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# Contributions of the scientific community to CTBT monitoring and verification

10 June 2011

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## Goals of verification

- Assurance of compliance
- Exposure of non-compliance to obligations and danger prevention
- Deterrence of violation of the treaty
- Confidence building by transparency and openness

## Levels of verification

- a. Development and demonstration of new methodologies and technologies  
(preparation phase)
- b. Fact finding and data gathering
- c. Sharing and publication of data and information
- d. Technical analysis of data and information
- e. Determination of non-compliance
- f. Political interpretation (post-processing phase)

Compare: Den Dekker, Guidio (2001): The Law of Arms Control: International Supervision and Enforcement, Martinus Nijhoff Publishers. Page 105

## Degree of integration with official procedures

1. Without relation (e.g. treaty or verification is non-existent but a norm)
2. Indirect connection (e.g. distributed via open source)
3. Informal interaction
4. Official contribution or mandate
5. Inside governmental organisations (national and international)

Compare: Meier, Oliver / Clare Tenner (2001): Non-governmental Monitoring of International Agreements. In: Trevor Findlay and Oliver Meier (Hg.). Verification Yearbook 2001. London. Verification Research, Training and Information Centre (VERTIC). Pages 206–227.

	A	B	C	D	E	F
Affected safeguard stage	Development and demonstration of new methodologies and technologies  (preparation phase)	Fact finding and data gathering	Sharing and publication of data and information	Technical analysis of data and information	Determination of non-compliance	Political interpretation
Degree of integration with official procedures						(post-processing phase)
1 Without relation (e.g. treaty or verification is non-existent but a norm)						
2 Indirect connection (e.g. distributed via open source)						
3 Informal interaction						
4 Official contribution or mandate						
5 Governmental scientists						

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Degree of integration with official procedures						(post-processing phase)
1 Without relation (e.g. treaty or verification is non-existent but a norm)	Specialised scientist					
2 Indirect connection (e.g. distributed via open source)	Scientific publications Commercial available technologies					
3 Informal interaction	Specialised associations and networks					
4 Official contribution or mandate	e.g. GSE, ISS					
5 Governmental scientists	Provisional Technical Secretariat, National Data Centres					

	Verification related scientific activities	Political developments
1945		First nuclear explosion
Since 1945	National technical means to detect nuclear tests	
1958 - 1960	Geneva Group of Experts (with experts from 10 countries)	
1963		Limited Test Ban Treaty
1974		Threshold Test Ban Treaty
1977-1980		Trilateral test ban negotiations
1976	Establishment of the Group of Scientific Experts (GSE)	by the Geneva Conference of the Committee on Disarmament (CCD)
1978	First comprehensive GSE report	
1980-83	GSE Global Telecommunication System technical tests	
1982/83		Ad Hoc Committee at the Conference on Disarmament
1984	GSE Technical Test GSETT-1	
1986/87		US-USSR bilateral negotiations
1991	GSE Technical Test GSETT-2	
1993-1996		CTBT negotiated in Geneva
starting 1995	GSE Technical Test GSETT-3 with Prototype International Data Center in Arlington	
1996		CTBT opened for signature
Since 1997	The Provisional Technical Secretariat of the PrepCom for the CTBTO is being established in Vienna	

Kalinowski, Martin B. (2001): Scientific Experts for complete nuclear disarmament. INESAP Information Bulletin No.18, September 2001, 66-68.

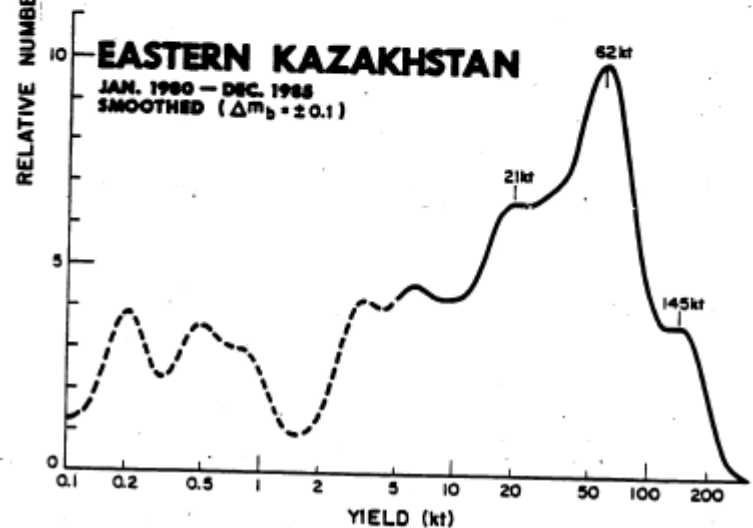
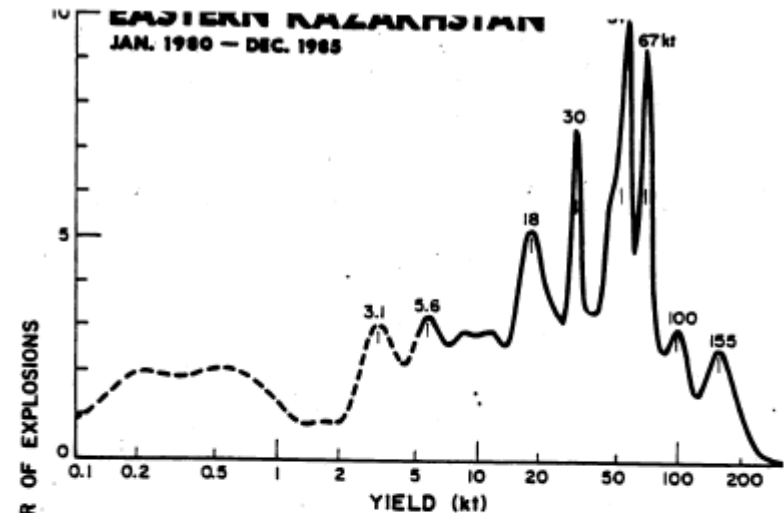
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Degree of integration with official procedures						(post-processing phase)
1 Without relation (e.g. treaty or verification is non-existent but a norm)		Whistleblower				
2 Indirect connection  (e.g. distributed via open source)		Seismic stations	Seismic networks			
		Whistleblower				
3 Informal interaction		e.g. commercial images	Illegal information transfer (e.g. Wikileaks.org)			
		e.g. radiation protection laboratories	Non-governmental organisations with access to information			
4 Official contribution or mandate	Defectors					
5 Governmental scientists	Non existent	Non existent				
	International Monitoring System, On-site Inspections	Global Communications Infrastructure				



# Example of seismological analysis of nuclear test explosions

Almost every single nuclear weapon test was **identified and located in space and time** by its seismic signals.

Relevance of **yield estimate** based on seismic magnitudes for possible violation of the TTBT and PNET provisions that the yield should not exceed 150 kt TNT.

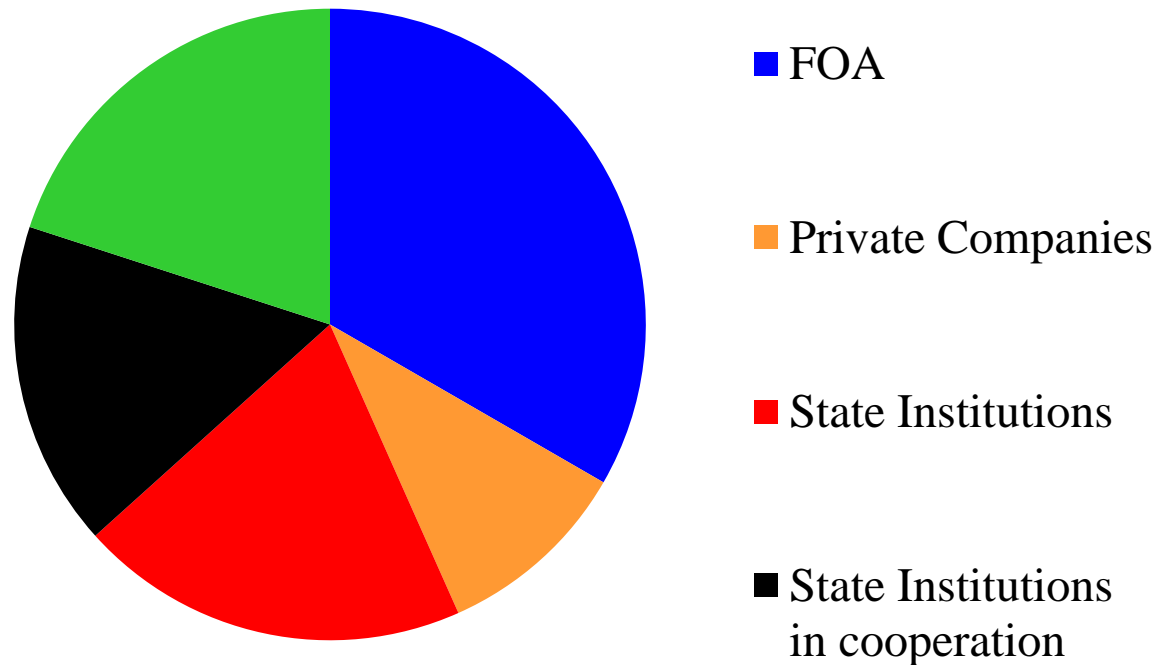


# Example of radionuclide observations associated with nuclear test explosions

52 tests were identified and reported in 30 peer-reviewed scientific publications.

Relevance for possible violation of the PTBT provision that radioactive debris should not be present outside of the territorial limits of the state conducting the test.

## Publishing Institutions



	A	B	C	D	E	F
Affected safeguard stage	Development and demonstration of new methodologies and technologies  (preparation phase)	Fact finding and data gathering	Sharing and publication of data and information	Technical analysis of data and information	Determination of non-compliance	Political interpretation
Degree of integration with official procedures						(post-processing phase)
1 Without relation (e.g. treaty or verification is non-existent but a norm)						Experts for the nuclear weapons control regime,  Technical specialised non-governmental organisations
2 Indirect connection (e.g. distributed via open source)						
3 Informal interaction						Lobbying and technical advice
4 Official contribution or mandate						Non existent
5 Governmental scientists						National governments; Conference of State Parties; UNSC

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Degree of integration with official procedures						(post-processing phase)
1 Without relation (e.g. treaty or verification is non-existent but a norm)				e.g. analysis of the North Korean nuclear tests		
2 Indirect connection (e.g. distributed via open source)				Seismologists	Arms-control specialists  specialised think tanks and networks	
				e.g. ISIS satellite images  e.g. radionuclide experts		
3 Informal interaction				?	technical advice	
4 Official contribution or mandate				Non existent	Non existent	
5 Governmental scientists	International Data Centre	National authorities with support of their NDCs				

# Tendencies regarding the access to relevant information

Open source information and data, in particular via Internet:

- Online press, social networks (e.g. [www.projectforthebt.org](http://www.projectforthebt.org), [lewis.armscontrolwonk.com](http://lewis.armscontrolwonk.com), [www.abovetopsecret.com](http://www.abovetopsecret.com), and many others)
- Seismic data (e.g. U.S. Geological Survey, Geophysical Survey of the Russian Academy of Sciences)
- Radionuclide observations (global radiation awareness map on [radiocial.org](http://radiocial.org), Nuclear Transparency in the Asia Pacific ([www.cscap.nuctrans.org](http://www.cscap.nuctrans.org)), Community Environmental Monitoring Program (CEMP) around Nevada Test Site)
- Online atmospheric transport models (in particular HYSPLIT)
- Open source and commercial remote sensing data (multispectral satellite images, Synthetic Aperture Radar data for interferometric analysis)

⇒ Enables contributions of NDCs and non-state actors to professional analysis and assessment of violations of nuclear-test-ban treaties

# Examples: North Korea's nuclear weapons tests

US Geological Survey

<http://earthquake.usgs.gov/eqcenter/recenteqsww/Quakes/us2009hbf.php>

Example:

Second nuclear weapons test of North Korea on 25 May 2009

**Magnitude 4.7 - NORTH KOREA**  
2009 May 25 00:54:43 UTC

**Earthquake Details**

<b>Magnitude</b>	4.7
<b>Date-Time</b>	Monday, May 25, 2009 at 00:54:43 UTC Monday, May 25, 2009 at 05:54:43 AM at epicenter <a href="#">Link to Earthquake in other time zones</a>
<b>Location</b>	41.306°N, 129.029°E
<b>Depth</b>	0 km (-0 miles) set by location program
<b>Region</b>	NORTH KOREA
<b>Distances</b>	79 km (49 miles) NNW of Kimchaek, North Korea 55 km (34 miles) SW of Chongjin, North Korea 185 km (115 miles) SSW of Yanji, Jilin, China 375 km (233 miles) NE of PYONGYANG, North Korea
<b>Location Uncertainty</b>	horizontal 1/-3.8 km (2.4 miles); depth fixed by location program
<b>Parameters</b>	NS1= 75, Nph= 75, Dmn= 371.4 km, Dms= 0.57 sec, Co= 72', M type body wave magnitude (Mb), Version: A
<b>Source</b>	USGS NDC (WDC010)
<b>Event ID</b>	us2009hbf

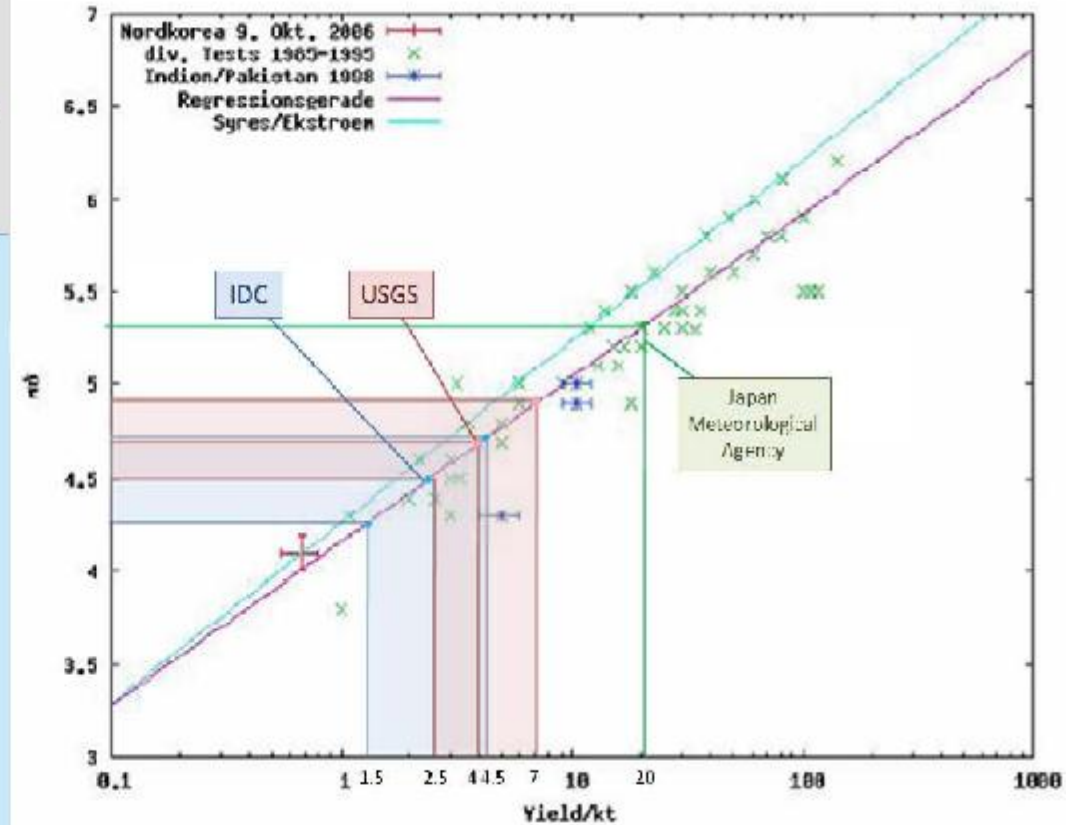
This event has been reviewed by a seismologist  
[Did you feel it?](#) Report shaking and damage at your location. You can also view a map displaying accumulated data from your report and others.



# Examples: North Korea's nuclear weapons tests

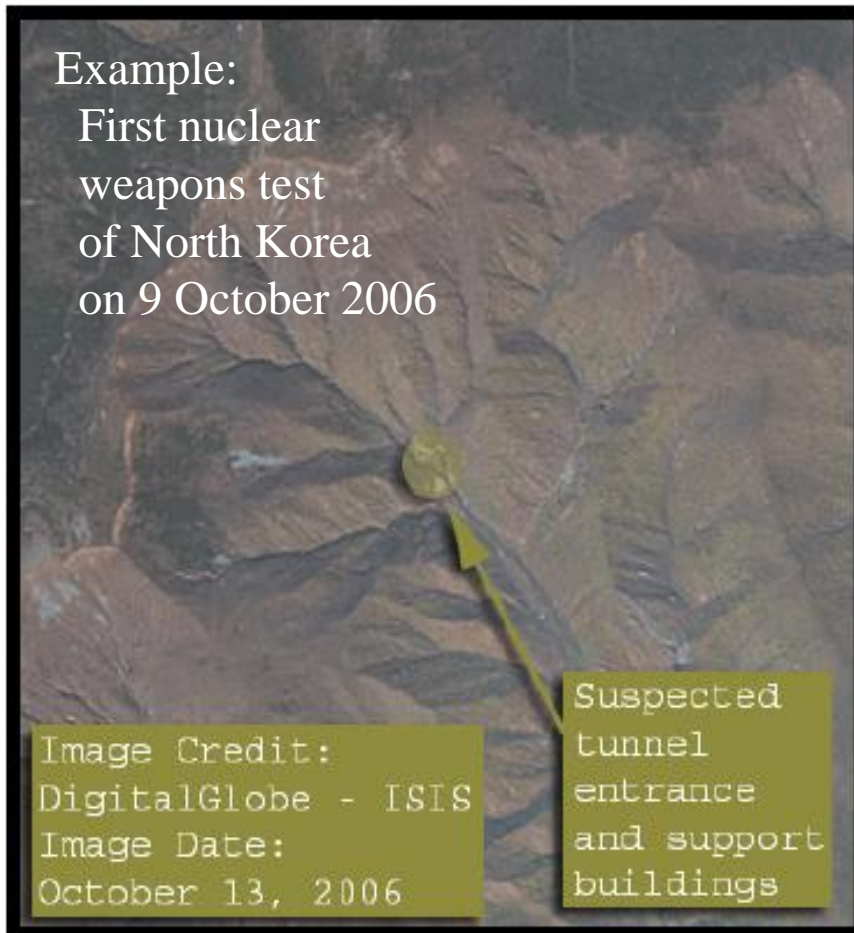
Analysis by the ZNF

Example:  
Second nuclear weapons test of North Korea on 25 May 2009



## Examples: North Korea's nuclear weapons tests

### Satellite image annotations by ISIS



Source: David Albright & Paul Brannan - ISIS Imagery Brief: North Korean Site After Nuclear Test. 17 Oct. 2006.



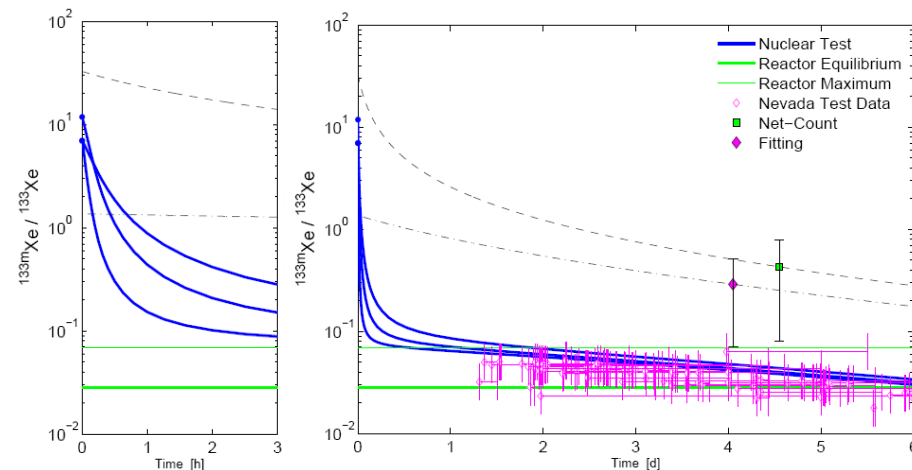
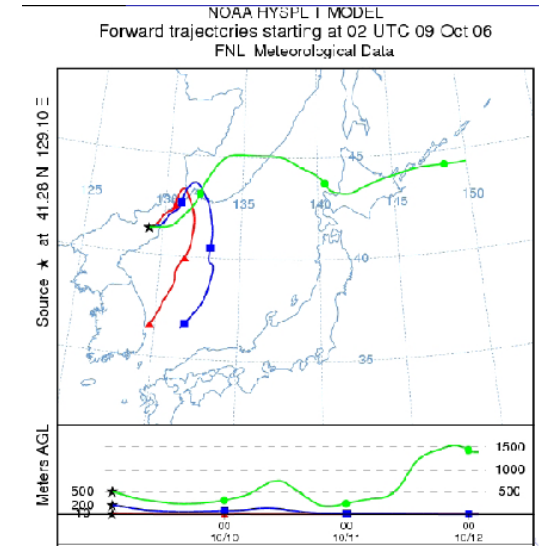
# Examples: North Korea's nuclear weapons tests

HYSPLIT, online model for atmospheric transport  
<http://ready.arl.noaa.gov/HYSPLIT.php>

Example:  
First nuclear  
weapons test  
of North Korea  
on 9 October 2006

In fact radioxenon was detected in  
South Korea during October 11-14, 2006  
by a Swedish team with SAUNA equipment.

This provided the data for the proof that the  
explosion was of nuclear nature.



## Contributions of the scientific community towards the goals of verification

- 1 Assurance of compliance  
mainly by step E: determination of non-compliance
- 2 Exposure of non-compliance to obligations and danger prevention  
mainly by step B: fact finding and data gathering  
and by step D: technical analysis of data and information
- 3 Deterrence of violation of the treaty  
mainly by step A: development and demonstration of methods
- 4 Confidence building by transparency and openness  
mainly by step C: Sharing and publication of data and information

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1 Without relation (e.g. treaty or verification is non-existent but a norm)	Specialised scientist	Whistleblower		e.g. analysis of the North Korean nuclear tests		Experts for the nuclear weapons control regime,  Technical specialised non-governmental organisations
2 Indirect connection (e.g. distributed via open source)	Scientific publications  Commercial available technologies	Whistleblower  e.g. commercial images  e.g. radiation protection laboratories	Seismic stations  Seismic networks  Illegal information transfer (e.g. Wikileaks.org)  Non-governmental organisations with access to information	Seismologists  e.g. ISIS satellite images  e.g. radionuclide experts	Arms-control specialists  specialised think tanks and networks	
3 Informal interaction	Specialised associations and networks	Defectors		?	technical advice	Lobbying and technical advice
4 Official contribution or mandate	e.g. GSE, ISS	Non existent		Non existent	Non existent	Non existent
5 Governmental scientists	Provisional Technical Secretariat, National Data Centres	International Monitoring System, On-site Inspections	Global Communications Infrastructure	International Data Centre	National authorities with support of their NDCs	National governments; Conference of State Parties; UNSC