RETHINKING NUCLEAR DISARMAMENT VERIFICATION
NEW CONCEPTS FOR ONSITE INSPECTIONS

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Revision 3
DISARMAMENT VERIFICATION

OVERLY COMPLICATED ... OR RELATIVELY SIMPLE?

Future nuclear disarmament treaties ... likely will contain more intrusive verification mechanisms, and operate in more challenging environments than any others in history.

Statement by the International Partnership for Disarmament Verification (IPNDV) December 2017

2017-2021.state.gov/the-international-partnership-for-nuclear-disarmament-verification-phase-i/index.html

How can the two presidents make the best of their one shot at setting the nuclear table?

I have some advice for them: Keep it simple.

Rose Gottemoeller, June 2021

Lead U.S. negotiator of New START (2009)

Photo credit: NATO
GRAND (VERIFICATION) CHALLENGES
GRAND (VERIFICATION) CHALLENGES

- Establishing confidence in the absence of undeclared stocks or production
- Verifying numerical limits on declared nuclear warheads
- Monitoring ongoing activities at military nuclear sites
- Monitoring nuclear warheads in storage
- Confirming completeness of baseline declarations using nuclear archaeology methods
- Confirming the authenticity of nuclear warheads (upon dismantlement)
THREE LEVELS OF ACCESS
FOR POSSIBLE ARMS-CONTROL INSPECTIONS

ONSITE INSPECTIONS
Direct inspector access to declared sites and (upon request) to other sites access offers the greatest level of reassurance, especially when combined with measurements.

REMOTE MONITORING
Satellite imagery can be an important tool to confirm the operational status of nuclear facilities or observe (the absence of) related activities.

PERIMETER MONITORING & STANDOFF DETECTION
For facilities where access is initially considered too intrusive, perimeter control or sensors at the site boundary could provide reassurance of compliance.

Source: DigitalGlobe (top), U.S. DOE (middle), IAEA (bottom)
# Toward Nuclear Disarmament

**Building up Transparency and Verification**

MALTE GÖTTSCHE AND ALEXANDER GLASER (EDITORS)

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M. Göttche and A. Glaser (eds.), *Toward Nuclear Disarmament: Building Up Transparency and Verification*  
German Federal Foreign Office, Berlin, May 2021

[www.auswaertiges-amt.de/blob/2462108/6dc81f5932e6b96b48b8bc222f4b2e58/towards-nuclear-disarmament-data.pdf](http://www.auswaertiges-amt.de/blob/2462108/6dc81f5932e6b96b48b8bc222f4b2e58/towards-nuclear-disarmament-data.pdf)
REFRESHING ONSITE INSPECTIONS

GUIDING PRINCIPLES & CRITERIA

MINIMIZING INTRUSIVENESS

Managed access procedures have been proposed to address main concerns, but they tend to further complicate inspection procedures.

REDUCING COSTS

An IAEA person-day of inspection (PDI) is up to $10,000/PDI (including overheads).

Verification of the INF Treaty (until 2001) corresponded to about 50% of the IAEA budget.

INCREASING TIMELINESS

Onsite inspections, especially in the arms-control context, are logistically challenging; typically, 24–48 hours pass between announcement and arrival.

Can we (physical) “separate” host & inspector?

Many concerns could be addressed and resolved if inspectors were not physically present onsite.

Can we remotely follow certain (allowed) activities that the host performs?

The host performs the prescribed activities onsite, while the inspector follows, influences, or directs the activities remotely.
3.4 MDV FOR ARMS CONTROL

3.4.1 Capability Needs

... Treaties that include weapons in storage or weapons designed for shorter-range delivery systems are anticipated to require new MDV techniques. As a minimum, such treaties would likely require access to storage areas either directly or remotely, and confirmation of warhead count (either a baseline confirmation or through routine/challenge inspections).

VIDEO FEED
for remote inspections
VIDEO FEED FOR REMOTE INSPECTIONS

KEY REQUIREMENTS

SECURITY & PRIVACY
How to follow relevant activities without also capturing additional information that is considered sensitive but irrelevant for the task at hand?

DATA TRANSMISSION & INTEGRITY
How to transmit the footage to an offsite location, especially from the interior of a hardened and highly secured building? (Can it be done in real-time?)

LIVE VERIFY & LOCAL VERIFY (Johnston and Warner, 2010)
How to ensure that the footage is recorded in real-time? (How to preclude replay attacks?)
How to ensure that the data is transmitted from the correct location?

Source: IAEA (top and middle) and author (bottom)
“EVENT-BASED VISION”

Misha Mahowald (1963–1996)
For a documentary on Mahowald’s work, see www.dailymotion.com/video/x28ktma

Misha Mahowald, *VLSI Analogs of Neuronal Visual Processing: A Synthesis of Form and Function*


iniVation DAVIS346
Event-based vision camera, 2019
“NOTHING TO SEE HERE”
EVENT-BASED VISION FOR INTRINSIC INFORMATION SECURITY

Event-based camera

Traditional (frame-based) camera

“Secret” information visible at inspected site

Recorded at TU Berlin, June 2022, courtesy of Guillermo Gallego
A PATH FORWARD
FOR NUCLEAR DISARMAMENT VERIFICATION

PERSISTENT AND EMERGING VERIFICATION CHALLENGES

25 years of research and development have not produced the technologies needed to verify future arms-control agreements.
Consider approaches that offer “on-ramps,” i.e., that start off simple and can accommodate “upgrades” later on.

RE-IMAGINING NUCLEAR DISARMAMENT VERIFICATION

Explore verification approaches that minimize the need of access to sites and treaty accountable items or avoid measurements on those.
Virtual inspection techniques could play an increasingly important role in future arms-control verification and safeguards.

Source: Author (top) and microsoft.com (bottom)
On-site inspection has been vastly overrated in the history of arms control.

Allan S. Krass, 1985