, length, or diameter) of which is less than two meters. Whenever a sensitive point is designated, or shrouded objects or containers are present, the escort team shall declare whether the sensitive point, shrouded object or container holds any **NUCLEAR WARHEAD**.
- Inspectors shall have the right to take photographs, including video, for the purpose of recording the presence of weapon. The escort team shall cooperate with the inspection team's taking of photographs.
- Photography of sensitive points shall be permitted only with the approval of the escort team.
- The inspection shall be deemed to have been completed once the inspection report has been signed and countersigned.
- After completion of an inspection at a **DECLARED FACILITIES** or within a specified area, if no sequential inspection has been declared, then the inspection team shall be transported to the appropriate point of Entry/Exit as soon as possible and shall depart the territory of the State Party where the inspection was carried out within 24 hours.

DECLARED FACILITIES INSPECTION

- Inspection of a **DECLARED FACILITIES** shall not be refused. Such inspections may be delayed only in cases of force majeure.
- An inspection team shall arrive on the territory of the State Party where an inspection is to be carried out through a point of Entry/Exit associated with the declared site it plans to designate as the first inspection site.
- The inspected State Party shall have the right to utilize up to six hours after designation of a **DECLARED FACILITIES** to prepare for the arrival of the inspection team at that site.
- At the number of hours after arrival at the point of Entry/Exit, which shall be no less than one hour and no more than 16 hours after arrival at the point of Entry/Exit, the inspection team shall designate the first **DECLARED FACILITIES** to be inspected.
- The inspected State Party shall ensure that the inspection team travels to the first declared site by the most expeditious means available and arrives as soon as possible but no later than nine hours after the designation of the site to be inspected, unless otherwise agreed between the inspection team and the escort team, or unless the inspection site is located in mountainous terrain or terrain to which access is difficult. In such case, the inspection team shall be transported to the inspection site no later than 15 hours after designation of that inspection site. Travel time in excess of nine hours shall not count against that inspection team's in-country period.
- Immediately upon arrival at the **DECLARED FACILITIES**, the inspection team shall be escorted to a briefing facility where it shall be provided with a diagram of the declared site. The declared site diagram, provided upon arrival at the declared site, shall contain an accurate depiction of the:

  (A) Geographic coordinates of a point within the inspection site, to the nearest 10 seconds, with indication of that point and of true north;

  (B) Scale used in the site diagram;

  (C) Perimeter of the declared site;

  (D) Major buildings and roads on the declared site;

  (E) Entrances to the declared site; and

  (F) Location of an administrative area for the inspection team.
- Within one-half hour after receiving the diagram of the declared site, the inspection team shall designate the **DECLARED FACILITIES** to be inspected. The inspection team shall then be given a pre-inspection briefing which shall last no more than one hour and shall include the following elements:

(A) Safety and administrative procedures at the inspection site;

(B) Modalities of transportation and communication for inspectors at the inspection site; and

(C) Holdings and locations at the inspection site.

- The pre-inspection briefing shall include an explanation of any differences between the numbers of **NUCLEAR WEAPONS** present at the inspection site and the corresponding numbers provided in the most recent notification, in accordance with the following provisions:

  (A) If the numbers of **NUCLEAR WEAPONS** present at the inspection site are less than the numbers provided in that most recent notification, such explanation shall include the temporary location of **NUCLEAR WEAPONS**; and

  (B) If the numbers of **NUCLEAR WEAPONS** present at the inspection site exceed the numbers provided in that most recent notification, such explanation shall include specific information on the origin, departure times from origin, time of arrival, and projected stay at the inspection site of such a **NUCLEAR WEAPONS**.

CHALLENGE INSPECTION WITHIN SPECIFIED AREAS

- Each State Party shall have the right to conduct challenge inspections within specified areas.
- The term “specified area” means an area anywhere, on the territory of a State Party within the area of application other than **DECLARED FACILITIES** within which a challenge inspection is conducted. A specified area shall not exceed 65 square kilometers. No straight line between any two points in that area shall exceed 16 kilometers.
- If the inspecting State Party intends to conduct a challenge inspection within a specified area as the first inspection after arrival at a point of Entry/Exit:

  (A) It shall include in its notification the designated point of Entry/Exit nearest to or within that specified area capable of receiving the inspecting State Party’s chosen means of transportation; and

  (B) At the number of hours after arrival at the point of Entry/Exit, which shall be no less than one hour and no more than 16 hours after arrival at the point of Entry/Exit, the inspection team shall designate the first specified area it wishes to inspect. Whenever a specified area is designated, the inspection team shall, as part of its inspection request, provide to the escort team a geographic description delineating the outer boundaries of area. The inspection team shall have the right, as part of that request, to identify any structure or facility it wishes to inspect.

- The inspected State Party shall have the right to refuse challenge inspections within specified areas.
- The inspected State Party shall inform the inspection team within two hours after the designation of a specified area whether the inspection request will be granted.
- If access to a specified area is granted:
  - The inspected State Party shall have the right to use up to six hours after it accepts the inspection to prepare for the arrival of the inspection team at the specified area;
  - The inspected State Party shall ensure that the inspection team travels to the first specified area by the most expeditious means available and arrives as soon as possible after the designation of the site to be inspected, but no later than nine hours from the time such an inspection is accepted, unless otherwise agreed between the inspection team and the escort team, or unless the inspection site is located in mountainous terrain or terrain to which access is difficult. In such case, the inspection team shall be transported to the inspection site no later than 15 hours after such an inspection is accepted. Travel time in excess of nine hours shall not count against that inspection team's in-country period; and
  - Within such specified area the escort team may delay access to or overflight of particular parts of that specified area. If the delay exceeds more than four hours the inspection team shall have the right to cancel the inspection. The period of delay shall not count against the in-country period or the maximum time allowed within a specified area.
- If the inspected State Party so wishes, the inspection team may be briefed on arrival at the specified area. This briefing is to last no more than one hour. Safety procedures and administrative arrangements may also be covered in this briefing.
- If access to a specified area is denied:
  - The inspected State Party or the State Party exercising the rights and obligations of the inspected State Party shall provide all reasonable assurance that the specified area does not contain **NUCLEAR WEAPONS**.
  - No inspection quota shall be counted, and the time between the designation of the specified area and its subsequent refusal shall not count against the in-country period. The inspection team shall have the right to designate another specified area or declared site for inspection or to declare the inspection concluded.

Annex 2. Exercise Handouts: Initial Declaration, Site Diagrams, and Photographs

INITIAL DECLARATIONS

Table V-2-1. Overall Holdings of Nuclear Weapons

Line Number	Category	Type of Nuclear Weapons	Number of Nuclear Weapons
1	NUCLEAR WEAPONS	TYPE A	800

Table V-2-2. Information on the Location, Numbers, and Types of Nuclear Weapons Not in Service with Armed Forces

Line Number	Location	Type of Nuclear Weapons	Number of Nuclear Weapons
1	FACILITY "RESEARCH&DEVELOPMENT" 151515N0151515E	TYPE A	1

Table V-2-3. Information on Declared Facilities

Line Number	Record Number and Location of Declared Facilities	Point of Entry/ Exit	Designation of Declared Facilities	Number of Nuclear Weapons	Type of Nuclear Weapons

1	001 LOCATION1 111111N0111111 E	01	FACILITY “NAVAL BASE”	100	TYPE A
2	005 LOCATION2 222222N0222222 E	01	FACILITY “ROCKET SILO”	100	TYPE A
3	006 LOCATION3 333333N0333333 E	01	FACILITY “MOBILE-ROAD POINT”	100	TYPE A
4	007 LOCATION4 444444N0444444 E	01	FACILITY “DISMANTLEMENT”	100	TYPE A
5	008 LOCATION5 555555N0555555 E	01	FACILITY “CENTRAL STORAGE”	100	TYPE A
6	009	01	FACILITY “AIR BASE 1”	100	TYPE A

	LOCATION6 666666N0666666E				
7	010 LOCATION7 777777N0777777E	01	FACILITY “AIR BASE 2”	100	TYPE A
8	011 LOCATION8 888888N0888888E	01	FACILITY “AIR BASE 3”	100	TYPE A

Table V-2-4. Points of Entry/Exit (POE)

Line Number	POE Record Number	Name of POE	Location	Type
1	01	POE1	999999N0999999E	AIR, GROUND

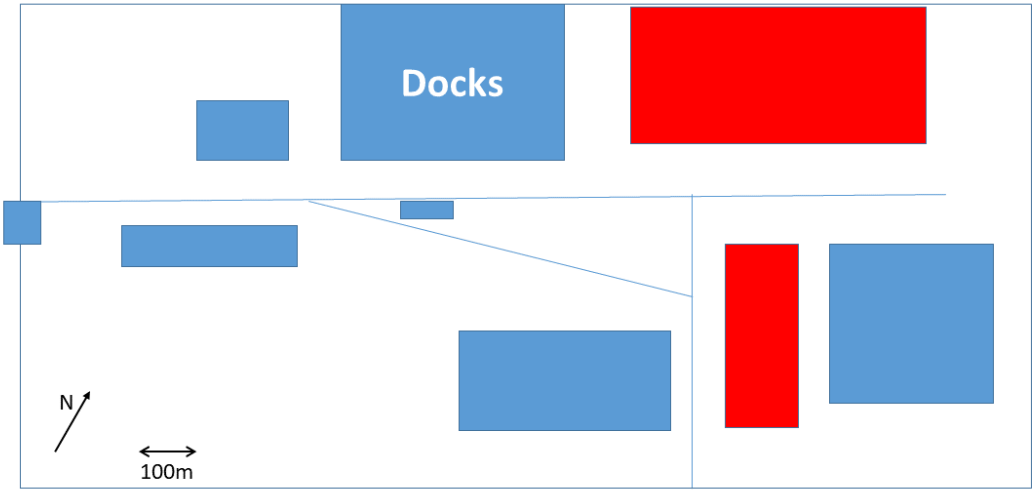
Table V-2-5. Information on the Location of Declared Sites which Nuclear Weapons Have Been Withdrawn

Declared Facilities Record Number	Declared Facilities	Location of Declared Facility	Year of Withdrawal

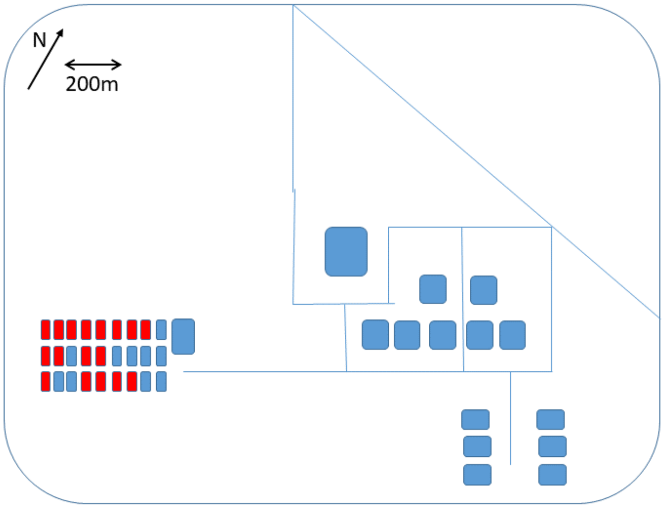
002	FACILITY “FORMER TEST SITE”	121212N0121212E	2015
003	FACILITY “FORMER AIR BASE”	131313N0131313E	2016
004	FACILITY “FORMER ROAD POINT”	141414N0141414E	2017

SITE DIAGRAMS

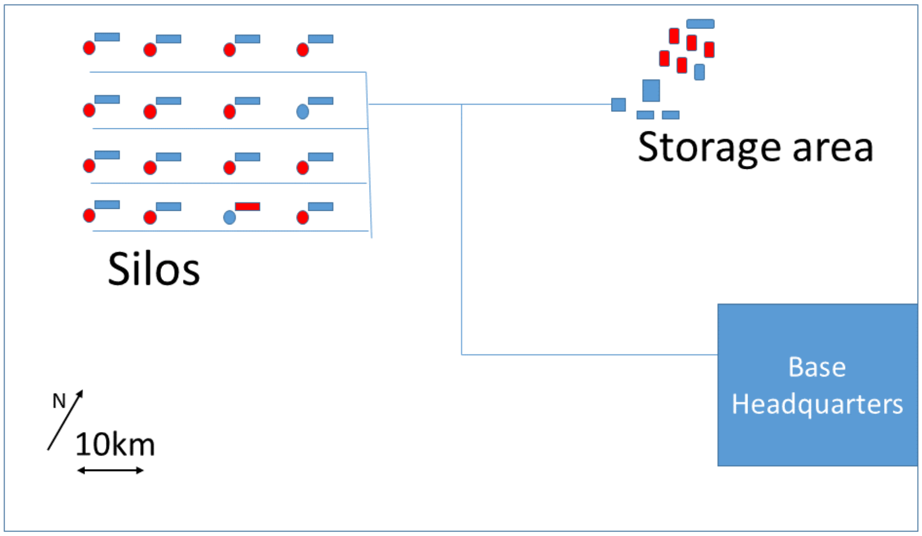
Naval Base site diagram



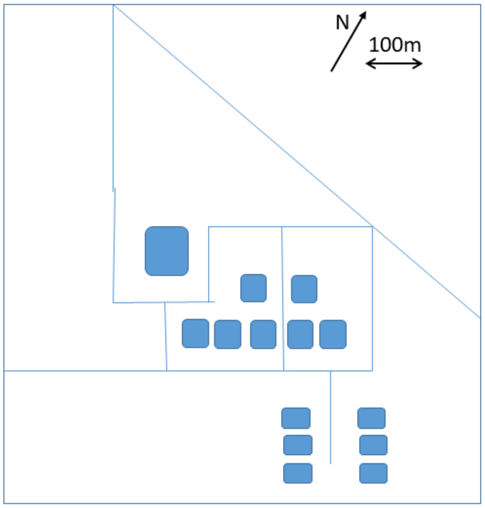
Road Mobile site diagram



Missile Silo site diagram

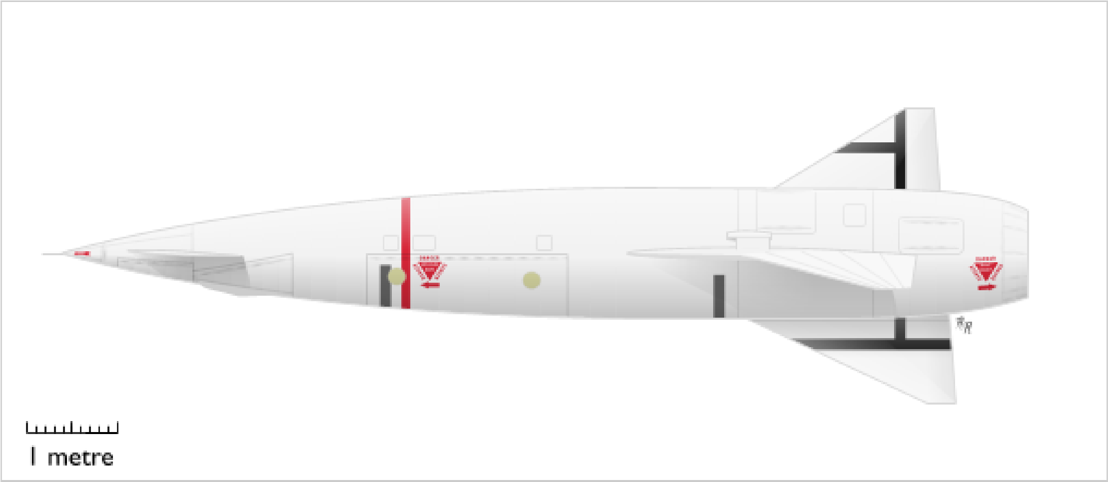


Missile Silo site diagram
Base Headquarters



PHOTOGRAPHS OF MISSILES AND WEAPON CONTAINERS

Road Mobile Missile—One Weapon per Missile



https://commons.wikimedia.org/wiki/File:Blue_Steel_missile.png

Road Mobile Missile—One Weapon per Missile

https://commons.wikimedia.org/w/index.php?search=blue+steel+missile&title=Special%3ASearch&go=Go&ns0=1&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1#/media/File:Blue_Steel_missile_at_RAF_Museum_London.JPG

Silo Based Missile—Up to Five Weapons per Missile

https://commons.wikimedia.org/wiki/File:Blue_Streak.JPG

Submarine Launched Missile—Up to Three Weapons per Missile

https://commons.wikimedia.org/w/index.php?search=british+missile&title=Special:Search&go=Go&ns0=1&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1&searchToken=4izguicf7bmtwv76li61yuiol#%2Fmedia%2FFile%3ABritish_Polaris_Missile_-_Imperial_War_Museum_1.jpg

Air Delivered Bomb

https://commons.wikimedia.org/wiki/File:We177_science_museum.jpg

Weapon Container

Photo courtesy of the QUAD nuclear disarmament verification partnership (UK, US, Norway, Sweden)

QUESTIONS AND ISSUES TO CONSIDER

- In examining the simplified CFE Treaty (in the order it is written), we might wish to ask questions not limited to the following. We may not be able to answer these immediately in our first session, but may need to revisit these after the exercise.
- Are photographs sufficient, or are exhibitions of the items required? What technical data are required on weapons, their containers, and delivery vehicles? Does this include certain baseline or template measurements?
- Regarding the notification system of only notifying changes of 10 percent or greater within five days, is this sufficient, if not, then why not?
- Is allowing 20 percent of the sites to be visited in one year sufficient? Given there are likely to be far fewer nuclear sites than military sites under CFE, what figure balances intrusiveness with providing sufficient confidence?
- Given the lower number of declared sites, the number of undeclared site visits in a year is likely to be very low (probably one in most nuclear weapon possessor States), does this matter? If so why?
- Are site visits of a maximum of 48 hours (less once travelling is included) sufficient? If not, what would balance intrusiveness and providing sufficient confidence?
- Does the notification timeline pose issues for the inspected State? Giving 36 hours of a notification of an inspection, but not identifying which site?
- The CFE allows use of inspector-supplied equipment; it has been suggested this is unlikely to be the case for nuclear weapons inspections. What issues does this pose? Does this apply in all areas of nuclear weapons facility or only in the highest sensitivity areas? Inspectors will need to be able to use their own computers and equipment for certain data analysis; the inspected State will need to enable this at a location in reasonable proximity to the inspection site.
- Is a team of nine inspectors in three sub-teams sufficient? How many could a nuclear site be expected to facilitate?
- Is the use of a helicopter reasonable at nuclear sites?
- The CFE uses a criterion of a two-meter door width to define which buildings can or cannot be inspected. Is this a useful concept for nuclear weapons facilities? If so, what would be an equivalent criterion?

- Shrouded items are likely to be used to protect sensitive security and proliferative items. Is a size criterion a useful concept of which are measured for absence? If so, what should the size be? Is there an alternative criterion?
- Is taking video footage helpful to inspectors? Would this pose security issues for the inspected State?
- The inspected State will get six hours' notice of which site will be inspected. Is this sufficient to allow inspected State preparations but without causing concerns over the integrity of the inspection?
- Are the site diagrams appropriate and sufficient? If not what else may be useful to or assist verification activities?
- For challenge inspections, is the limit on area size a useful concept? Is 65 square kilometers appropriate?
- The time allowed for challenge inspections is the same as for declared sites. Does that seem appropriate or are there reason they should be different? What might determine this?
- Is the concept of not being able to refuse inspections to declared sites, but being able to refuse challenge inspections appropriate?

Questions and Issues to Consider for Inspection and Monitoring Activities at Nuclear Bases

- Distribution of **SUBTEAMS—**one team will need to be based in an office to collate information, communicate with the field teams, and to be able to swap members of the field team as the day progresses.
- No inspector should ever be left alone.
- There is **LIMITED TIME** available, so we need to decide on priority actions:
    - How should we prioritize between counting declared items and looking for undeclared items?
    - Do we need to make confirmation measurements on declared items and if so on how many?

    - What kind of non-declared items do we need to measure to confirm absence of nuclear/explosive material?

- Measurements on nuclear weapons will take time, as they will almost certainly have to be moved to be measured in a safe location. Measurements on one weapon are likely to take a minimum of half a day if in storage and potentially up to a whole day if they are being removed from a missile. Only one weapon can be measured in any location at a time.
- For **SILO** sites, these could be physically very large, visiting all of the site will not be practicable. How might the use of the overflight or areal observations be used?
- For **NAVAL** and **ROAD MOBILE** bases, many of the nuclear weapons will be deployed outside of the base at unknown locations. How can we count these systems? Including using multiple inspections over multiple years? Do we need to keep track of or uniquely identify the delivery vehicles?
- In **STORAGE** locations, weapons will be in containers.
- Any unique identifier for the weapons will have to be applied to the container as the weapon will not be accessible to inspectors. How does this affect confidence and verification options?
- On any subsequent visit it is possible a different set and number of weapons will be on deployment; how does this affect keeping track of the weapons? Containers may have different weapons (of the same type) inside them to the ones seen on previous visits.
- **DEPLOYED** systems will be attached to missiles, how does this affect access arrangements? If missile nose sections can be opened to show inspectors the number of weapons attached, they will be shrouded so only “covers” will be seen, this may include non-nuclear items as well as the declared weapons.
- For buildings declared **FREE OF WEAPONS**, are there building types that should be prioritized for checking? Are there buildings that can be safely ignored (e.g., offices)? Is there an equivalent to the two-meter rule from the CFE as to which buildings to check?

Questions and Issues to Consider for Inspection and Monitoring Activities at Non-Declared Sites

How to choose where to inspect?

- What sites will be most important to inspect?

- Are there sites that should be off limits for such inspections? (Government headquarters offices? City center locations?)
- Are there sites that should have more regular monitoring options? Which are these?
- Consideration should be given to:
    - Previous nuclear weapons facilities and bases;
    - Former nuclear test sites;
    - Military bases with large explosive/conventional weapons storage facilities, or with conventional missile capabilities (dual use systems?);
    - Military ranges and exercise areas;
    - Government laboratories;
    - Nuclear facilities;
    - Explosive facilities;
    - Isolated industrial complexes (Does government or commercial ownership matter?);
    - Different geographical terrains—remote areas where items may be hidden, particularly areas with tunneling activities, some road/rail access would likely be required.
- What use can remote monitoring play (including areal or satellite monitoring, commercial, national or international capabilities)?
- Which of these sites may pose issues for the inspected State in terms of the security and sensitivity of legitimate non-nuclear weapons related activities?

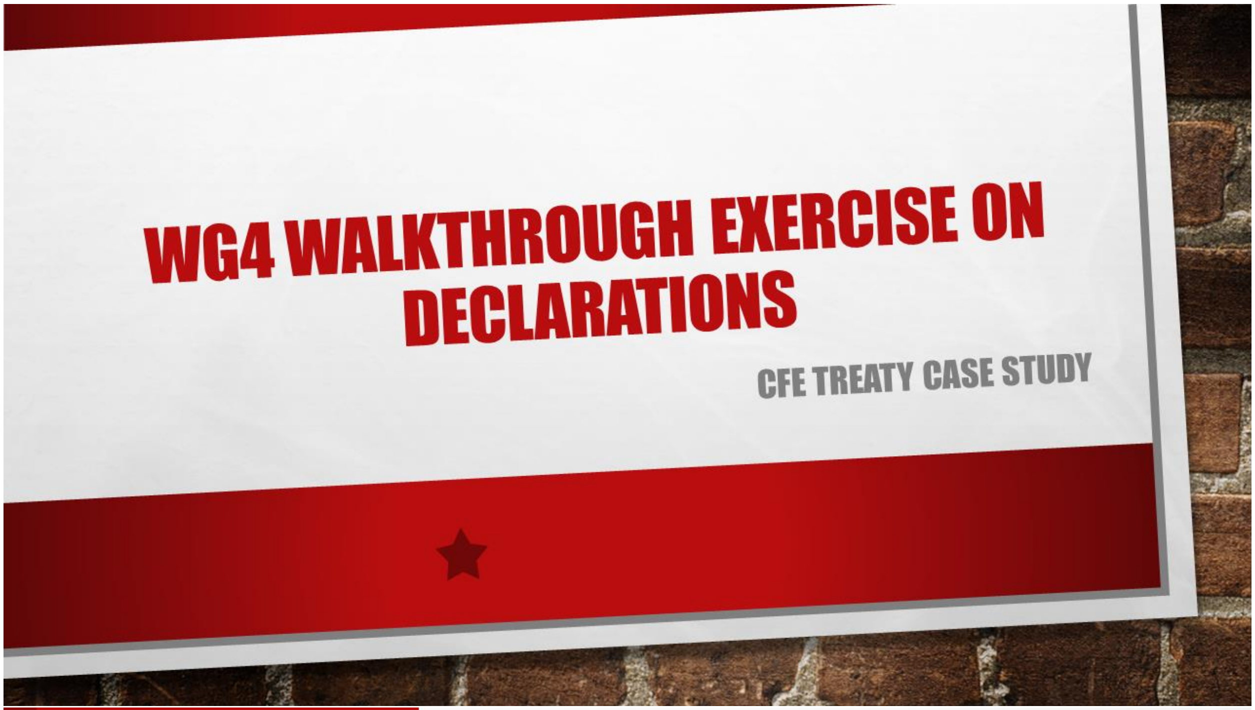
How to approach inspecting a site once it has been chosen?

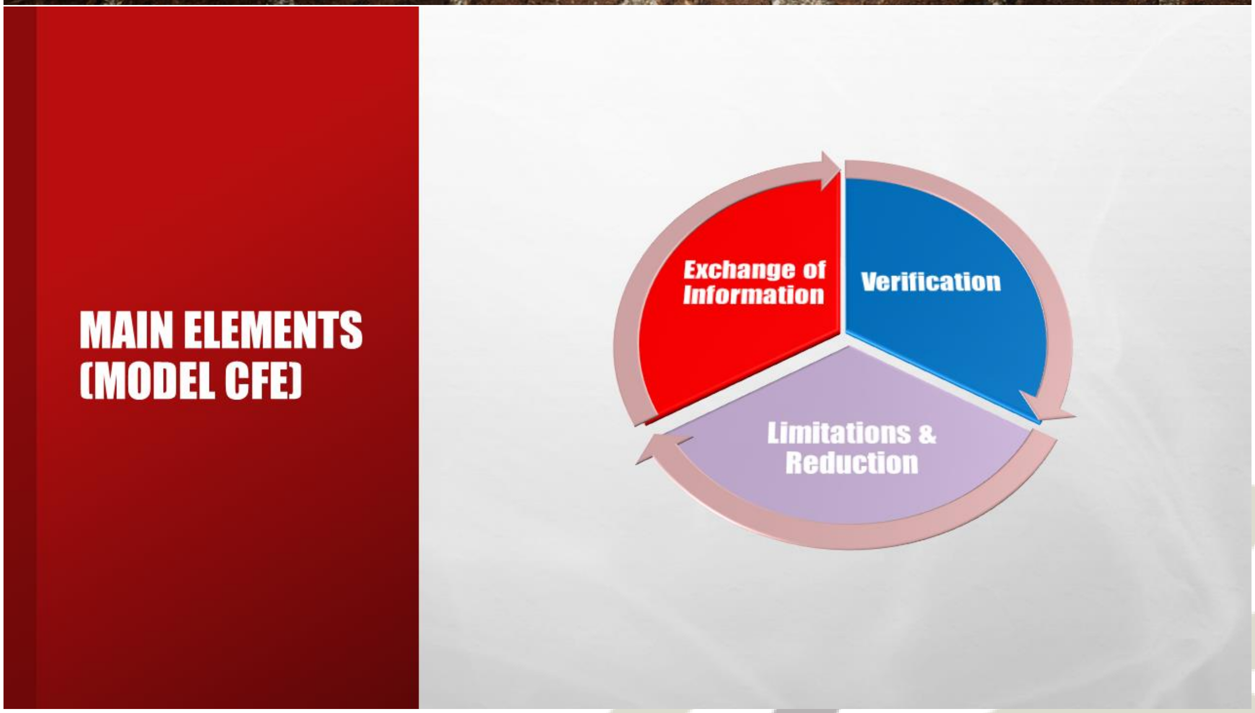
- Distribution of **SUBTEAMS**—one team will need to be based in an office to collate information, communicate with the field teams, and to be able to swap members of the field team as the day progresses.
- No inspector should ever be left alone.
- There is **LIMITED TIME** available, so we need to decide on priority actions:
    - These sites could be physically very large, visiting all of the site will not be practicable. How might the use of the overflight or areal observations be used?

    - Are there building types that should be prioritized for checking? Are there buildings that can be safely ignored (e.g., offices)? Is there an equivalent to the two-meter rule from the CFE as to which buildings to check?

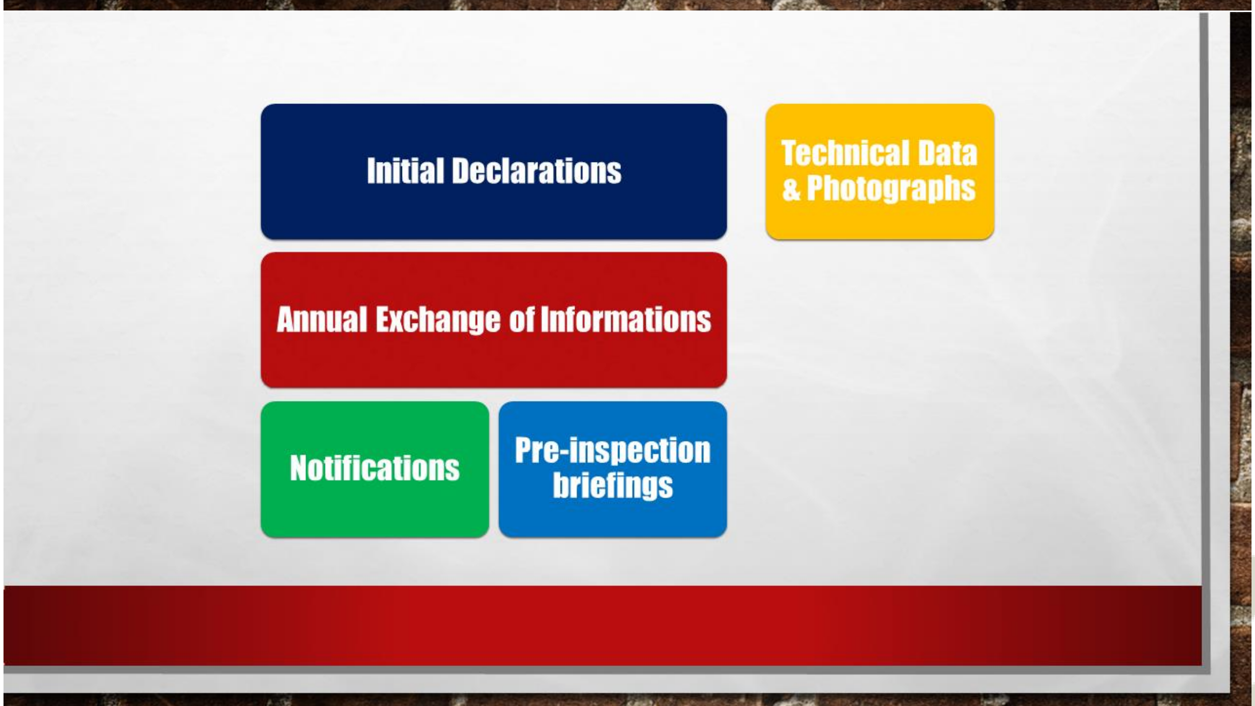
- Should inspectors be searching for the weapons themselves, or start looking for other features? What might these be?
    - Swipe sampling for nuclear/explosive material?
    - Nuclear/explosive related health and safety infrastructure?
    - Attitude and compliance of the host?
    - Can the hosts explanation of the site be validated?
- What kind of items do we need to measure to confirm absence of nuclear/explosive material?

Annex 3. Walkthrough Presentation





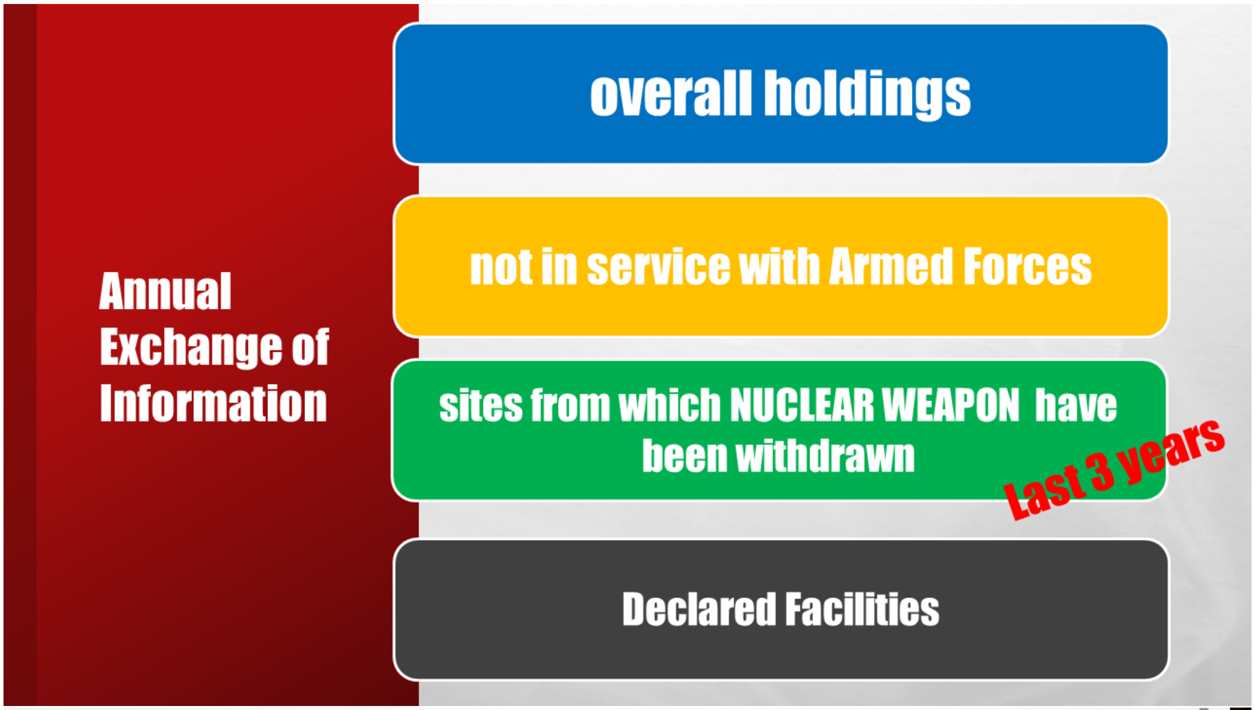

INFORMATION EXCHANGE

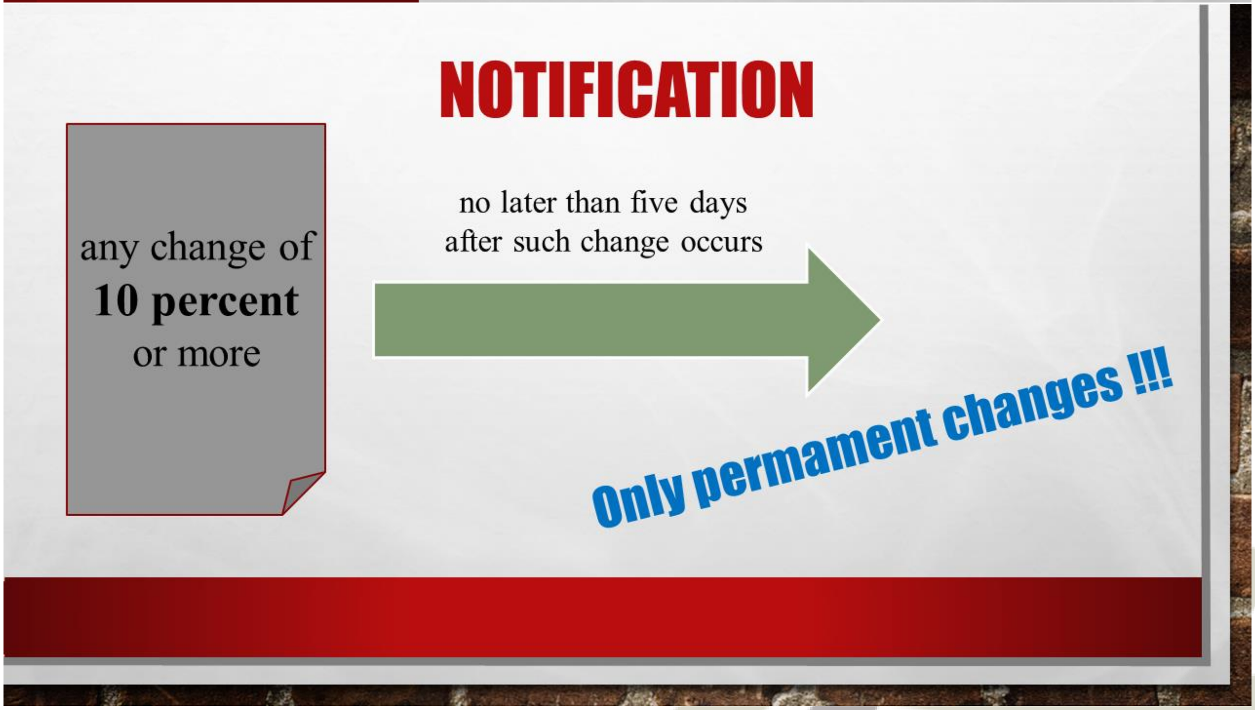

Initial Declarations
Technical Data & Photographs
Annual Exchange of Informations
Notifications
Pre-inspection briefings

Initial Declarations &
Technical data and photographs

QUESTIONS

- ***ARE PHOTOGRAPHS SUFFICIENT, OR ARE EXHIBITIONS OF THE ITEMS REQUIRED? WHAT TECHNICAL DATA IS REQUIRED ON WEAPONS, THEIR CONTAINERS AND DELIVERY VEHICLES? DOES THIS INCLUDE CERTAIN BASELINE OR TEMPLATE MEASUREMENTS?***


Annual Exchange of Information
overall holdings
not in service with Armed Forces
sites from which NUCLEAR WEAPON have been withdrawn
Last 3 years
Declared Facilities


NOTIFICATION
any change of 10 percent or more
no later than five days after such change occurs
Only permament changes !!!

QUESTIONS

- ***THE NOTIFICATION SYSTEM OF ONLY NOTIFYING CHANGES OF 10% OR GREATER WITHIN 5 DAYS, IS THIS SUFFICIENT, IF NOT WHY NOT?***

SITE DIAGRAM

- GEOGRAPHIC COORDINATES OF A POINT WITHIN THE INSPECTION SITE, TO THE NEAREST 10 SECONDS, WITH INDICATION OF THAT POINT AND OF TRUE NORTH;
- SCALE USED IN THE SITE DIAGRAM;
- PERIMETER OF THE DECLARED FACILITY;
- MAJOR BUILDINGS AND ROADS ON THE DECLARED FACILITY;
- ENTRANCES TO THE DECLARED SITE; AND
- LOCATION OF AN ADMINISTRATIVE AREA FOR THE INSPECTION TEAM.

QUESTIONS

- *ARE THE SITE DIAGRAMS APPROPRIATE AND SUFFICIENT? IF NOT WHAT ELSE MAY BE USEFUL TO OR ASSIST VERIFICATION ACTIVITIES?*

PRE-INSPECTION BRIEFING

An explanation of any differences between the numbers of NUCLEAR WARHEADS present at the inspection site and the corresponding numbers provided in the most recent notification:

(A) if the numbers of NUCLEAR WARHEADS present at the inspection site are less than the numbers provided in that most recent notification, such explanation shall include **the temporary location** of NUCLEAR WARHEAD; and

(A) if the numbers of NUCLEAR WARHEADS present at the inspection site exceed the numbers provided in that most recent notification, such explanation shall include specific **information on the origin, departure times from origin, time of arrival and projected stay at the inspection site** of such a NUCLEAR WARHEAD.


QUESTIONS
• IT IS POSSIBLE, FROM A SECURITY POINT OF VIEW, TO PROVIDE INFORMATION ON TEMPORARY LOCATION OF NW? IF NOT HOW CAN YOU CHECK THE CORRECTNESS OF THE INFORMATION PROVIDED?


VERIFICATION

TYPES OF INSPECTION

- **DECLARED FACILITIES INSPECTION**
- **CHALLENGE INSPECTION WITHIN SPECIFIED AREA** (A SPECIFIED AREA SHALL NOT EXCEED 65 SQUARE KILOMETRES. NO STRAIGHT LINE BETWEEN ANY TWO POINTS IN THAT AREA SHALL EXCEED 16 KILOMETRES)

QUESTIONS

- **FOR CHALLENGE INSPECTIONS, IS THE LIMIT ON AREA SIZE A USEFUL CONCEPT? AND IS 65 SQUARE KILOMETRES APPROPRIATE?**

REFUSAL OF THE INSPECTION

- Inspection of a DECLARED FACILITIES shall not be refused. Such inspections may be delayed only in cases of force majeure.
- The inspected State Party shall have the right to refuse challenge inspections within specified areas. The inspected State Party shall inform the inspection team within two hours after the designation of a specified area whether the inspection request will be granted. If access to a specified area is denied, the inspected State Party or the State Party exercising the rights and obligations of the inspected State Party shall provide all reasonable assurance that the specified area does not contain NUCLEAR WARHEADS.

QUESTIONS

- **IS THE CONCEPT OF NOT BEING ABLE TO REFUSE INSPECTIONS TO DECLARED FACILITIES, BUT BEING ABLE TO REFUSE CHALLENGE INSPECTIONS APPROPRIATE?**

NUMBER OF DECLARED FACILITIES INSPECTIONS

DECLARED FACILITIES INSPECTION QUOTA FOR EACH SPECIFIED TIME PERIOD:

- DURING THE FIRST 120 DAYS AFTER ENTRY INTO FORCE OF THE TREATY - **20** PERCENT OF **DECLARED FACILITIES**;
- EACH YEAR, COMMENCING AFTER COMPLETION OF THE 120 DAYS AFTER ENTRY INTO FORCE OF THE TREATY, FOR THE DURATION OF THE TREATY, - **15** PERCENT OF **DECLARED FACILITIES**.

NUMBER OF CHALLENGE INSPECTIONS

EACH STATE PARTY WITH TERRITORY WITHIN THE AREA OF APPLICATION SHALL BE OBLIGED TO ACCEPT CHALLENGE INSPECTIONS AS FOLLOWS:

- DURING THE BASELINE VALIDATION PERIOD, UP TO **15 PERCENT** OF THE NUMBER OF INSPECTIONS OF **DECLARED FACILITIES** WHICH THAT STATE PARTY IS OBLIGED TO RECEIVE ON ITS TERRITORY;
- DURING EACH YEAR OF THE RESIDUAL PERIOD, UP TO **23 PERCENT** OF THE NUMBER OF INSPECTIONS OF **DECLARED FACILITIES** WHICH THAT STATE PARTY IS OBLIGED TO RECEIVE ON ITS TERRITORY.

NUMBER OF INSPECTION

A MINIMUM OF ONE INSPECTION EACH YEAR OF ITS DECLARED FACILITIES,

AND ONE INSPECTION EACH YEAR WITHIN A SPECIFIED AREA.

QUESTIONS

- *IS ALLOWING 15 % OF THE SITES TO BE VISITED IN ONE YEAR SUFFICIENT? GIVEN THERE ARE LIKELY TO BE FAR FEWER NUCLEAR SITES THAN MILITARY SITES UNDER CFE, WHAT FIGURE BALANCES INTRUSIVENESS WITH PROVIDING SUFFICIENT CONFIDENCE?*
- *GIVEN THE LOWER NUMBER OF DECLARED SITES, THE NUMBER OF UNDECLARED SITE VISITS IN A YEAR IS LIKELY TO BE VERY LOW (PROBABLY 1 IN MOST WEAPON STATES), DOES THIS MATTER? IF SO WHY?*

NOTIFICATION OF INTENT OF INSPECTION

The inspecting State Party shall notify the inspected State Party of its intention to carry out an inspection, such notifications shall be made **no less than 36 hours in advance of the estimated time of arrival** of the inspection team at the point of entry/exit and shall include:

(A) the point of entry/exit to be used;

(A) the estimated time of arrival at the point of entry/exit;

(A) the means of arrival at the point of entry/exit;

(A) a statement of whether the first inspection shall be conducted as a DECLARED FACILITIES or challenge inspection and whether the inspection will be conducted on foot, by cross-country vehicle, by helicopter or by any combination of these;
(B) the time interval between the arrival at the point of entry/exit and the designation of the first inspection site;
(C) the likely number of sequential inspections.

QUESTIONS

- DOES THE NOTIFICATION TIMELINE POSE ISSUES FOR THE HOST? GIVING 36 HOURS OF A NOTIFICATION OF AN INSPECTION, BUT NOT IDENTIFYING WHICH SITE?

POE PROCEDURES

- The escort team shall meet the inspection team and transport crew members at the point of entry/exit upon their arrival.
- Equipment and supplies that the inspecting State Party brings into the territory of the State Party where an inspection is to be carried out shall be subject to examination each time they are brought into that territory. This examination shall be completed prior to the departure of the inspection team from the point of entry/exit to the inspection site. Such equipment and supplies shall be examined by the escort team in the presence of the inspection team members.

QUESTIONS

- THE CFE ALLOWS USE OF INSPECTOR SUPPLIED EQUIPMENT, IT HAS BEEN SUGGESTED THIS IS UNLIKELY TO BE THE CASE FOR NUCLEAR WEAPON INSPECTIONS, WHAT ISSUES DOES THIS POSE? DOES THIS APPLY IN ALL AREAS OF A NUCLEAR WEAPON FACILITY OR ONLY IN THE HIGHEST SENSITIVITY AREAS? INSPECTORS WILL NEED TO BE ABLE TO USE THEIR OWN COMPUTERS AND EQUIPMENT FOR CERTAIN DATA ANALYSIS, THE HOST WILL NEED TO ENABLE THIS AT A LOCATION IN REASONABLE PROXIMITY TO THE INSPECTION SITE.

GENERAL RULES FOR CONDUCTING INSPECTION

- 9 INSPECTORS MAY DIVIDE IP TO 3 SUB-TEAMS
- INSPECTION COULD BE CONDUCTED ON FOOT, BY CROSS-COUNTRY VEHICLES, BY HELIKOPTER
- 1 HOUR HELIKOPTER OVERFLIGHTS OF DECLARED FACILITIES (NO OBLIGATION IF AREA IS LESS THAN 20 SQUARE KILOMETERS)

QUESTIONS

- *IS A TEAM OF 9 INSPECTORS IN THREE SUB TEAMS SUFFICIENT? HOW MANY COULD A NUCLEAR SITE BE EXPECTED TO FACILITATE?*
- *IS THE USE OF A HELICOPTER REASONABLE AT NUCLEAR SITES?*

GENERAL RULES FOR CONDUCTING INSPECTION

DURING AN INSPECTION OF A DECLARED FACILITIES OR WITHIN A SPECIFIED AREA, INSPECTORS SHALL BE PERMITTED ACCESS, ENTRY AND UNOBSTRUCTED INSPECTION:

- IN THE CASE OF A SPECIFIED AREA, WITHIN THE ENTIRE SPECIFIED AREA;
- INSPECTORS SHALL NOT HAVE THE RIGHT TO ENTER OTHER STRUCTURES OR AREAS WITHIN STRUCTURES THE ENTRY POINTS TO WHICH ARE PHYSICALLY ACCESSIBLE ONLY BY PERSONNEL DOORS NOT EXCEEDING TWO METRES IN WIDTH AND TO WHICH ACCESS IS DENIED BY THE ESCORT TEAM.

QUESTIONS

- THE CFE USES A CRITERIA OF A 2M DOOR WIDTH TO DEFINE WHICH BUILDINGS CAN OR CANNOT BE INSPECTED, IS THIS A USEFUL CONCEPT FOR NUCLEAR WEAPON FACILITIES? IF SO WHAT WOULD BE AN EQUIVALENT CRITERIA?

SENSITIVE POINTS

- THE INSPECTED STATE PARTY SHALL HAVE THE RIGHT TO SHROUD INDIVIDUAL SENSITIVE ITEMS OF EQUIPMENT.
- THE ESCORT TEAM SHALL HAVE THE RIGHT TO DENY ACCESS TO SENSITIVE POINTS, THE NUMBER AND EXTENT OF WHICH SHOULD BE AS LIMITED AS POSSIBLE, TO SHROUDED OBJECTS AND TO CONTAINERS ANY DIMENSION (WIDTH, HEIGHT, LENGTH OR DIAMETER) OF WHICH IS LESS THAN TWO METRES. WHENEVER A SENSITIVE POINT IS DESIGNATED, OR SHROUDED OBJECTS OR CONTAINERS ARE PRESENT, THE ESCORT TEAM SHALL DECLARE WHETHER THE SENSITIVE POINT, SHROUDED OBJECT OR CONTAINER HOLDS ANY **NUCLEAR WARHEAD**.

QUESTIONS

- **SHROUDED ITEMS ARE LIKELY TO BE USED TO PROTECT SENSITIVE SECURITY AND PROLIFERATIVE ITEMS, IS A SIZE CRITERIA A USEFUL CONCEPT OF WHICH ARE MEASURED FOR ABSENCE? IF SO WHAT SHOULD THE SIZE BE? IS THERE AN ALTERNATIVE CRITERIA?**

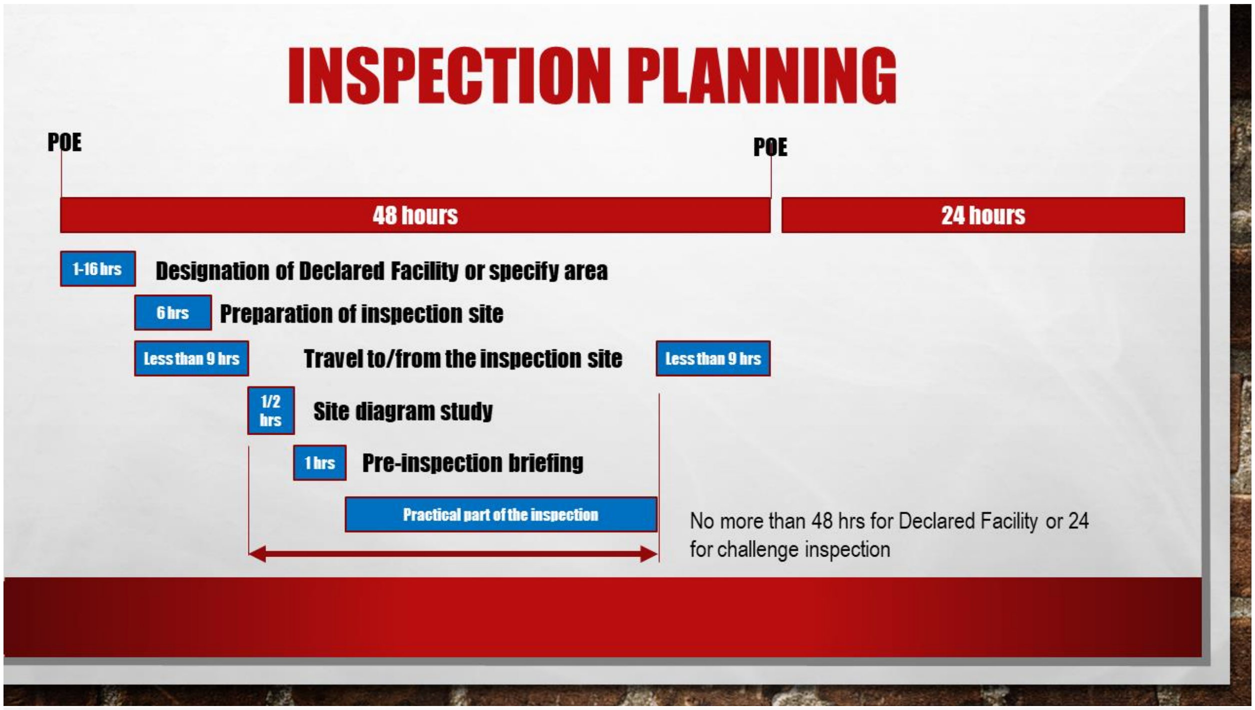
RULES OF PHOTO TAKING

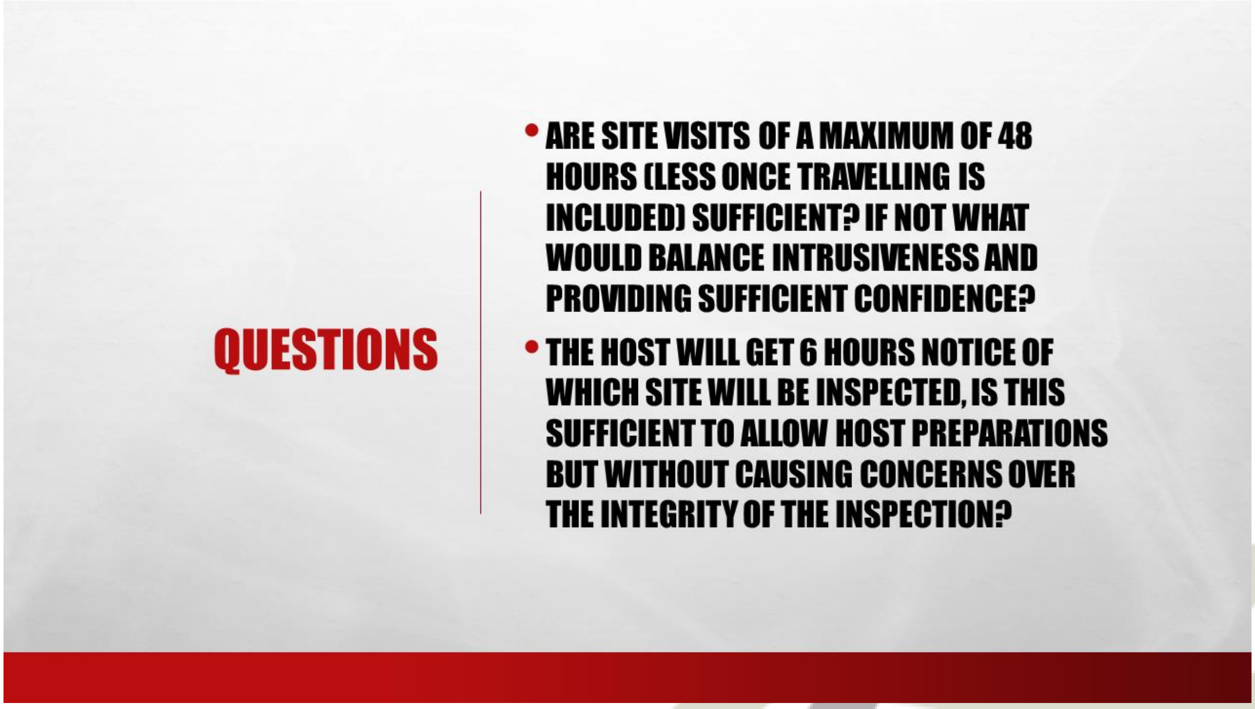
- INSPECTORS SHALL HAVE THE RIGHT TO TAKE PHOTOGRAPHS, INCLUDING VIDEO, FOR THE PURPOSE OF RECORDING THE PRESENCE OF WEAPON. THE ESCORT TEAM SHALL COOPERATE WITH THE INSPECTION TEAM'S TAKING OF PHOTOGRAPHS.

- PHOTOGRAPHY OF SENSITIVE POINTS SHALL BE PERMITTED ONLY WITH THE APPROVAL OF THE ESCORT TEAM.

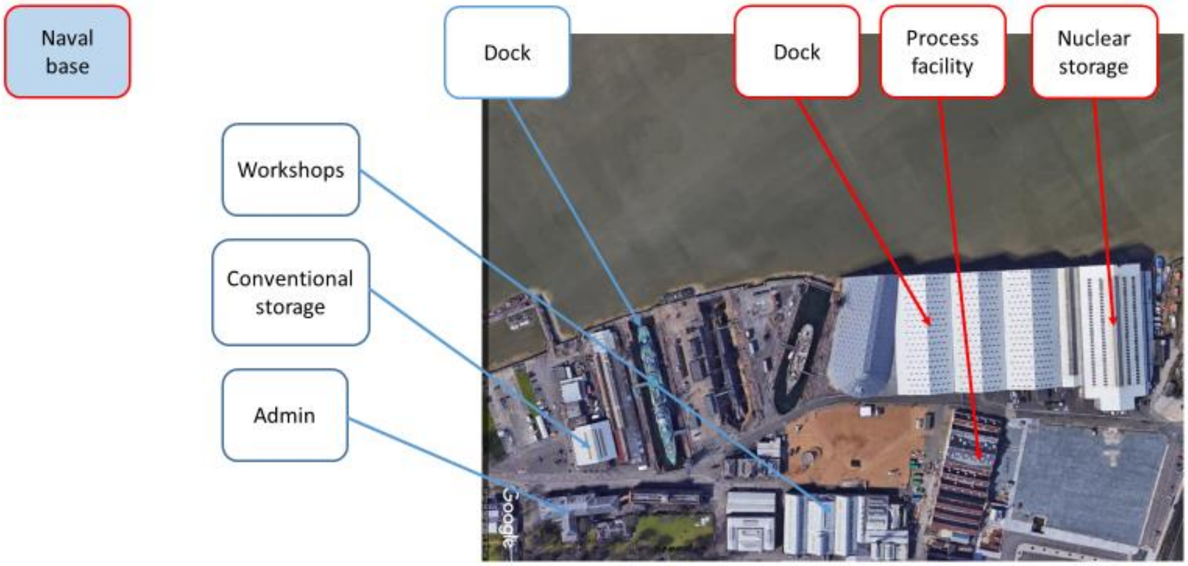
QUESTIONS

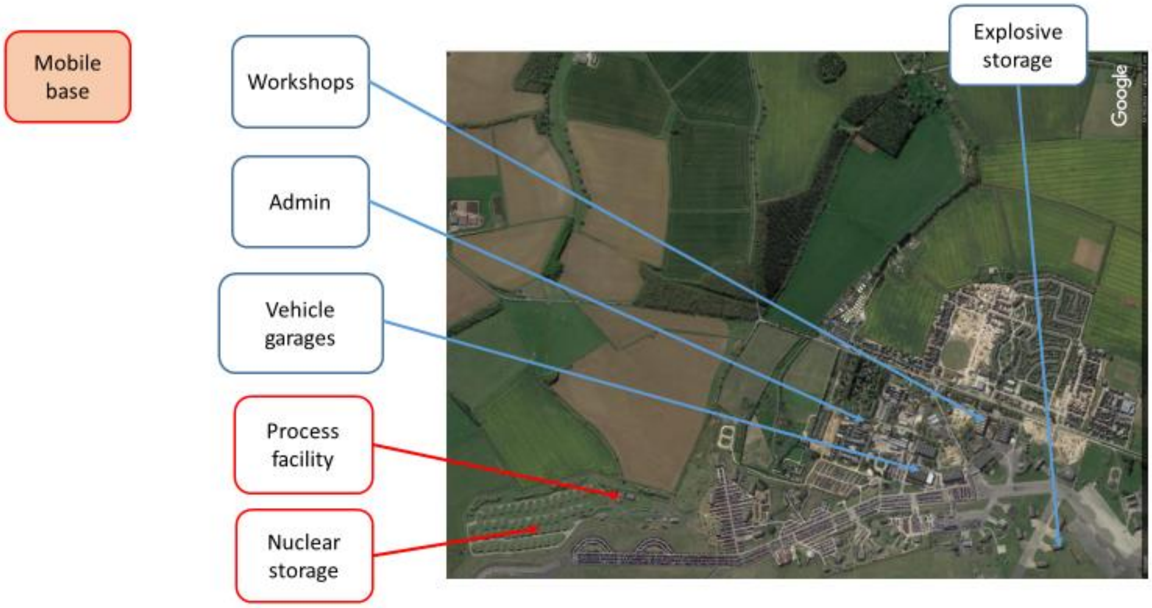
- IS TAKING VIDEO FOOTAGE HELPFUL TO INSPECTORS? WOULD THIS POSE SECURITY ISSUES FOR THE HOST?


INSPECTION PLANNING
POE
POE
48 hours
24 hours
1-16 hrs
Designation of Declared Facility or specify area
6 hrs
Preparation of inspection site
Less than 9 hrs
Travel to/from the inspection site
Less than 9 hrs
1/2 hrs
Site diagram study
1 hrs
Pre-inspection briefing
Practical part of the inspection
No more than 48 hrs for Declared Facility or 24 for challenge inspection

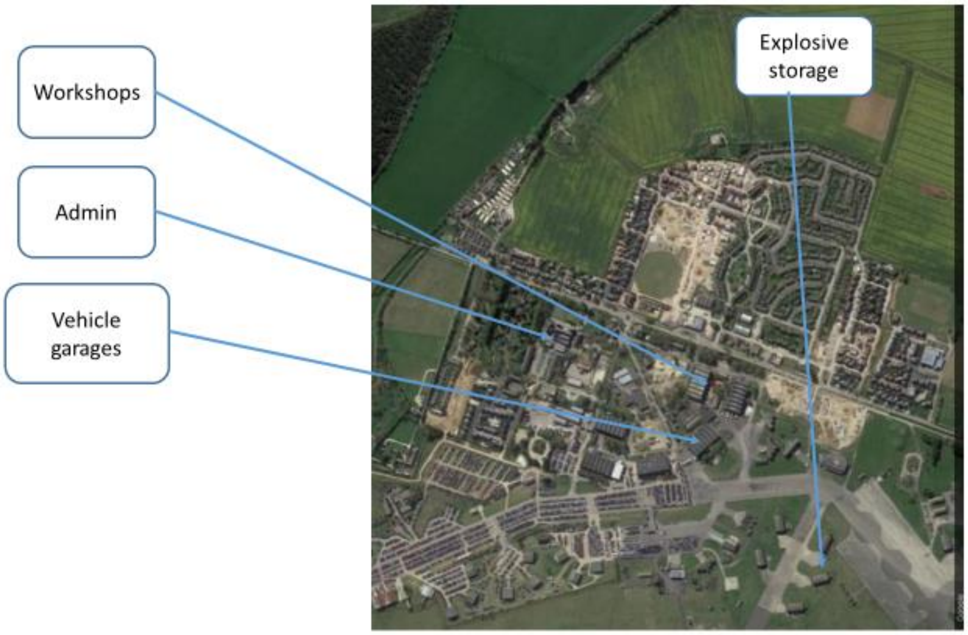

QUESTIONS
• ARE SITE VISITS OF A MAXIMUM OF 48 HOURS (LESS ONCE TRAVELLING IS INCLUDED) SUFFICIENT? IF NOT WHAT WOULD BALANCE INTRUSIVENESS AND PROVIDING SUFFICIENT CONFIDENCE?
• THE HOST WILL GET 6 HOURS NOTICE OF WHICH SITE WILL BE INSPECTED, IS THIS SUFFICIENT TO ALLOW HOST PREPARATIONS BUT WITHOUT CAUSING CONCERNS OVER THE INTEGRITY OF THE INSPECTION?

Annex 4. Overhead Photographs of Facilities

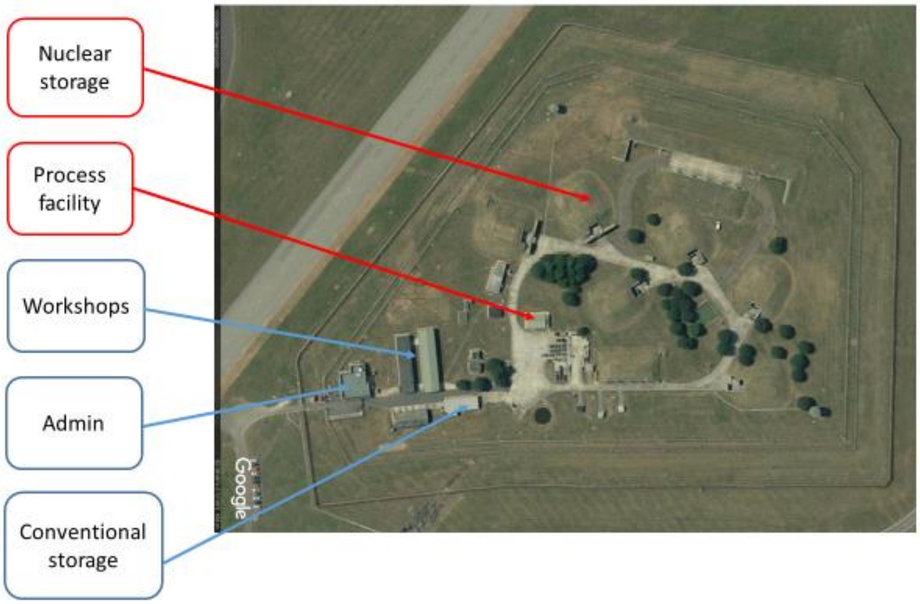




Ground base



Ground base – warhead storage



Ground base – silo area

This is a product of the IPNDV Working Group 4: Verification of Nuclear Weapon Declarations. For more information on the IPNDV Working Groups, please see www.ipndv.org/working-groups.

About the IPNDV:

The IPNDV is an ongoing initiative that includes more than 25 countries with and without nuclear weapons. Together, the Partners are identifying challenges associated with nuclear disarmament verification and developing potential procedures and technologies to address those challenges.

The IPNDV is working to identify critical gaps and technical challenges associated with monitoring and verifying nuclear disarmament. To do this, the Partnership assesses monitoring and verification issues across the nuclear weapon lifecycle.

The IPNDV is also building and diversifying international capacity and expertise on nuclear disarmament monitoring and verification. Through the Partnership, more countries understand the process, as well as the significant technical and procedural challenges that must be overcome. At the same time, the Partnership is highlighting the importance of verification in future reductions of nuclear weapons.