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6.4 Research into Nuclear Disarmament: The UK-Norway Initiative on Nuclear Warhead Dismantlement Verification (UKNI)

6.4.1 Introduction

Both the UK and Norway are as signatories to the Nuclear Non-Proliferation Treaty (NPT) committed to the long-term goal of a world without nuclear weapons. NPT Article VI requires all states parties to the NPT to undertake to pursue "negotiations in good faith on effective measures relating to cessation of the nuclear arm race at an early date and to nuclear disarmament, and on a Treaty on general and complete disarmament under strict and effective international control". Any future disarmament process would need to be underpinned by a verification regime that can demonstrate with confidence that nuclear disarmament has taken place. With this principle in mind, the UK and Norway have been working together since 2007 in a technical collaboration referred to as the UK-Norway Initiative (UKNI) to address some of the technical and procedural challenges that verifying the dismantlement of nuclear warheads could pose. UKNI has included both technical development and a number of unique, ground-breaking exercises.

UKNI has been a process of building trust and cooperation in an area which presents significant technical and political challenges to both parties. The principal objectives for the collaboration are:

- To create scenarios in which Norwegian and United Kingdom participants can explore issues relating to nuclear arms control verification without the risk of proliferation
- To promote understanding between a Nuclear Weapon State (NWS) and a Non-Nuclear Weapon State (NNWS) on the issues faced by the other party
- To promote discussion on how a NNWS can be involved in a nuclear arms control verification process.

Specifically, UKNI focuses on increasing the role of NNWS and has brought together a NWS and a NNWS for the first time to discuss what verification tools and methods could be required to verify nuclear disarmament, and also to explore how all states parties to the NPT can contribute and cooperate to this end.

Results from UKNI have been presented in various forums, and in particular at meetings of the NPT Preparatory Committee and at the 2010 NPT Review Conference. This contribution is based on material extracted from such recent presentations, in particular Backe et al. (2012), UKNI (2010) and UKNI (2012).

6.4.2 Initialization of collaboration and areas of work

Early in 2007, representatives from four Norwegian laboratories, the Norwegian Radiation Protection Authority (NRPA), the Institute for Energy Technology (IFE), the Norwegian Defence Research Establishment (FFI) and NORSAR, met with representatives from the UK Ministry of Defence, the Atomic Weapons Establishment (AWE plc) and the Non-Governmental Organisation VERTIC to discuss a potential cooperation on matters related to the technical verification of nuclear arms control. It was agreed that an unclassified exchange within this field of research was feasible and that a programme of work should be developed. Under this initiative, two areas of research have so far been pursued: Information Barriers and Managed Access.

In its simplest state, an Information Barrier takes data from a measurement device, processes the data relative to predetermined criteria and provides a pass/fail output. Crucially, the Information Barrier must prevent the disclosure of sensitive measurement data to 'uncleared' personnel. Information Barriers are an important concept when considering future inspections, as inspectors would not be given unrestricted access to nuclear warheads, as such access would breach the mutual non-proliferation obligations of the NPT, as well as reveal national security-sensitive information. In 2007, the United Kingdom and Norway therefore embarked on the joint development of a robust, simple and relatively inexpensive Information Barrier system capable of identifying radiological sources. Such systems are intended to be used by the inspectors to verify if sealed containers hold Treaty Accountable Items or not. Used in combination with other inspection techniques, an Information Barrier system is a tool for maintaining a chain of custody and to verify that the disarmament takes place in accordance with a declaration by the country subjected to an inspection (the host country). The use of an Information Barrier system thus enables the parties to meet the requirements of the NPT and prevents disclosure of national security-sensitive information.

In a future verification regime for nuclear warhead dismantlement, inspecting parties are likely to request access to highly sensitive facilities and weapon components. Such access will have to be managed carefully by the inspected party to prevent the disclosure of sensitive information, both in compliance with the NPT and in consideration of national security. At the same time, it will be incumbent on the inspectors not to gain proliferation-sensitive information. Managed Access is the process by which 'uncleared' personnel are given access to such sensitive facilities, or supervised areas, under the terms of an agreed procedure or protocol.

6.4.3 Managed Access Exercises in 2008/2009

The first major element in UKNI was the conduct of Managed Access exercises in 2008 and 2009, as detailed in the following.

Preparatory work

The first stage in the UK-Norway investigation into Managed Access was the creation of a framework for the conduct of practical exercises. This framework was developed by a joint UK-Norway planning team, with VERTIC acting as an independent observer. The core element of the framework was a hypothetical treaty and its associated Verification Procedure, between two hypothetical countries, the "Kingdom of Torland," a NWS, and the "Republic of Luvania," a NNWS. In an initial declaration, Torland stated its intention to dismantle its ten remaining Odin class nuclear weapons (gravity bombs). Torland invited Luvania to verify the dismantlement process for one of these weapons. The Verification Procedure allowed for the Luvanian inspectors to undertake a Familiarization Visit to Torland's nuclear weapon complex, and to subsequently carry out a Monitoring Visit to the same facilities to verify the dismantlement of one Odin class bomb. The dismantlement would be considered complete once the Odin pit (the pit is the notional fissile component within the Odin nuclear weapon) had been placed in a monitored store. The exercise was designed to have a broad enough scope to provide an overview of the whole dismantlement and verification process.

The key objective for Luvania was to establish confidence in the declaration made by Torland with regards to the Treaty Accountable Item (the Treaty Accountable Item was the Odin pit) and to demonstrate, to the satisfaction of both parties, a chain of custody through the dismantlement process. Luvania, as the inspecting party, would produce an inspection report in accordance with the

Verification Procedure. The key objective for Torland was to demonstrate compliance with their obligations under the treaty whilst protecting national security and proliferation sensitive information.

Several steps were taken during the planning stages for the Managed Access exercises to minimize the risk of proliferation. Initially, and continuously during the work, each of the parties assessed their roles and obligations related to NPT Articles I and II and implemented several measures including:

- For the purpose of the Managed Access exercises, it was decided that the United Kingdom and Norway would 'swap roles'. Norway would play the NWS while the United Kingdom would play the NNWS. This also gave the participants the opportunity to explore the problem from the other side's viewpoint
- It was decided that the exercises would take place in Norway
- Although the exercise play was based on a framework involving "the Odin class nuclear weapon," the actual object used during the notional dismantlement process was based on a cobalt-60 radiological source
- The development of Torland's "Atomic Weapons Laboratory", where the Managed Access exercises took place, was undertaken via discussions of a generic facility model comprising simple, logical building blocks which might conceivably be present within any nuclear weapon complex.

Conduct of the exercises

Prior to the Monitoring Visit, Luvanian inspectors visited Torland's "Atomic Weapons Laboratory" in December 2008 to familiarize themselves with the facilities (see Fig. 6.4.1; 'TAI' is the Treaty Accountable Item), the level of access, access controls and the timeline for the dismantlement. During this Familiarization Visit, broad agreement was reached in terms of the permissible inspection activities, and the control measures which would be instigated by the host.

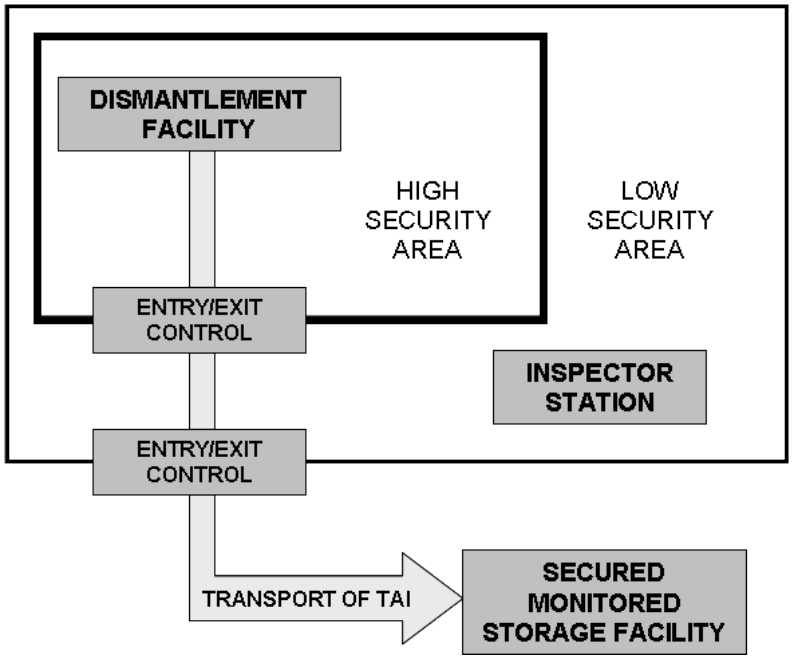

Fig. 6.4.1 Torland's "Atomic Weapons Laboratory" for the Managed Access exercises in 2008/2009.

During the Monitoring Visit in June 2009, the Odin weapon was dismantled in stages in a process that took several days to complete. The Inspectors were presented with the containerised Treaty Accountable Item at agreed points in this process; each point involved the use of a different sealed container. Two jointly designed Information Barrier prototypes were tested during the Monitoring Visit exercise; this was the first field test of the Information Barrier technology developed as part of the UK-Norway Initiative. At the end of each day, the item was stored in an interim storage area. This storage area was secured so that the inspectors were confident that no tampering or diversion activities had occurred. At the end of the dismantlement process, the Treaty Accountable Item was transported from the dismantlement facility to a secured monitored storage facility (Fig. 6.4.1). Pictures taken at various stages of the dismantlement process are shown in Figs. 6.4.2 through 6.4.7.

Fig. 6.4.2 The picture shows the inspectors (in orange coats) in their first contact with the Odin "nuclear weapon", held within a transport container.

The inspectors were provided with an "Inspector Station," which was located within a low security area (Fig. 6.4.1). Within this facility restrictions on activities were minimal, allowing the inspectors to pursue negotiations, review documentation, write reports and perform data analysis.

At the beginning of each day, the inspecting party and the host party met within the Inspector Station to review the facilities and operations scheduled for that day including the dismantlement and inspection activities to be performed. The inspectors were then taken through an entry/exit control point into the high security area (Fig. 6.4.1) where the host deployed a number of Managed Access techniques to ensure that the inspection activities did not breach health and safety regulations, disclose proliferative information or reveal information related to national security.

At the end of the inspection process, Luvania produced a report commenting on the degree to which the monitoring activities had demonstrated Torland's compliance with the initial declaration, and their level of confidence in the overall chain of custody. Torland responded with their observations on Luvania's report.

Host techniques for controlling inspection activities

The Torian host team deployed a number of tactics in order to handle security and inspection activities:

- Identity checks before and during the visit
- Security briefings
- Change of clothing and metal detector checking
- Escorting and guarding
- Shrouding and exclusion zones
- Host control of equipment and measurements
- Documentation and information control including numbered notepads.

Fig. 6.4.3 An inspector watches as a host representative performs measurements using the Information Barrier system. Measurements are performed on the Odin "nuclear weapon", which is still inside the transport container.

Torland ensured that Luvania could not carry any covert monitoring devices during the facility based inspection activities, by requesting that "contraband" items (such as mobile phones or watches) were surrendered prior to taking the inspectors into the high security area. Torland confirmed that all such items had been handed over by asking the inspectors to (notionally) change into clothing provided by Torland and by using a metal detector to perform a search. Whilst within the high security area, escorts and guards were assigned to ensure that the Luvanian inspectors only performed agreed activities within designated areas. Torland used shrouding to conceal items which could provide sensitive or proliferative information. Exclusion zones were marked to identify areas prohibited to inspectors.

Notionally, Torland ensured that the equipment used by the inspectors did not contain any covert monitoring features and did not measure parameters which would be considered sensitive or proliferative. In order to achieve this, all inspection equipment was notionally agreed, authenticated and certified for use within the facility prior to the commencement of the exercise. The equipment used within the high security area was host supplied. It was agreed that Torland facility staff should undertake all measurement and sealing activities under Luvanian supervision.

Fig. 6.4.4 The Odin "nuclear weapon" is taken out of the transport containers. The inspectors were not allowed to watch this step.

The inspection process was documented and signed off by both parties; the measurement data were held jointly until officially released by Torland for use within the Inspector Station. All numbered notepads and pens used within the high security area were supplied by Torland. These were issued

just before entrance into the high security area and collected before exiting. Torland reviewed all notes to ensure that no sensitive information had been recorded.

Many of the above measures were primarily based on security concerns, however, health and safety was also an overriding consideration for the host. Many areas within a nuclear weapon complex are subject to strict regulations and the host must ensure that these are followed during the course of the visit. Torland provided additional health and safety briefings along with appropriate protective and restrictive measures.

Inspection activities

The Luvanian inspectors deployed a number of techniques and processes in order to support the verification activities as agreed during the Familiarization Visit:

- Radiation monitoring
- Tags and seals
- Digital photography of the tags and seals
- CCTV cameras (closed-circuit television)
- Information Barrier system for gamma measurements
- Photography of inspection relevant items, in-situ and with inspectors present
- Review of documentation relating to the Odin device, and visual observations and dimensional measurements of the Odin weapon and containers.

All necessary equipment was supplied by the host to ensure compliance with health, safety and security requirements. The inspectors were permitted to use their own equipment at the Inspector Station, but not inside the dismantlement facility. Authentication of host supplied equipment was not carried out in the exercise. However, some of these issues were addressed in the Information Barrier project.

Prior to any activities being undertaken within the dismantlement facility, the inspectors needed to convince themselves of the absence of materials and sources which could impinge on the inspection activities. Radiation monitoring activities were undertaken using gamma and neutron count rate monitors supplied by Torland. The overall sweeping concept was designed to gain confidence in the integrity of the inspection activities. Once the Inspectors had ensured that the area was clear, all personnel, equipment and containers were monitored in and out of the area. The only exceptions were sealed containers declared to contain the Odin weapon or its components. This procedure was repeated once the dismantlement was complete, to ensure that no treaty relevant materials had been left within the facility.

Tags and seals were used for three reasons: to be able to uniquely identify any containers with the Odin weapon or its components, to ensure that no containers had been opened and to ensure that during dismantlement no materials had been removed from the facilities. Tags and seals were applied to the inside of the facilities immediately after sweeping. The deployed, commercial tags and seals were based on research undertaken in the United States of America and for the International Atomic Energy Agency. The method relied on the inherent tamper-indicating properties of the seals, with the inspectors adding unique random particulate identification tagging (RPIT) to each seal.

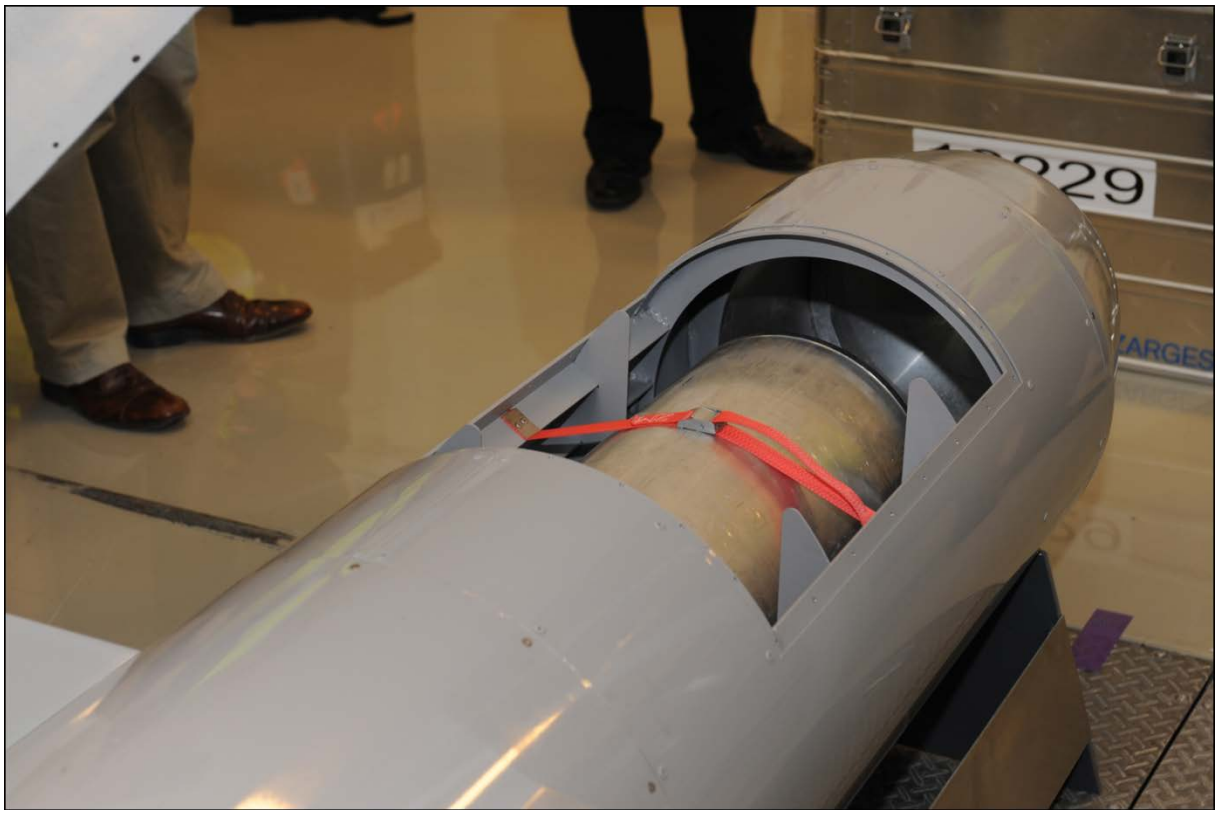

Fig. 6.4.5 The picture shows the Odin pit (fissile component) within the Odin "nuclear weapon" after removal of a hatch. Inspectors were not permitted to see the weapon at this step in the dismantlement process.

The tags and seals were verified by photographing the RPIT. For the exercise, the RPIT consisted of simple glitter supplied by the inspectors and randomly encapsulated in an adhesive. This was applied to the host supplied seals in the Inspector Station shortly before use in the facilities. It is important that the Inspectors are able to impose their own unique identifying feature, particularly if the seals are host supplied, to ensure that the seals cannot be swapped. During the exercise, the images of the seals were taken to the Inspector Station to be compared via a blink comparison technique. Undertaking this in the Inspector Station allowed the inspectors to use their own software to ensure high confidence in the results.

CCTV cameras were deployed notionally at points of interest where the information, within the agreed field of view, was considered to be insensitive by the host. The CCTV cameras provided a direct visual confirmation that no personnel or material had entered or left the facility while the inspectors were not present. Examples include views of ceilings within dismantlement facilities and of exit doorways, which the host had agreed would not be used during the dismantlement activities.

The Information Barrier system was used to confirm that the initial container, declared to contain the Odin weapon system, had a gamma radiation signature compatible with the host's declaration. After each stage of dismantlement, the Information Barrier system was used to confirm that the container declared to hold the Treaty Accountable Item met this agreed signature. All other containers were then monitored with the non-barriered radiation detectors to confirm the absence of any radioactive material. Once a container was confirmed as empty of radioactive material, it could be removed from

the facility. The container with the Treaty Accountable Item was sealed to ensure the further chain of custody.

Some redacted documents containing a limited history of the Odin device with serial number, dates and signatures were provided by the host. Prior to the dismantlement, a limited number of inspectors were allowed to see the outer casing of the Odin device. Some documents were provided by the host to show physical parameters and serial numbers which could be verified by the inspectors on the systems as presented to them. The collection of documents made available to the inspectors by the host was intended to provide further confidence that the item under verification was indeed an Odin system.

Fig. 6.4.6 Information Barrier measurements are performed on the Odin pit contained inside the blue barrel. Both Information Barrier prototypes were used.

Strategy and negotiations

Neither party had developed a comprehensive strategy prior to the exercise, though both had elements in place. All of the participants understood that national security and non-proliferation commitments were an overriding consideration.

During negotiations, the Torian hosts were reminded that they had invited Luvania to inspect the dismantlement process. This, coupled with the non-reciprocal nature of the agreement, placed Torland in what was regarded as a slightly weaker negotiating position. However, as the exercise progressed the Luvanian team became more aware that their actions and conclusions would be the subject of scrutiny by the international community, increasing the pressure on the Luvanian Inspectors to deliver what had been agreed.

A number of issues were subjects of negotiation: facility schematics, images of inspectors within facilities, physical measurements on the weapon itself, the use of open source images, serial numbers and surfaces interfacing with seals. Even though both parties had considered that most issues were resolved by the end of the Familiarization Visit, it soon became apparent that a large number of details still required negotiated agreement before monitoring activities could proceed.

Torland's negotiating stance allowed concessions to be made on points where national security or non-proliferation was not an issue. This fitted well with Luvania's view of a co-operative process which inspired trust and confidence. As the negotiations progressed, and the Luvanian Inspectors continued to request activities beyond the initially agreed scope, the Torland Hosts began to adopt a firmer stance to Luvania's demands.

Lessons learned

The exercise emphasised the key challenge facing the host during any verification regime operating within a nuclear weapon complex: how to provide the inspectors with the opportunity to gather sufficient evidence, while at the same time protecting sensitive or proliferative information. The host will share in the responsibility to ensure that the verification regime has been applied comprehensively. The host will not want to be unjustly accused of hindering the inspection activities or indeed cheating.

The host has to take care when considering national security and proliferation concerns, that the information provided to satisfy individual inspector requests does not become sensitive when it is aggregated. The host might consider agreeing to requests "in principle" until all of the Inspector requests have been collated.

The escorting concept deployed during the exercise focused on controlling the inspectors. Both guards and facility staff were involved in escorting duties, although there was some confusion amongst the facility staff as to their responsibilities, as they also had to facilitate the inspection activities. It was clear that the Torian team did not have enough staff to support both the security escorting and the technical inspection activities. At times the inspectors outnumbered the host staff allowing the opportunity for some of the inspectors to perform unsupervised measurements.

Shrouded objects are an issue, particularly where the shrouding is hiding tooling which will be used in the dismantlement process – these items cannot be sealed. Unsealed shrouded objects could be hiding shielded covert sources or shielded containers to be used during material diversion. This is an issue that requires further thought.

The tagging and sealing process highlighted a number of issues. Over time some of the seals started to peel off the painted walls. This indicates how important it is to consider the surfaces that the seals will be applied to, not just the seals themselves. Whilst it was possible to place the seals in almost any location, taking images of the RPIT was difficult in awkward positions. Over an extended period of time, any vulnerability could be exploited by the host, who after all has all the resources of a state party. If the seals were only going to be relied on for a short time, the deployed solution might be adequate; for longer periods, new ideas must be considered. The large number of seals proved to be time consuming to deploy and evaluate, while the vehicles proved almost impossible to seal to the inspectors' satisfaction.

The concept of CCTV needs further consideration if it were to be deployed within a nuclear weapon complex. However, the exercise has shown that CCTV can be usefully deployed in situations without significant security or proliferation risks, such as the monitoring of ceilings and of entrances not used during dismantling activities.

The inspectors felt that to effectively deploy chain of custody measures, the team needed to give greater consideration to the threat and the vulnerabilities. Such an assessment would form part of a risk/benefit analysis where the inspectors would consider the threat, the likelihood of the scenario occurring and the confidence levels associated with the deployment of a particular concept. The inspectors commented that it would have been better to have stepped back and considered the area more thoroughly rather than rushing in to complete the work. It should be noted that schematic drawings are unlikely to have sufficient three-dimensional detail to satisfy all the requirements of the inspectors in developing comprehensive chain of custody measures.

Radiation monitoring, sealing and the deployment of CCTV cameras have to be considered as parts of a unified strategy for securing an area. Overall, it is the consideration of the entire verification system that is important rather than each element in isolation. The inspectors will always be looking for anomalies relative to the regime as a whole. The concept of multiple layers of protection proved to be particularly important.

Host/inspector interactions became friendlier as the week progressed. This phenomenon has been observed in other exercises, as well as in real inspections, and can be instrumental in building trust. However, this does need to be managed so that professional detachment is maintained.

The exercise did emphasise the importance of considering the movement of information and equipment across areas with differing security restrictions. It was deemed very important for the inspectors to have access to an Inspector Station where they could work with a minimum of restrictions (this includes the use of equipment to record and analyse inspector observations and measurement data). This Inspector Station would need to be outside all host sensitive facilities. The movement of information and equipment between the sensitive facilities and the Inspector Station is a complex issue that should not be underestimated. All such transfers will need host approval and be under host control. For example, written notes on host-supplied paper or photographs of a seal are likely to be approved, while computers, electronic equipment and complex data files are unlikely to gain approval. Inspectors must carefully consider such issues when designing their verification approach.

The remit of the verification regime is driven by the host's declaration as the inspectors can only confirm what has been declared. The choice and capabilities of the equipment will then need to reflect this information. For example, the Information Barrier system cannot incorporate a mass threshold if no indication of mass has been given. The problem for the host is what the declaration can say, given the non-proliferation and security requirements. The host will need to perform a rigorous risk assessment considering proliferation and security concerns with respect to the overall potential gains in inspector confidence. This is both a technical and political matter for further consideration.

Inspector/host confidence

The Luvanian inspector team wrote an inspection report which was issued to Torland for comment. In summary, the inspectors made the following observations:

- The inspectors were able to deploy all the techniques deemed necessary to sustain an unbroken chain of custody of the item declared by Torland as the Treaty Accountable Item, from start to finish of the inspection
- The Information Barrier system was successfully deployed four times during the inspection process – the presence of the notional weapons grade plutonium (in reality, radioactive cobalt) was confirmed each time
- The co-operation from Torland was exemplary
- As a result of the above, the inspection team was able to confirm with a high degree of confidence that the objects declared as the Odin weapon, and its associated containers, moved through the declared dismantlement process
- Further scientific measurements and documentation indicating provenance could, in future dismantlement processes, provide greater reassurance that the object was the Odin system.

The Torian host team added the following observations to the inspection report:

- Torland was satisfied that their national security had not been compromised and that non-proliferation obligations had been observed at all times
- Torland felt that Luvania's requests for additional information had been reasonable and acceptable
- Torland agreed that further technological development was necessary, particularly in the area of Information Barrier measurements, in order to confirm the identification of the Odin system.

Despite obvious weaknesses in the verification technologies and procedures and in the host security arrangements, both teams had high confidence that they met their obligations.

Several points were highlighted where the host might have considered diverting materials or performed a spoofing scenario. However, as these opportunities could not have been predetermined and were unlikely to be repeated, would the host risk taking advantage of them? Overall, the inspectors need to take a rigorous, but risk-based approach – the inspectors will never be 100 % confident.

None of the verification measures used could confirm that the object was an Odin class weapon as declared. The Information Barrier measurements, along with the documentary evidence, built confidence but were not definitive proof. It was not the intention of this series of exercises to solve this "initialisation problem"; however, they have highlighted the issue.

If the international community is to have a discussion on the issues of inspector/host "confidence" or "trust," ideally some form of metric for these parameters needs to be developed.

Conclusions

The text above has mainly described the exercise from the perspective of the players Torland and Luvania. In the following, we try to summarize conclusions from the out-of-play perspective of Norway and the United Kingdom.

As stated earlier, Article VI of the NPT sets out, among other elements, that each of the parties undertakes to pursue effective measures relating to arms control and disarmament, and their verification, NNWS and NWS alike. Establishing effective verification measures will be an important precondition for fulfilling the goals of Article VI. During this exercise, the UK-Norway Initiative (with the Non-Governmental Organisation VERTIC as an independent observer) explored activities in line with these obligations, with both parties mindful of their roles and obligations under international agreements and national regulations.

The broad scope of the Monitoring Visit scenario provided the participants with a global view of how all of the elements of the verification regime would fit together in order to support the inspection process. A number of Managed Access concepts were deployed in order to control inspection activities within the facilities. The exercise process emphasized the importance of controlling the movement of information, equipment and personnel across areas of differing security restrictions and the need to improve on procedures supporting this process.

A variety of inspection techniques were deployed in order to create a multi-layer approach to the chain of custody and overall inspection activities. It was noted that to effectively deploy these chain of custody measures, a rigorous risk assessment considering the potential threats and vulnerabilities needs to be undertaken. Radiation monitoring, sealing and surveillance technologies have to be considered in one unified strategy for securing an area prior to inspection activities. The practical experience from the use of these techniques highlighted many lessons, for example, the resource intensive nature of seal deployment and verification demonstrated the need to investigate alternative approaches. The concepts of authentication, certification and chain of custody of inspection equipment were only played notionally; however, these aspects are recognized as being vital elements within a verification regime.

The jointly developed Information Barrier systems were successfully deployed throughout the exercise. The exercise remit for the Information Barrier system was to confirm the presence of (notional) weapons grade plutonium. This alone would not be sufficient to give the inspectors confidence that the host had not cheated. Future proposed developments to the system include the ability to confirm material grade and perform a mass threshold measurement. The project will continue to look to incorporate the concepts of authentication and certification. It was felt that this technological concept would only ever be able to confirm that the measured attributes are consistent with the presence of a nuclear weapon, but would not be able to provide a definitive identification. This calls into question the ability of the inspecting party to initialise the verification process, in other words, to confirm that the item presented is indeed the declared nuclear weapon (known as the “initialisation problem”). Attempts were made to compensate for this deficiency by requesting documentation related to provenance, but this will only have limited value unless it is linked to measurements and other supporting evidence.

Fig. 6.4.7 The picture shows the participants from Norwegian and UK institutions, as well as VERTIC, after completion of the Managed Access Monitoring Visit exercise in Norway in June 2009.

The United Kingdom and Norway believe that it should be possible to maintain a chain of custody for nuclear warhead dismantlement to a high degree of confidence when the relevant technologies have been developed to the necessary level of functionality. The initialization problem is an ongoing issue which requires further consideration before a technical solution could be proposed.

This technical exchange showed that a NWS and a NNWS can collaborate within this field and successfully manage any risks of proliferation. It has been found that many of the underpinning issues can be posed in generic terms which would allow NNWS to contribute to technological developments; the development of flexible, generic solutions means that the results could be tailored to support a number of future, "real life" scenarios. The participants felt that the involvement of NNWS would be vital in creating international widespread acceptance of, and trust in, a proposed verification regime. The United Kingdom found that the Norwegian participants brought a fresh perspective to the problems which challenged long-standing opinions and viewpoints.

6.4.4 Managed Access exercise in 2010

The lessons learned from the 2008/2009 exercises were wide ranging, but two in particular were singled out when a potential follow on exercise was initially discussed:

- National security and proliferation concerns permeate through everything
- The implications of Health and Safety regulations must not be underestimated.

The Norwegian facilities used to host the 2008/2009 exercises were not 'high security' facilities; therefore the security aspects of the scenario could only be played lightly. Health and Safety

regulations were included in the scenario, but again it was felt that these did not quite match the level that would be experienced in an actual nuclear weapons complex. It was decided that a 'focused exercise' was required which would more realistically explore the impact of host security measures on the Inspection regime and demonstrate some aspects of the safety regulatory environment associated with a nuclear weapons complex. In order to achieve the level of realism required, it was agreed the exercise would take place at a UK facility with the UK now taking the role of the host NWS party Torland.

Preparatory work

It was decided that the focused exercise would use the same documentation as in 2008/2009; however the players were warned that the implementation of the scenario would be different. The exercise focused on a Familiarization Visit to an initial storage/receipt facility. The inspecting Luvanian team (Norway) was tasked to:

- Understand relevant processes, routes and facilities by obtaining access to the initial storage/receipt facility
- Become familiar with the container types that would be used in the dismantlement process
- Consider a strategy for a future monitoring regime. The exercise provided an opportunity to trial potential seal types on the containers
- Maintain the safety and security of the team and comply with obligations under the NPT.

In order to play this scenario with an increased level of realism, the UK suggested the use of a low security facility within the boundaries of one of the AWE sites. Simulated facilities were set up to demonstrate increasing levels of security that would have to be negotiated in order to access an inner Storage/Receipt facility (Fig. 6.4.8). This arrangement had two advantages:

- It provided an opportunity for Norway to play the inspecting party (Luvania)
- The exercise benefited from the expertise of AWE's staff and utilisation of AWE's existing infrastructure. Although the actual facility used was in a low security area not associated with the dismantlement process, AWE's security and facility team were asked to create a facility that mimicked many of the techniques and processes which might be deployed to manage access within a typical nuclear weapons complex.

The host team (Torland) was given the same primary objective as in 2008/2009, to demonstrate compliance with their obligations under the treaty whilst protecting national security and proliferation sensitive information. However, whereas during 2008/2009 both teams were instructed that the process was collaborative, for the 2010 exercise the planners decided to change the emphasis for the host team. In this exercise, the Torian host was described as:

- Having a heavy emphasis on security as a first priority
- Inexperienced in dealing with inspection activities
- Reactive rather than proactive.

The planners were aware that the above changes would result in a more confrontational scenario than had been played in 2008/2009, but this was considered to be in keeping with the overall objective of the focused exercise. The exercise was set up to maximize host security intrusion; given this, the planners accepted that the inspectors might not be completely satisfied with the outcome of

their inspection activities. For the planners, a successful conclusion to the exercise was ensuring that the impact of security on the inspection process had been fully explored.

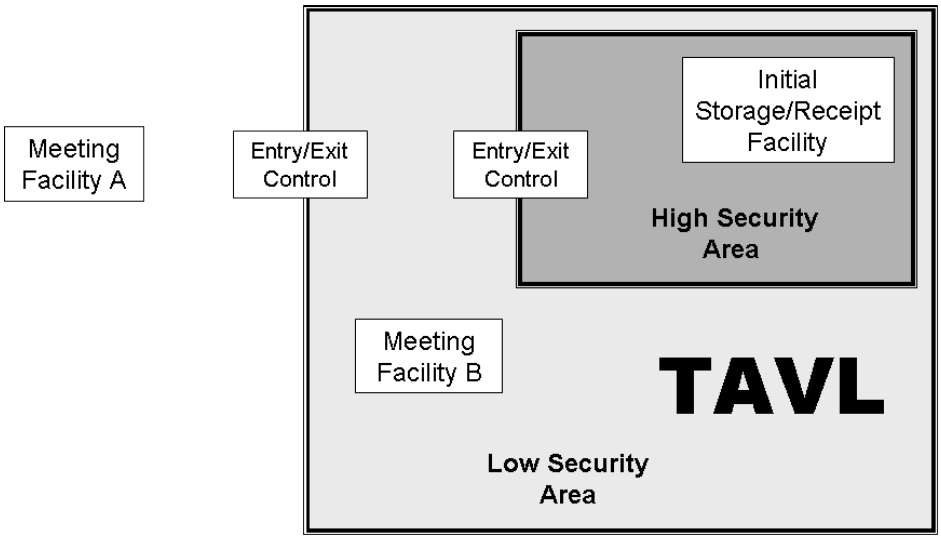

Fig. 6.4.8 TAVL, Torland's "Atomic Weapons Laboratory" for the Managed Access exercise in 2010.

Conduct of the exercise

The Luvanian inspecting party arrived at Meeting Facility A (Fig. 6.4.8) with pre-prepared procedural documentation and a structure for the inspection report. The team anticipated that the host would provide a full, detailed briefing on the facilities and processes prior to the on-site visit. A Health and Safety plan had been developed, and a request was made for a side discussion to agree the contents. It was anticipated that the inspectors would have full access to all areas of relevance to the inspection process, along with supporting schematics which would allow them to identify potential material diversion routes. In order to fully understand the role of the facility within the dismantlement process, Luvania also requested details of the operations which would take place within the facility, including any associated transport phases. Furthermore, they wished to confirm the location of the site and relevant facilities with a GPS system.

Torland pointed out that TAVL, Torland's "Atomic Weapons Laboratory", was a high security facility, and that Torland had a responsibility to maintain the physical security surrounding assets, staff and operations. Torland regarded the exact layout and design of the facilities as an integral part of the physical security of the site, therefore, maps and schematics could not be released. Torland also pointed out that no-one, including host personnel, would be allowed to take GPS readings on-site. The physical security surrounding transport phases was particularly sensitive for Torland. Consequently no information was provided regarding the transport vehicles or the timetable for transport phases; inspectors would not be allowed to witness transport phases.

Torland noted a misunderstanding in terms of the function of the Storage/Receipt facility. This was not a long term storage area but an area that had been set aside to support inspection activities. A containerised Odin weapon would be brought to the facility at the beginning of the inspection process; inspectors would be given the agreed level of access at that point. Host concerns over site

physical security measures meant that they were not prepared to reveal the location or design of the long term storage facility to Luvania. It was noted that the function of the Storage/Receipt facility had not been adequately defined within the initial documentation.

The Torian host team welcomed the inclusion of the Luvanian pre-prepared documentation and was prepared to discuss the Health and Safety plan. The Host team pointed out that the Storage/Receipt facility was subject to both explosive and radiological safety regulations. As a result, Torland intended to limit the time within the Storage/Receipt facility to a maximum of 75 minutes with only four inspectors per visit. Torland suggested two visits so that all the inspectors would have an opportunity to see the facility. It should be noted that Torland had a secondary security based motive to limit time and numbers, as this made the visit easier to manage. By insisting on the host supply and operation of equipment, Torland could ensure that it would not be possible for Luvania to take covert measurements within the facility.

The host provision and operation of equipment impacted on Luvanian plans to trial seals on the containers. This was primarily required to test whether the proposed seal types were fit for purpose. Luvania pointed out that both sides needed to have trust in the equipment. It was agreed to trial a "random sampling" regime which would allow the inspecting party to take away a sample of the host provided seals for testing. Also, the inspecting party insisted that they be allowed to check the seals once they had been applied. It was jointly agreed that the discussion of the sealing system should extend to a consideration of the seal reader and the management of any measurement data.

In addition to the 'guards, guns and gates' which are associated with the TAVL site, Torland deployed several additional levels of security to manage the Luvanian access onto the Storage/Receipt facility:

- Initial entry into the protected area involved identification checks, searches and the removal of prohibited items (such as cameras, phones and recording devices)
- Shrouding was deployed to ensure that inspectors only viewed areas of site directly related to the inspection process
- The inspectors were escorted and monitored at all times
- Entry into and egress from the high security area involved additional identity checks and the deployment of search and detection equipment
- Entry into and egress from the Storage/Receipt facility was via a Change Barrier (a change into protective clothing). As well as meeting Health and Safety requirements, the implementation of the barrier provided an added a layer of security assurance
- Movement within the facility was restricted to prescribed walkways; the inspecting party was not allowed to approach the container or the walls of the facility
- Additional escorts were deployed within the facility
- Shrouding was used within the facility to conceal items which could provide sensitive or proliferative information
- Notepads were issued on entry to the Storage/Receipt facility and retained by Torland on exiting the facility. The notepad content was checked by Torland security and photocopies of cleared documents were provided to the Inspectors
- All equipment was supplied by Torland
- All equipment was operated by Torland. One inspector was allowed to approach the container to check the integrity of the deployed seals.

The inspectors were based inside Meeting Facility B (Fig. 6.4.8) for the day and were moved to the Storage/Receipt facility, one group at a time, for the two agreed visits. The level of security came as a surprise as the briefing had not given full details of the Managed Access procedures that would be deployed. As a definition of the function and extent of the facility had not been agreed, there was a misunderstanding with regard to the time allotted to each visit. The inspectors defined the facility as the room in which the container was housed whereas the host defined the facility as the whole building including the Change Barrier area. The Change Barrier process took a significant amount of time away from the agreed inspection activities. However, the inspectors did successfully gain entry into the facility and visual access to the container.

The procedure for seal deployment began with a random selection activity. Torland presented a selection of seals to Luvania; the seals were of a jointly agreed type and had not previously been taken into the high security area. Luvania randomly selected two sample sets:

- The inspectors were allowed to keep set 1. These were taken off site and destructively analysed
- Set 2 were placed in a clear plastic bag and were held in dual custody. The host party had physical possession of the seals, but the inspecting party had visual contact at all times. These seals remained within the facility following application.

In the facility, the Torian staff applied the seals to the container and took reference photographs. A Luvanian inspector was then allowed to approach the container to physically check the integrity of the seal. Although the random selection process was successful, both sides lost visual custody of the seals at points during the period between selection and deployment within the facility. Despite the increased escorting activities within the Storage/Receipt facility, the escorting team found it challenging to manage the agreed sealing activity.

Lessons learned

Although lessons should be learned from past experience within other regimes (i.e., that of the Chemical Weapons Convention), this scenario also offered some unique challenges for the inspecting party. Observations were made on the difficulty, particularly from the viewpoint of a NNWS, of inspecting such an unfamiliar environment and process. Multiple Familiarization Visits would probably be required to support the inspection process.

The primary objective for the Inspectors was to understand relevant processes, routes and facilities by obtaining access to the initial Storage/Receipt facility. Host security and proliferation concerns meant that the preliminary information provided during the negotiation phase was limited. Ambiguity in the language used to describe the facility, both during discussions and within the supporting documentation, meant that there was a fundamental misunderstanding with regard to the function of the Storage/Receipt facility. Inspectors successfully negotiated access to the facility with a view to clarifying the situation and compensating for the lack of building schematics. However, Torland's Managed Access procedures limited time within the facility and did not provide the freedom of movement to fully explore inside the facility or view adjoining areas. As a result, potential material diversion routes could not be identified. The inspectors left with an overview of the facility and related operations, but not how those operations linked to the overall dismantlement process.

The second objective for the inspectors was to consider a strategy for a future monitoring regime. The two concepts that were discussed were a sealing strategy for the container and the deployment of a radiation detector behind an Information Barrier. Torland was unwilling to discuss the construction of the container because of security concerns; this made it hard to assess the effectiveness and vulnerability of the proposed technologies. A lack of information about the facility in which the radiation measurement system was to be deployed again prompted questions in terms of the host's ability to 'spoof' the measurement.

The inspecting team felt that the safety regime was more intrusive than expected. The primary impact experienced by the Inspectors in this exercise scenario was in terms of the limit on the number of inspectors allowed into the facility. This safety measure results from a combination of explosives and fire regulations. This had two effects on the inspection regime: time and communication. The time required for the inspection process increased because multiple visits were required to the facility. The inspection team was split between multiple buildings which made communication, and consequently coordination, increasingly difficult.

Conclusions

The focused 2010 Managed Access exercise showed how the security/safety regime implemented by the host state could impact on the inspectors' ability to assess the potential threats to, and vulnerabilities of, a potential future monitoring regime. It should be noted that despite the intrusive levels of the host security and safety arrangements, the inspecting party still managed to complete the objectives of the Familiarization Visit, albeit with a low level of confidence in the outputs from the visit. A comparison between the adversarial environment of the 2010 exercise and the collaborative environment of the 2008/2009 exercises indicate that a collaborative environment, and a proactive host, could help to facilitate the inspection process and increase confidence levels in the overall verification regime. However, even in a cooperative environment, security and safety will still have a significant impact on the inspection regime.

In conclusion, the exercise provided a common understanding within the UKNI collaboration of the impact that host security and safety could have on an inspection regime. This is essential for technology and procedural development in the future.

6.4.5 Workshop in 2011

During 7-9 December 2011, the UK and Norway hosted a three day workshop which aimed to bring together Non-Nuclear Weapon States to discuss verification tools and methods needed to verify nuclear dismantlement, and to explore how all States Parties to the NPT can contribute to their NPT Article VI obligations. The workshop drew upon the results and methods from the UK-Norway Initiative to date. It demonstrated how a NWS and a NNWS could work together to make significant contributions to nuclear disarmament verification research. It was also an important opportunity for the UK and Norway to gain feedback on their research progress to date.

Twelve NNWS attended, along with the United States as subject matter experts on arms control verification research. Invitations were sent to those countries that had previously expressed an interest in the UK-Norway Initiative.

Workshop agenda and format

The workshop programme covered both policy and technical issues. Technical topics covered included discussion of concepts such as managed access, information barriers and chain of custody (i.e. containment and surveillance). Broad themes were: the background to the Initiative, some of the joint exercises that have taken place, the creation of the Information Barrier technology and future steps for the Initiative. Technical and policy officials from Non-Nuclear Weapons States were invited. This included negotiators or inspectors involved in arms control regimes or nuclear safeguards, or those with experience as a facility manager with responsibility for controlling access of foreign inspectors to a sensitive site.

Each day featured a number of presentations on different aspects of the UKNI, followed by an opportunity for discussion amongst the delegates. The workshop sought to promote active participation through small working groups. Participants were encouraged to be prepared to discuss relevant tools and methods, both technical and non-technical, and also to think about how both NWS and NNWS can contribute to nuclear disarmament research using their own technical expertise. With this in mind, the UKNI arranged an informal poster and technical demonstration session to which states were invited to contribute; several states took this opportunity to present on technically relevant topics.

Day 1 of the workshop provided an opportunity for delegates to discuss the 'challenge' of nuclear warhead dismantlement verification. Discussion topics included:

- The scope of the UKNI programme
- A generic facility concept
- Host and inspector viewpoints
- The potential impact of security and proliferation concerns.

Day 2 looked at how the UKNI has attempted to address the technical challenges associated with nuclear warhead dismantlement verification. This was an opportunity for the delegates to offer feedback, ideas and perspectives on the current UKNI research programme, and discuss technologies which have an application within a verification regime. The following topics were outlined and discussed:

- The planning, conduct and lessons learned from the 2008 and 2009 Managed Access exercise programme
- The Information Barrier project.

Day 3 was about future research. The objectives, conduct and new lessons learned from the 2010 Managed Access exercise were outlined. The broader lessons and challenges ahead in the verification of nuclear disarmament were considered. Finally, delegates discussed the future direction of the UK-Norway Initiative, and opportunities for the work of others.

Workshop discussions

Throughout the three days of the workshop, delegates were provided with opportunities to discuss topics relevant to the workshop. Some of the main topics had been extensively addressed in the exercises reported above, and included the initialization problem, declarations, confidence, host/inspector relationships, and national security and non-proliferation.

Delegates were asked to give feedback, ideas and perspectives on the current UKNI research programme:

General Feedback: Delegates commented that the scenario developed within UKNI was 'realistic' when compared with experience from other 'real world' regimes, but it was also noted that real world regimes may present a more hostile environment in comparison with the cooperative scenario discussed by UKNI. Both inspectors and host have an incentive for the regime to succeed since failure would reflect badly on the overall process and might adversely affect the international reputation of the host. This point of view was evident in the discussion sessions and as a key learning point from the UKNI.

Exercises: The programme of exercises was viewed as an effective way of identifying new issues, exploring scenarios and minimising the risk of failure in the future. But it was noted that the application of different cultures/background/personalities/experiences could yield different results. There was some discussion on the possible involvement of a third party (e.g. NGOs) in the inspection process but no conclusion was reached.

Information Barrier: This was recognised as an important technology requiring further development as this would allow measurements of treaty relevant items while still protecting nationally sensitive or proliferative information. The UKNI instigated a 'step-by-step' approach to Information Barrier development which promoted a mutual understanding of the technology and issues, whilst ensuring that non-proliferation obligations were met.

During the discussion session, a number of broader themes were also covered. Some of these were the question of whether designated or dedicated facilities for nuclear warhead dismantlement would mitigate the national security or proliferation sensitivities, the role of language, culture and understanding, lessons learned from other regimes and organisations, and the credibility of any future regime with the international community.

Workshop summary

It was recognized that all states parties to the NPT have an obligation under Article VI to contribute to the development of verification regimes but that active NNWS involvement in the inspection process brought both benefits and risks. However, it was felt that NNWS involvement would be essential if the verification regime was to be internationally credible and transparent. The UKNI has demonstrated that successful and productive collaborative verification research is possible between NWS and NNWS, whilst still fulfilling NPT Articles I and II.

There was widespread acceptance that major technological development is still required to produce jointly trustable systems for deployment in the verification of nuclear warhead dismantlement. Collaborative disarmament verification research will be necessary in order to achieve effective and mutually trusted approaches and solutions to support any possible future multilateral disarmament regime. It was also highlighted that the issue of inspector and host confidence requires much greater consideration. Key questions in this regard are: how to define it, how to measure it and most importantly, how to establish what can be considered sufficient in the context of verifying the dismantlement of a nuclear warhead.

The technical focus of the UKNI still represents an effective means of advancing the UK and Norway's shared goal of a world without nuclear weapons. The UKNI workshop was an important opportunity for education and outreach on disarmament verification research, and helped to enhance the transparency of the initiative. The workshop provided NNWS with the opportunity to peer review and influence the future direction of the UKNI.

6.4.6 Future work

The requirement for future work was discussed from two perspectives; firstly the next stage of the UKNI technical collaboration was presented and discussed, and secondly delegates were asked how they thought the broader international community might be able to contribute to the field of nuclear warhead disarmament verification.

The main points made on the UKNI next steps were:

- It will remain a bilateral technical cooperation between the UK and Norway
- It will continue testing and developing the joint Information Barrier system and will look to develop the procedures for trusted deployment
- It will continue development of the verification process based on lessons learned from the UKNI exercises
- It will strive for a better understanding of inspector/host confidence referring initially to its experience of the previous UKNI exercises
- It will undertake focused exercises as required to explore the above issues
- It will look to other international regimes to ensure that any and all potential lessons are properly assimilated
- It will continue to report progress on the margins of the NPT Preparatory Commissions and Review Conferences, together with presenting technical updates to appropriate professional forums
- It will endeavour to encourage and advise any new initiative in this field that may request it.

Discussion on the wider engagement by the international community was interesting and a number of key points emerged:

- NNWS should get involved as a way of meeting commitments under Article VI of the NPT
- NNWS could get involved in the technical development process and such involvement could add real value
- Academia and NGOs could also make significant contributions.

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