CTBTO
PREPARATORY COMMISSION

PUTTING AN
END TO NUCLEAR
EXPLOSIONS

THE CTBT
VERIFICATION REGIME

Monitoring planet Earth for nuclear test explosions

CTBTO on-site inspection training course held in the Dead Sea area of Jordan

CTBTO on-site inspection regional training course conducted in Cape town, South Africa with participants from 33 African countries

Integrated on-site inspection exercise conducted by the CTBTO in Semipalatinsk, Kazakhstan (measuring the Earth's magnetic field)

> "A prohibition on nuclear testing is an essential element of a nuclear weapon-free world. A quarter of a century after its negotiation, the CTBT has created an almost universally adopted norm against the testing of nuclear weapons."

António Guterres
The UN Secretary-General's message to Article XIV Conference of the CTBT

Over 300 stations using four technologies monitor planet Earth for nuclear explosions.

THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY (CTBT) BANS ALL NUCLEAR WEAPON TESTS. ITS UNIQUE VERIFICATION REGIME IS DESIGNED TO DETECT NUCLEAR EXPLOSIONS ANYWHERE ON THE PLANET – IN THE OCEANS, UNDERGROUND AND IN THE ATMOSPHERE.

Once complete, the International Monitoring System (IMS) will consist of 337 facilities (321 monitoring stations and 16 radionuclide laboratories) located in 89 countries around the globe. The IMS is nearing completion with over 90% of its facilities already operational.

The monitoring stations generate data which are transmitted to the International Data Centre (IDC) at the headquarters of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) in Vienna. Data and products are made available to Member States.

THE IMS WATCHES FOR SIGNS OF A NUCLEAR EXPLOSION

The IMS facilities monitor the planet continuously for any sign of a nuclear explosion. The system uses four complementary verification methods, utilizing the modern technologies available. Seismic, hydroacoustic and infrasound stations monitor underground, the oceans, and the atmosphere respectively. Radionuclide stations detect radioactive particles from atmospheric or underwater nuclear explosions or noble gases from underground explosions. While the latter technique may be the most time-consuming, it constitutes the "smoking gun" of whether an explosion was actually nuclear or not.

DETECTING NORTH KOREA'S NUCLEAR TESTS

In 2006, 2009, 2013, twice in 2016 (January and September), and in 2017, the Democratic People's Republic of Korea (DPRK) announced that it had conducted a nuclear test. In all six instances, CTBTO's monitoring stations detected the event with reliability and precision. Within two hours—and in 2009, 2013 and 2017 before the DPRK's announcements that it had conducted a nuclear test — Member States received the first automatic analysis of the data, containing preliminary information on time, location and magnitude.

DATE	MAGNITUDE	NO. OF IMS STATIONS ESTABLISHED AT THE TIME	NO. OF IMS STATIONS THAT DETECTED THE EVENT
9 OCT 2006	4.1	180	22
25 MAY 2009	4.5	252	61
12 FEB 2013	4.9	286 (85%)	96
6 JAN 2016	4.8	301 (89%)	102
9 SEPT 2016	5.1	301 (90%)	108
3 SEPT 2017	6.1	304 (90%)	134

4 VERIFICATION TECHNOLOGIES

> "The CTBTO has built a state-of-the-art verification regime, which has proven to be effective at detecting nuclear explosions. This regime also provides a treasure trove of data that can be used for civil and scientific applications."

Robert Floyd
EXECUTIVE SECRETARY OF THE CTBTO

1 SEISMIC

Seismic technology is used to monitor the ground for shockwaves that are caused by nuclear explosions. The seismic network is made up of 50 primary stations which send their data in real time to the CTBTO, and 120 auxiliary stations which make their data available upon request by the CTBTO. Seismic data allow seismic events to be located and to distinguish between an underground explosion and other seismic events such as earthquakes or mining events that occur around the globe every year.

2 HYDROACOUSTIC

The hydroacoustic network scans the oceans for sound waves emitted by nuclear explosions. Since sound waves travel very efficiently under water, 11 stations are sufficient to monitor all the oceans. The data from these stations are used to distinguish between underwater explosions and other phenomena, such as submarine volcanic eruptions and earthquakes, which also propagate acoustic energy into the oceans.

3 INFRASOUND

The infrasound network of 60 stations uses microbarometers (acoustic pressure sensors) to detect very low frequency sound waves in the atmosphere produced by natural and man-made events. The data enable the International Data Centre (IDC) in Vienna to locate atmospheric explosions and distinguish them from natural phenomena such as meteorites, volcanoes and meteorological events or man-made phenomena such as re-entering space debris, rocket launches and supersonic aircraft.

4 RADIONUCLIDE

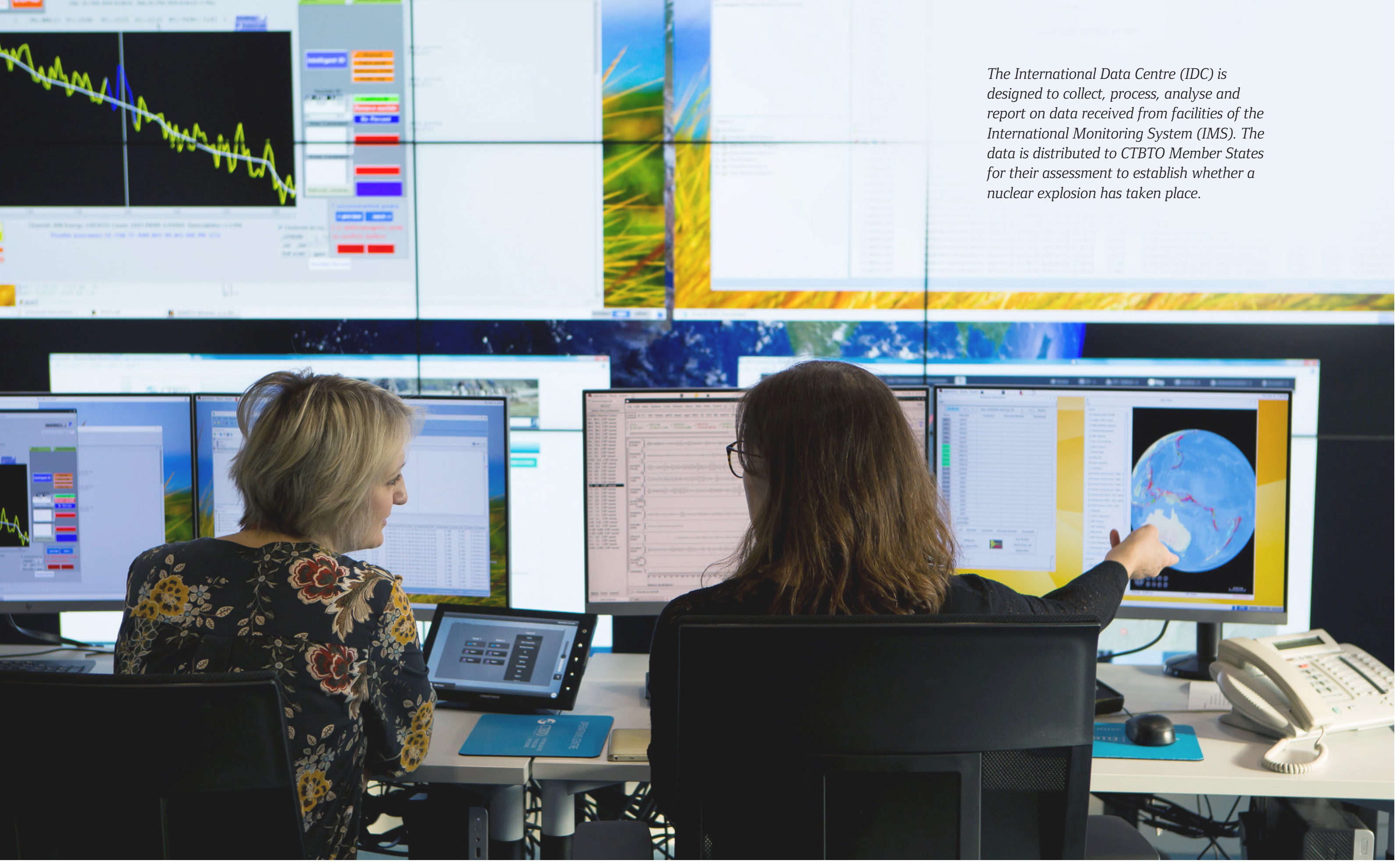
The radionuclide network consists of 80 stations which use air samplers to detect radioactive particles released from atmospheric nuclear explosions and those vented from shallow underground or underwater explosions. Half of these stations will also have the capacity to detect radioactive xenon, a noble gas which is a by-product of nuclear explosions and can enter the atmosphere after an underground explosion. The presence of certain radionuclide particles and noble gases and their relative abundance make it possible to identify the source of an emission, i.e. a civilian application or a nuclear test explosion. Thus, the radionuclide technology provides ultimate clarity as to whether or not a nuclear explosion has taken place. The network's 16 radionuclide laboratories make a thorough analysis of radioactive particle samples containing radionuclide materials that may have been produced by a nuclear explosion.


Primary Seismic Station PS21, Tehran, Iran


Hydroacoustic Station HA03, Juan Fernandez Island, Chile


Infrasound array IS55,Windless Bight, Antarctica, United States


Radionuclide station RN49, Spitsbergen, Norway



The International Data Centre (IDC) is designed to collect, process, analyse and report on data received from facilities of the International Monitoring System (IMS). The data is distributed to CTBTO Member States for their assessment to establish whether a nuclear explosion has taken place.

IDC: Providing the Information Member States Need

TRANSMISSION OF THE SIGNALS TO HEADQUARTERS IN VIENNA

Once one or more stations have detected a signal indicating a possible nuclear explosion, they transmit data on the time, location and intensity of the 'event', as CTBT experts refer to it, to the CTBTO's headquarters in Vienna. Data are transmitted via the Global Communications Infrastructure (GCI), which uses modern communication technology such as satellites and secure data connections on the ground. The entire GCI system was updated in 2018 and transferred to the network of a new service provider. It delivers 30 gigabytes of data daily, the equivalent of 20 days of continuous digitized music. It only takes a maximum of 5 seconds from the time the signal from a possible test is registered by a station to the time the data arrive at the IDC in Vienna. In addition, all GCI components meet the high standard of 99.5 percent data availability.

PROCESSING AND ANALYSING THE DATA AND TRANSMISSION TO MEMBER STATES

In Vienna, computer programmes process and analyse the incoming data to provide crucial information on a detected event, such as its location and nature. Experts review analysis results to ensure the highest possible quality. The precision with which the location and nature of the event can be determined depends largely on the number of stations that have detected the signal and their geographical distribution.

If radioactive particles or noble gases have been detected by one of the radionuclide stations, their region of origin can be identified through a method called Atmospheric Transport Modelling (ATM). The region of origin is then cross-checked with the results of the other verification technologies. A cooperation agreement with the World Meteorological Organization (WMO) providing access to ATM computations from world-renowned centres has greatly enhanced the CTBTO's capabilities in this field.

The processing and analysis of data provides States with the information needed to answer the most pressing questions after the detection of an event, such as its location and its nature. Consequently, the raw data and products are made available on the Secure Web Portal (SWP) for the States' final assessment.

OSI: The final verification measure

LAUNCHING AN ON-SITE INSPECTION AT THE REQUEST OF A MEMBER STATE

Once the CTBT enters into force, the Comprehensive Nuclear-Test-Ban Treaty Organization will be able to conduct an on-site inspection (OSI) at the request of one or more Member States. An OSI should, if possible, be preceded by a consultation and clarification process through which the Member States should first try to clarify and resolve the possible Treaty violation amongst themselves or through the Organization.

Once an OSI has been approved, the Organization will launch the inspection within a few days' notice because the evidence of a nuclear explosion, such as seismic aftershocks or certain radioactive particles, quickly fades. The area that may be inspected is limited to 1000 square kilometres.The inspectors use many different verification techniques in synergy. These range from visual observation from helicopters to different kinds of seismic measurements or environmental sampling to detect radioactive particles or noble gases.

The OSI regime faces a key challenge during any inspection. It needs to strike a careful balance between the ability to detect signs of nuclear testing and protecting the national security interests of the inspected Member State. Two full-scale simulated OSIs have been conducted by the CTBTO: The Integrated Field Exercise in Kazakhstan in 2008 (IFE08) and the Integrated Field Exercise in Jordan in 2014 (IFE14). During these exercises, an inspection team conducted a meticulous search of a clearly defined inspection area to establish whether or not a nuclear explosion had been conducted. IFE08 and IFE14 were both carried out in response to a technically realistic and stimulating, but fictional scenario and have proven that OSIs are a strong and reliable deterrent to any would-be violator of the CTBT.

MEMBER STATES DECIDE OVER POSSIBLE TEST BAN VIOLATION

The CTBT verification regime is a unique global alarm system with a set of impressive and sophisticated tools to monitor the planet for any nuclear explosion. Member States have the right to access all raw data and analysis products resulting from observations made by this system. It is their prerogative to draw final conclusions about a suspicious event based on information provided by the verification regime. Should data and data analysis point to a possible violation of the CTBT, Member States can take measures to ensure compliance with the Treaty. Such measures include bringing the case to the attention of the United Nations.

LEFT: *CTBTO on-site inspection exercise in Bruckneudorf, Austria (set-up of a base of operations)*
RIGHT: *Integrated on-site inspection exercise carried out near the Dead Sea area of Jordan*

Member States can receive data from CTBTO's monitoring stations, which can help save lives by allowing countries to issue faster, more accurate tsunami warnings.

MONITORING DATA: A TREASURE TROVE FOR SCIENCE

CTBT data have many potential civil and scientific applications. These include natural disaster risk management, research on the Earth's core, monitoring earthquakes, tsunamis and volcanoes, meteor and climate change research, to name but a few. The CTBTO is already providing real time monitoring data to tsunami warning centres in the Indian and Pacific Oceans helping them to issue tsunami warning alerts several minutes earlier than other systems.

CTBTO's data can be used for a range of applications that benefit the environment, including research on climate change, whale biology and creation of icebergs.

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