

# UNITED AGAINST NUCLEAR TEST EXPLOSIONS





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The front cover contains the flags of the six countries that ratified the Comprehensive Nuclear-Test-Ban Treaty in 2022: Dominica, Equatorial Guinea, São Tomé and Príncipe, The Gambia, Timor-Leste and Tuvalu.

Throughout the document, countries are referred to by the names that were in official use in the period for which the text was compiled.

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The maps on pages 13-16 show the approximate locations of International Monitoring System facilities based on information in Annex 1 to the Protocol to the Treaty adjusted, as appropriate, in accordance with proposed alternative locations that have been approved by the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization for reporting to the initial session of the Conference of the States Parties following entry into force of the Treaty.

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# UNITED AGAINST NUCLEAR TEST EXPLOSIONS



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FROM THE EXECUTIVE SECRETARY

I am pleased to present to you the 2022 Annual Report of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO).

Looking back at the first full calendar year of my tenure, I am pleased that despite the serious challenges facing the non-proliferation and disarmament regime more broadly, it was a positive year marked by progress and celebration for our Organization. The CTBTO community remained united in its core objectives and pursuit of a world free of nuclear explosions.

The work of the Provisional Technical Secretariat (PTS), with the support of States Signatories, has been guided by four strategic priorities:

- Universalization and entry into force of the Comprehensive Nuclear-Test-Ban Treaty (CTBT);
- Ensuring that a complete, robust and sustainable verification regime is in place at entry into force of the CTBT;
- Ensuring that all States Signatories benefit fully from Treaty membership; and
- Ensuring an efficient, effective and agile PTS.

The CTBT's essential role in the global non-proliferation and disarmament framework was recognized and highlighted at various high level multilateral for a throughout 2022. These included the Conference on Disarmament, the 10th Review

Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons and the United Nations General Assembly plenary meeting to commemorate the International Day against Nuclear Tests.

This year saw an unprecedented renewal of effort and momentum toward universalization of the CTBT. The ratification of the Treaty by six states in 2022 – Dominica, Equatorial Guinea, São Tomé and Príncipe, The Gambia, Timor-Leste and Tuvalu – brought the total number of signatures to 186 and ratifications to 176

by the end of the year. I am so pleased that we now have complete adherence to the CTBT in the Latin American and the Caribbean region, in South-East Asia, and in Central and West Africa. These are historic achievements, only made possible by the tireless work of States and international partners to advocate for the Treaty and its global benefits.

Our 25th anniversary culminated with a celebration of those ratifications on the margins of the high level segment of the seventy-seventh session of the United Nations General Assembly, both through a dedicated event and the 10th Friends of the CTBT meeting, co-chaired by the Prime Minister of Japan and the Minister for Foreign Affairs of Australia. But these were more than celebrations: they were welcome opportunities to reaffirm global commitment to our shared goals and to advance efforts towards entry into force of the CTBT. I very much appreciated the participation of the President of Finland, the Prime Minister of New Zealand, the President of the Union of the Comoros and the United

*“Despite the serious challenges facing the non-proliferation and disarmament regime more broadly, it was a positive year.”*

Nations Under-Secretary-General and High Representative for Disarmament Affairs at these events, as well as the support from many foreign ministers and senior government officials.

In mid-2022 I launched the National Data Centres for All initiative which aims to ensure that all States are able to access the benefits of Treaty membership and build capacity to receive and use International Monitoring System (IMS) data and International Data Centre (IDC) products. Twenty-five years after the CTBT opened for signature, about 25% of CTBT States Signatories have not created a Secure Signatory Account and/or established an National Data Centre (NDC). The creation of a Secure Signatory Account is the first step towards the establishment of an NDC. As a result of the initiative, two States Signatories designated their Secure Signatory Account; two States Signatories established their NDCs; 15 States Signatories requested capacity building systems, with eight sets of equipment distributed and installed, providing the necessary computer hardware and software to receive and analyse data from the IMS through the IDC. This is a great start, but only the beginning of our efforts to ensure all States can fully benefit from their participation in the Treaty.

We now have 304 out of 337 IMS facilities established and certified. This year radionuclide station RN2 was established in Argentina, primary seismic station PS35 in the Russian Federation and

the noble gas capability at radionuclide laboratory RL5 in Canada were certified and the noble gas capability of RN43 in Mauritania was installed and certified for operation. But after 25 years, parts of the system have aged, and many facilities are nearing end of life. Sustainment and recapitalization will be a key priority that will occupy States and the PTS in the coming years.

The IDC continued to further strengthen and improve the services it provides to States Signatories. The secure web portal, one of the primary services used by experts from States Signatories around the world to access IMS data and IDC products, was significantly enhanced in several ways, which included a modern intuitive mobile interface, extended content and document search options. Throughout the year, the IDC continued to support the development of software tools that can be used in NDCs and launched several important updates to the NDC in a box suite.

Work on readying the on-site inspection (OSI) capability continues to progress. In 2022 this included the development of the next OSI training plan and the OSI exercise plan 2022-2025, and the full resumption of training activities leading towards a large scale Integrated Field Exercise in 2025, 11 years after the last was conducted. In addition, the comprehensive draft list of equipment for use during OSIs published in 2021 was the subject of in-depth technical discussion with experts from States Signatories during the OSI Workshop-25,

*“Sustainment and recapitalization will be a key priority that will occupy States and the PTS in the coming years.”*

held online in October 2022 and in-person from 7 to 11 November 2022.

The third Science Diplomacy Symposium, held in December 2022, highlighted the CTBT's contribution to international peace and security, the science and technology that underpin its verification regime and the many civil and scientific benefits that go hand in hand with membership. Academics, diplomats, members of civil society and the next generation of non-proliferation and disarmament experts made up the 260 participants that joined us from across the globe.

Throughout 2022, the CTBTO Youth Group also continued to support and energize promotion of the Treaty, through engagements with government officials, technical experts, academics and the media. I am excited that our Youth Group has grown to nearly 1300 members from over 125 countries – my ongoing interactions with members of the Youth Group give me tremendous confidence that our future is in safe hands.

Thanks to strong support from States, the PTS is fortunate to have a diverse workforce, comprised of over 90 nationalities, that is coming increasingly closer to gender parity. By the end of 2022, nearly 40% of staff across the Professional and higher category positions were women. This is meaningful progress, but more work is needed to encourage the best candidates, from across geographical

regions, to apply for positions in the Organization. To further advance the goals of women's empowerment and gender equality, especially among the next generation of talent, the CTBTO in partnership with the CTBTO Youth Group successfully piloted a mentoring programme for early career women in science, technology, engineering and mathematics from the Global South.

Finally, we undertook a total redesign and restructuring of our corporate webpage with the aim of being more user friendly and easier to navigate. Please check it out at [www.ctbto.org](http://www.ctbto.org).

*“By the end of 2022, nearly 40% of staff across the Professional and higher category positions were women.”*

I have given here a short account of some of our many collective achievements. I am confident that our joint progress in 2022, as detailed in this annual report, sets a solid ground for even greater success in 2023 and beyond.



**Robert Floyd**  
Executive Secretary  
CTBTO Preparatory Commission  
Vienna, April 2023

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# EVENTS

## Abbreviations

3-C	three component	PTS	Provisional Technical Secretariat
ATM	atmospheric transport modelling	QA/QC	quality assurance and quality control
BGAN	broadband global area network	QMS	Quality Management System
BIPM	International Bureau of Weights and Measures	QMPM	Quality Management and Performance Monitoring (Section)
BOO	base of operations	REB	Reviewed Event Bulletin
CBS	capacity building system	RSTT	regional seismic travel time
COPC	CTBTO Operations Centre	SAUNA	Swedish Automatic Unit for Noble Gas Acquisition
CTBT	Comprehensive Nuclear-Test-Ban Treaty	SEL	Standard Event List
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization	SHI	seismic, hydroacoustic and infrasound
ECMWF	European Centre for Medium-Range Weather Forecasts	SnT	CTBT: Science and Technology conference
ECS	Experts Communication System	SPALAX	Système de prélèvement automatique en ligne avec l'analyse des radio xénon
EIMO	Equipment and Instrumentation Management System for OSI	SOH	state of health
EU	European Union	SOP	standard operating procedure
GCI	Global Communications Infrastructure	SSA	Secure Signatory Account
GIMO	Geospatial Information Management for OSI	SSI	standard station interface
IDANT	International Day against Nuclear Tests	STEM	science, technology, engineering and mathematics
IDC	International Data Centre	SWP	secure web portal
IMS	International Monitoring System	TIP	Test Implementation Plan
LEB	Late Event Bulletin	UNGA	United Nations General Assembly
NDC	National Data Centre	VATP	validation and acceptance test plan
O&M	operation and maintenance	VBO	VIC based international organization
OSI	on-site inspection	VIC	Vienna International Centre
PCA	post-certification activity	VPN	virtual private network
PKI	public key infrastructure	VSAT	very small aperture terminal
PRTTool	performance reporting tool	WGA	Working Group A
PTE	proficiency test exercise	WGB	Working Group B

## The Treaty

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) is an international treaty that outlaws all nuclear explosions. By totally banning nuclear testing, the Treaty seeks to constrain the qualitative improvement of nuclear weapons and to end the development of new types of nuclear weapons. It constitutes an effective measure of nuclear disarmament and non-proliferation in all its aspects.

The Treaty was adopted by the United Nations General Assembly and opened for signature in New York on 24 September 1996. On that day, 71 States signed the Treaty. The first State to ratify the Treaty was Fiji on 10 October 1996. The Treaty will enter into force 180 days after it has been ratified by all 44 States listed in its Annex 2.

When the Treaty enters into force, the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) will be established in Vienna, Austria. The mandate of this international organization is to achieve the objective and purpose of the Treaty, to ensure the implementation of its provisions, including those for international verification of compliance with it, and to provide a forum for cooperation and consultation among States Parties.

## The Commission

In advance of the entry into force of the Treaty and the establishment of the CTBTO proper, a Preparatory Commission for the Organization was established by the States Signatories on 19 November 1996. The Commission was given the mandate of preparing for entry into force.

The Commission, which is located at the Vienna International Centre in Austria, has two main activities. The first is to make all necessary preparations to ensure that the Treaty verification regime can be brought into operation at entry into force. The second is the promotion of signature and ratification of the Treaty in order to achieve entry into force.

The Commission is made up of a plenary body responsible for directing policy and comprising all States Signatories, and a Provisional Technical Secretariat to assist the Commission in its duties, both technically and substantively, and carry out such functions as the Commission determines. The Secretariat started work in Vienna on 17 March 1997. It is multinational in composition, with staff recruited from States Signatories on as wide a geographical basis as possible.



# UIN

## THE INTERNATIONAL MONITORING SYSTEM

### HIGHLIGHTS

The acceptance process for the Xenon International noble gas system was completed

Certifications of a noble gas system at RN43, PS35 and of noble gas capability at radionuclide laboratory RL5

The International Hydroacoustics Workshop 2022 and the seventh edition of the Operations and Maintenance Workshop 2022 were held in person in Vienna

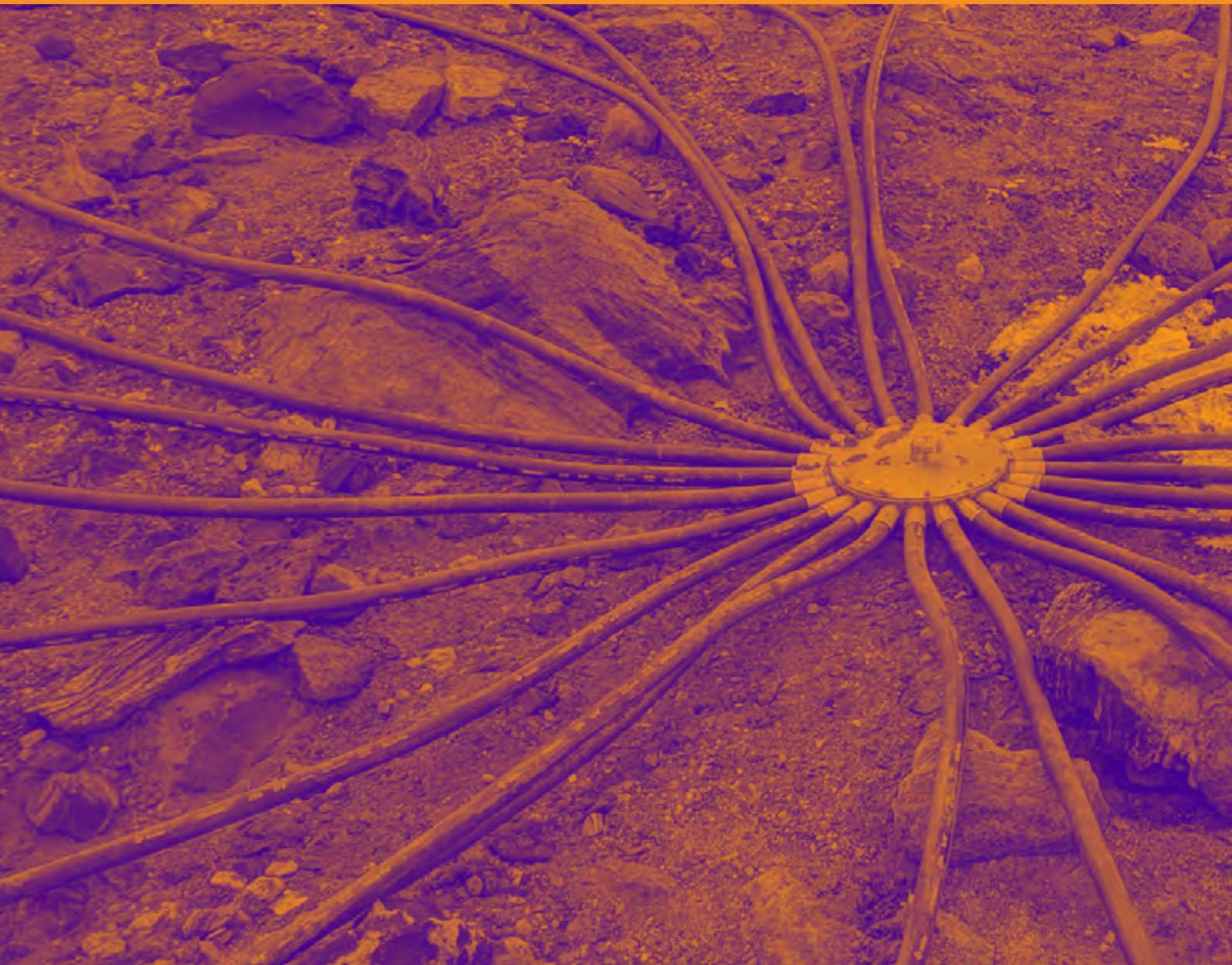
The International Monitoring System (IMS) is a global network of facilities for detecting and providing evidence of possible nuclear explosions. When completed, the IMS will consist of 321 monitoring stations and 16 radionuclide laboratories at locations around the world designated by the Treaty. Many of these locations are remote and difficult to access, posing major engineering and logistical challenges.

The IMS uses seismic, hydroacoustic and infrasound (SHI) ('waveform') monitoring technologies to detect and locate energy released by an explosion – whether nuclear or non-nuclear – or a natural event that takes place underground, underwater or in the atmosphere.

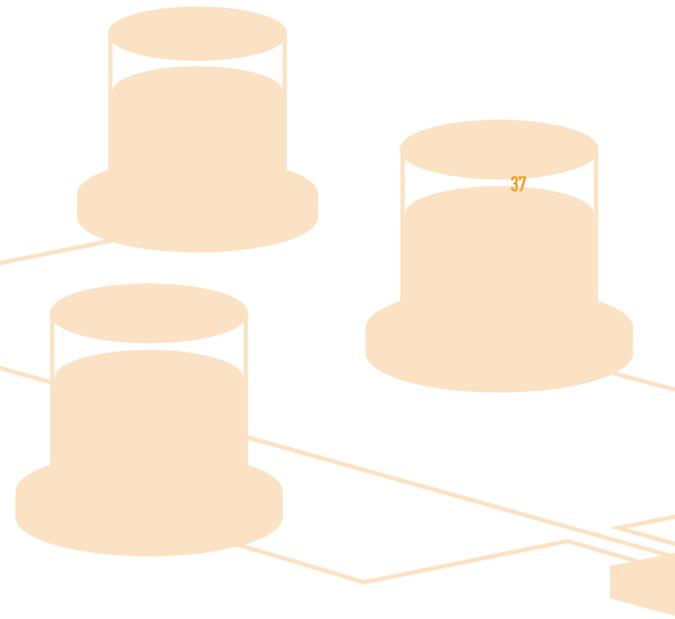
The IMS uses radionuclide monitoring technologies to collect particles and noble gases from the atmosphere. The acquired samples are analysed for evidence of physical products (radionuclides) that are created by a nuclear explosion and carried through the atmosphere. This analysis can confirm whether an event recorded by the other monitoring technologies was actually a nuclear explosion.



# PROFILES OF THE MONITORING TECHNOLOGIES



## SEISMIC STATIONS



The objective of seismic monitoring is to detect and locate underground nuclear explosions. Earthquakes and other natural events, as well as anthropogenic events, generate two main types of seismic wave: body waves and surface waves. The faster body waves travel through the interior of the earth, while the slower surface waves travel along its surface. Both types of waves are examined during analysis to collect specific information on a particular event.

Seismic technology is very efficient at detecting a suspected nuclear explosion, as seismic waves travel fast and can be registered within minutes of an event. Data from seismic stations of the IMS provide information on the location of a suspected underground nuclear explosion and help identify the area for an on-site inspection (OSI).

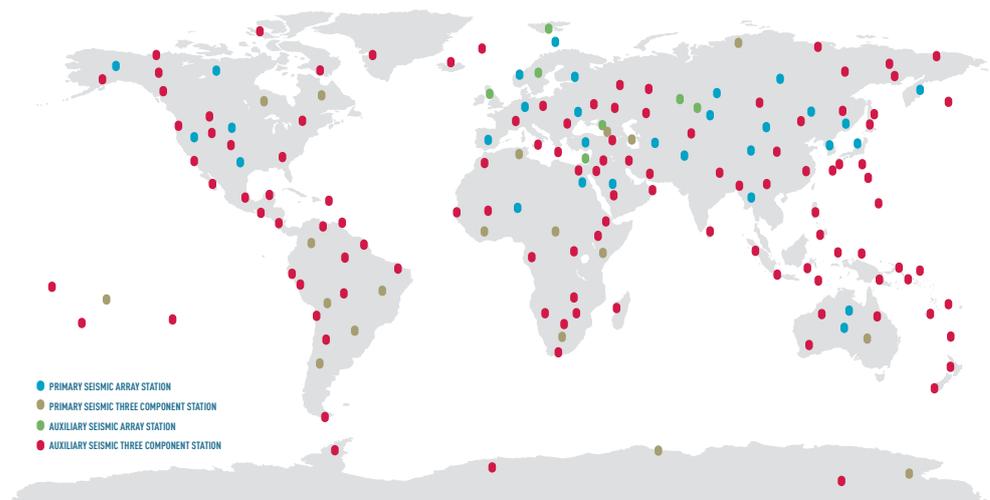
The IMS has primary and auxiliary seismic stations. Primary seismic stations send continuous data in near real time to the International Data Centre (IDC). Auxiliary seismic stations provide data on request from the IDC.

An IMS seismic station typically has three basic parts: a seismometer to measure ground motion, a system to record the data digitally with an accurate time stamp, and a communication system interface for the transmission of data.

An IMS seismic station can be either a three component (3-C) station or an array station. A 3-C station records broadband ground motion in three orthogonal directions. An array station generally consists of multiple short period seismometers and 3-C broadband instruments that are separated spatially allowing more precise determination of event location. The primary seismic network is mostly composed of arrays (30 of 50 stations), while the auxiliary seismic network is mostly composed of 3-C stations (112 of 120 stations).

**120**  
AUXILIARY SEISMIC  
STATIONS

**50**  
PRIMARY SEISMIC  
STATIONS



## INFRASOUND STATIONS

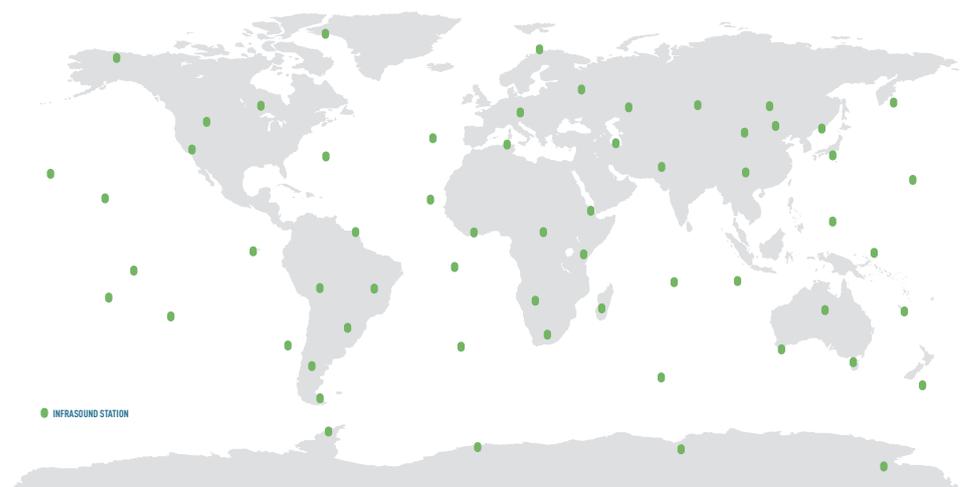
Acoustic waves with very low frequencies, below the frequency band audible to the human ear, are called infrasound. Infrasound is produced by a variety of natural and anthropogenic sources. Atmospheric and shallow underground nuclear explosions can generate infrasound waves that may be detected by the infrasound monitoring network of the IMS.

Infrasound waves cause minute changes in the atmospheric pressure that are measured by microbarometers. Infrasound has the ability to cover long distances with little dissipation, which is one reason infrasound monitoring is a useful technique for detecting and locating atmospheric nuclear explosions. In addition, since underground nuclear explosions also generate infrasound, the combined use of infrasound and seismic technologies enhances the ability of the IMS to identify possible underground tests.

The IMS infrasound stations exist in a wide variety of environments, ranging from equatorial rainforests to remote windswept islands to polar ice shelves. However, an ideal site for deploying an infrasound station is within a dense forest, where it is protected from prevailing winds, or at a location with the lowest possible background noise in order to improve signal detection.

An IMS infrasound station (also known as an array) typically employs several infrasound array elements arranged in different geometrical patterns, a meteorological station, a system for reducing wind noise, a central recording processing facility and a communication system for the transmission of data.

**60**  
INFRASOUND  
STATIONS



## HYDROACOUSTIC STATIONS

Nuclear explosions underwater, in the atmosphere near the ocean surface or underground near oceanic coasts generate sound waves that can be detected by the IMS hydroacoustic monitoring network.

Hydroacoustic monitoring involves recording signals that show changes in water pressure generated by sound waves in the water. Owing to the efficient transmission of sound through water, even comparatively small signals are detectable at large distances. Therefore 11 stations are sufficient to monitor most of the world's oceans.

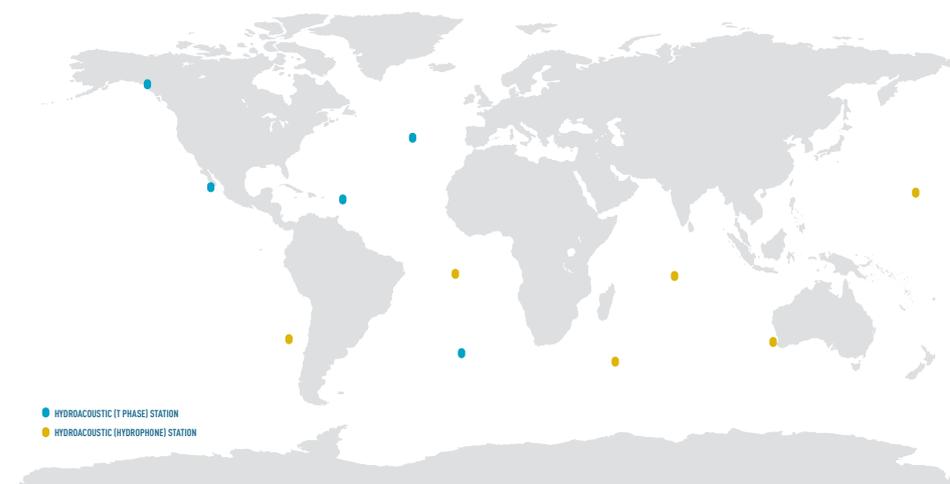
There are two types of hydroacoustic stations: underwater hydrophone stations and T phase seismometer stations on islands or on the coast. Underwater hydrophone stations are more effective than T phase stations and are among the most challenging and costly monitoring stations to manufacture and install. They must be designed to function in extremely inhospitable environments and be able to withstand temperatures close to freezing point, huge pressure and saline corrosiveness.

The deployment of the underwater components of a hydrophone station (i.e. accurately placing the hydrophones and laying the cables) is a complex ocean engineering undertaking. It involves the chartering of specialized ships, extensive underwater work and the use of materials and equipment engineered to withstand the challenging underwater environment. The sustainment of these stations is a technologically complex undertaking, involving underwater work with divers and remotely operated vehicles to inspect nearshore undersea cables, and maritime operations with specialized ships and cable handling equipment for repairs.

Scientific outreach is an important component of hydroacoustic sustainment, something that was elaborated on during the International Hydroacoustics Workshop held in person in Vienna, Austria in September 2022. The workshop attracted 31 participants from 12 countries. State of the art scientific projects in ocean acoustics, marine engineering, data analysis, signal processing and advanced hydroacoustic modelling were presented. A hands-on training demonstration of National Data Centre (NDC) in a box software for processing hydroacoustic data was also included. Initiatives of this kind facilitate access to and encourage the use of IMS hydroacoustic data. The participants truly embraced this event.

# 11

## HYDROACOUSTIC STATIONS



## RADIONUCLIDE PARTICULATE STATIONS

Radionuclide monitoring technology complements the three waveform technologies employed in the Treaty verification regime. It is the only technology that is able to confirm whether an explosion detected and located by the waveform methods is indicative of a nuclear test. It provides the means to identify the 'smoking gun', whose existence would be evidence of a possible violation of the Treaty.

Radionuclide stations detect radionuclide particles in the air. These can be emitted directly from a fission event, or be produced as a decay product of an escaped noble gas isotope. Each station contains an air sampler, detection equipment, computers and a communication set-up. At the air sampler, air is forced through a filter, which retains most particles that reach it. The used filters are examined and the gamma radiation spectra resulting from this examination are sent electronically to the IDC in Vienna for analysis.

**96**  
FACILITIES



### *Noble Gas Detection Systems*

The Treaty requires that, by the time it enters into force, 40 of the 80 IMS radionuclide particulate stations also have the capability to detect radioactive forms of noble gases such as xenon and argon. Special detection systems have therefore been developed and are being deployed and tested in the radionuclide monitoring network before they are integrated into routine operations.

Noble gases are inert and rarely react with other chemical elements. Like other elements, noble gases have various naturally occurring isotopes, some of which are unstable and emit radiation. There are also radioactive noble gas isotopes that do not occur naturally, but which can be produced only by nuclear reactions. By virtue

of their nuclear properties, four isotopes of the noble gas xenon are particularly relevant to the detection of nuclear explosions. Radioactive xenon from a well contained underground nuclear explosion can seep through layers of rock, escape into the atmosphere and be detected later, thousands of kilometres away.

All of the noble gas detection systems in the IMS work in a similar way. Contaminants of different kinds, such as dust and water vapour are eliminated before the collected air is injected into a processing unit for collection, purification, concentration and quantification of xenon. The resulting sample contains a high concentration of xenon, in both its stable and unstable (i.e. radioactive) forms. The radioactivity of the isolated and concentrated xenon is measured and the data is sent to the IDC for further analysis.

### *Radionuclide Laboratories*

Sixteen radionuclide laboratories, each located in a different State, support the IMS network of radionuclide monitoring stations. These laboratories have an important role in corroborating the results from an IMS station, in particular to confirm the presence of fission products or activation products that could be indicative of a nuclear test. In addition, they contribute to the quality control of station measurements and the assessment of network performance through regular analysis of routine samples from all certified IMS stations. These world class laboratories also analyse other types of samples, such as those collected during a station site survey or certification.

**16**  
**LABORATORIES**

Fourteen radionuclide laboratories are certified under rigid requirements for analysis of particulate samples, and four radionuclide laboratories have been certified for noble gas analysis. The certification process provides assurance that the results provided by a laboratory are accurate and valid. These laboratories also participate in the annual proficiency test exercises (PTEs) organized by the Commission.

## COMPLETING THE INTERNATIONAL MONITORING SYSTEM

**45**  
PRIMARY SEISMIC STATIONS WERE INSTALLED AND CERTIFIED AS OF 2022

Establishment of a station is a general term referring to the building of a station, from its initial stages until its completion. Installation typically refers to all work performed until the station is ready to send data to the IDC in Vienna. This includes, for instance, site preparation, construction and equipment installation. A station receives certification when it meets all technical specifications, including requirements for data authentication and transmission through the Global Communications Infrastructure (GCI) link to the IDC. At this point the station is considered an operational facility of the IMS.



**32**  
NOBLE GAS SYSTEMS WERE INSTALLED AT IMS RADIONUCLIDE STATIONS

The establishment and certification of PS35, the primary seismic array at Peleduy in 2022, completes the installation of the primary seismic stations in the Russian Federation. With the certification of this station, as of 2022 45 primary seismic stations were installed and certified in total throughout the IMS network. Furthermore, certification of the noble gas system at RN43 and of noble gas capability at RL5 were also accomplished in 2022.

The monitoring of radionuclide noble gases plays an essential role in the verification system of the Treaty, as was demonstrated following the announced nuclear tests by the Democratic People's Republic of Korea in 2006 and 2013. It also proved to be invaluable following the nuclear accident at Fukushima, Japan, in 2011. In line with its priorities, the Commission continued to focus on the noble gas monitoring programme in 2022 through close cooperation with the developers of next generation noble gas systems. Since the acceptance process for the SPALAX NG noble gas system was successfully concluded in 2021, two next generation systems were accepted for use in the IMS.



The establishment and certification of the primary seismic array at Peleduy in 2022 means the installation of primary seismic stations in the Russian Federation is complete.

As of the end of the year, 32 noble gas systems were installed (80% of the planned total of 40) at IMS radionuclide stations. Of these, 26 systems were certified as meeting the stringent technical requirements.

PTEs are key elements of quality assurance and quality control (QA/QC) of IMS laboratories. This includes both particulate and noble gas PTEs.

### Status of the Installation and Certification Programme for International Monitoring System Stations as of 31 December 2022

IMS Station Type	Installation Complete		Under Construction	Contract Under Negotiation	Not Started
	Certified	Not Certified			
Primary seismic	45	1	-	1	3
Auxiliary seismic	109	7	1	-	3
Hydroacoustic	11	-	-	-	-
Infrasound	53	1	1	-	5
Radionuclide	72	1	-	2	5
<b>Total</b>	<b>290</b>	<b>10</b>	<b>2</b>	<b>3</b>	<b>16</b>

### Installations and Certifications of Noble Gas Systems at Radionuclide Stations as of 31 December 2022

Total Number of Noble Gas Systems	Installed	Certified
40	32	26

### Certifications of Radionuclide Laboratories as of 31 December 2022

Total Number of Laboratories	Certified for Particulate Capability	Certified for Noble Gas Capability
16	14	5

All these advancements contribute to the prospective completion of the IMS network.

## AGREEMENTS FOR MONITORING FACILITIES

The Commission has the mandate to establish procedures and a formal basis for the provisional operation of the IMS before the Treaty enters into force. This includes concluding agreements or arrangements with States that host IMS facilities to regulate activities, such as site surveys, installation or upgrading work, and certification and post-certification activities (PCAs).

In order to efficiently and effectively establish and sustain the IMS, the Commission needs to fully benefit from the immunities to which it is entitled as an international organization, including exemption from taxes and duties. Consequently, facility agreements or arrangements provide for the application (with changes where appropriate) of the Convention on the Privileges and Immunities of the United Nations to the activities of the Commission or explicitly list the privileges and immunities of the Commission. This may require a State that hosts one or more IMS facilities to adopt national measures to bring these privileges and immunities into effect.

In 2022, the Commission continued to address the importance, for example at the seventh workshop on the operation and maintenance (O&M) of the IMS, of concluding facility agreements and arrangements and their subsequent national implementation. The absence of such legal mechanisms in some cases results in substantial costs (including in human resources) and major delays in sustaining certified IMS facilities. These costs and delays adversely affect the availability of data from the verification system.

Of the 89 States that host IMS facilities, 49 have signed a facility agreement or arrangement with the Commission, and 41 of these agreements and arrangements are in force. States are showing increased interest in this subject, and it is hoped that ongoing negotiations will be concluded in the near future and that negotiations with other States may be initiated soon.

## POST-CERTIFICATION ACTIVITIES

Following the certification of a station and its incorporation into the IMS, its operation focuses on the delivery of high quality data to the IDC.

PCA contracts are fixed cost contracts between the Commission and some station operators. These contracts cover station operations and various preventive maintenance activities. The total expenditure of the Commission related to PCAs in 2022 was US\$21 137 386. This amount covers the costs related to PCAs for 184 IMS facilities, including noble gas systems and radionuclide laboratories.

Each station operator submits a monthly report on PCA performance, which the Provisional Technical Secretariat (PTS) reviews for compliance with O&M plans. The Commission has developed standardized criteria for the review and evaluation of the performance of station operators.

The Commission continued to standardize the services provided under PCA contracts. It requested all new budget proposals to include a standard O&M plan template. By the end of 2022, 139 out of 168 stations and noble gas systems under PCA contracts had submitted O&M plans in the standard format.

## SUSTAINING PERFORMANCE

The life cycle of the IMS facilities proceeds from conceptual design and installation to operation, sustainment, disposal of parts to upgrade or rebuilding. Sustainment covers O&M activities through necessary preventive and predictive actions, repairs, replacement, upgrades and continuous improvements to ensure technological concurrency of the monitoring capabilities. This process involves management, logistics, coordination, obsolescence and support for the full life cycle of each facility component, performed as efficiently and effectively as possible. In addition, as IMS facilities reach the end of their designed life cycles, there is the need to plan, manage and optimize the recapitalization (replacement) of the facility in order to minimize downtime and maintain mission capability.

The Commission is focusing on identifying the root causes of failures at IMS stations. Ongoing efforts to improve data availability based on IMS-wide failure analysis include upgrades to station electrical power and intra-site communication systems, lightning protection and grounding, station security and infrastructure, equipment standardization, appropriate sparing levels at IMS stations and depots, and enhanced and targeted station operator technical training courses.

The optimization and performance enhancement involves the continuous improvement of data quality, reliability and resilience. Therefore the Commission continued to put emphasis on QA/QC, state of health (SOH) monitoring, IMS facility calibration activities (which are essential for the reliable interpretation of detected signals) and the improvement of IMS technologies. These activities contribute to maintaining a credible and technologically relevant monitoring system.



*The CTBTO Technology Support and Training Centre stores equipment and hosts training sessions.*

## *Logistics*

The central logistics support function continued to provide PTS-wide logistics support including operation and management of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) Technology Support and Training (TeST) Centre in Seibersdorf, Austria. It utilizes Vienna International Centre (VIC) facilities and the CTBTO TeST Centre as platforms to play a central role in logistics support for the PTS in shipping, warehouse management, goods/asset management and for the build-up and sustainment of verification activities.

The CTBTO TeST Centre continued its operations to store PTS equipment and to undertake operational activities in support of programme activities to develop, test and maintain verification technology and techniques as well as auxiliary equipment. In 2022, several training sessions and events organized by the PTS took place at the CTBTO TeST Centre for which the central logistics support function provided support.

The PTS maintained its capability for supportability analysis which underpins the sustainment decision making processes, while at the same time ensuring overall operational availability of stations. This activity involved developing, documenting and maintaining the data infrastructure, integrating data from different sources

and using tools to prepare and analyse the data to report, find and share actionable insights.

Supply and support contracts related to equipment and services for IMS facilities continued to be established and maintained as an important component of the sustainment strategy, for example the effort to establish an equipment support contract for SPALAX NG.

The Commission continued to work with States and station operators on shipment procedures for IMS equipment and consumables to ensure their timely arrival and tax- and cost-free customs clearance. Shipping and customs clearance processes continued to be time consuming and resource intensive. The establishment and national implementation of facility agreements contributes to smooth import and customs processes where otherwise the Commission may be requested to pay import taxes and duties.

## *Maintenance*

The PTS provides maintenance support and technical assistance at IMS facilities around the globe.

In 2022, numerous maintenance issues were addressed on-site or remotely, including long running data availability problems at several IMS facilities. Based on lessons learned during the COVID-19 pandemic, enhanced remote assistance to station operators for preventive and corrective maintenance was systematically conducted prior to on-site maintenance visits.

A programme to standardize equipment at radionuclide stations has largely been completed. The programme aimed to overcome obsolescence and address equipment becoming non-standard as newer equipment is rolled out to newly certified stations. This resulted in improved data availability and simplified sustainability. The IMS is planning to implement equipment standardization at SHI stations.

As the entity closest to an IMS facility, the station operator is in the best position to prevent problems at stations and ensure timely resolution of any problems that occur. In 2022, the Commission continued to advance the technical capabilities of station operators. A technical training programme for station operators of manual radionuclide stations in the Russian Federation was held in Dubna in the Russian



*IMS staff conducted preventative and troubleshooting visits to RN51.*

Federation in 2022. In addition, training sessions were held for radionuclide and SHI public key infrastructure (PKI) operators, and online technical training for station operators of IMS infrasound and seismic stations with Kinometrics equipment. All station visits by PTS staff systematically included hands-on training for local station operators.

A considerable number of remote or on-site maintenance, sustainment and/or technical support activities were performed during the reported period, in cooperation with station operators and subcontractors. This included equipment and software troubleshooting, equipment repair or replacement, infrastructure repairs and spares replenishment, etc. In addition, several particulate and noble gas radionuclide detectors were replaced and calibrated due to failures

or to ensure continued compliance with requirements.

IMS staff conducted the following station visits: resumed preventative maintenance visits to SAUNA, radionuclide aerosol sampler and analyser and SPALAX stations after COVID-19 lockdown at stations where visits are now possible again. Preventive maintenance/troubleshooting visits to RN51, AS75, AS119, to the Universidad Nacional Autónoma de Mexico for HA6 upgrade, PS2 and IS7.

Efforts were made to advance towards a complete and updated station specific technical documentation, that contributes to the efficient sustainment of IMS stations.

The combination of technical training for station operators, better coordination between the operators and the Commission to optimize PCA contracts, and improved station specific O&M plans and station information contributed to enhancing the capability of station operators to undertake more sophisticated maintenance tasks at their stations. This is essential for the sustainment and performance of the IMS network.

## Recapitalization

The final phase in the life cycle of equipment for IMS facilities involves its replacement and disposal. In 2022, the Commission continued to recapitalize IMS facility components as they reached the planned end of their operational life cycle.

When managing recapitalization, the Commission and station operators took into account both life cycle data and station specific failure analysis and risk assessment. To optimize the obsolescence management of the IMS network and associated resources, the Commission continued to prioritize the recapitalization of components with high failure rates or risks and components whose failure would cause significant downtime. At the same time, the replacement of components that proved to be robust and reliable is delayed beyond the planned end of their operational life cycles, where suitable, in order to optimize the use of available resources.

*Recapitalization was followed by revalidation to ensure that stations continued to meet technical requirements.*

Several recapitalization projects were in progress or completed at certified IMS facilities in 2022, involving a substantial investment in human and financial resources. In seven cases, namely AS15, AS102, PS19, PS24, IS47, HA2 and HA7, recapitalization was followed by revalidation to ensure that the stations continued to meet technical requirements. Several important recapitalization projects have also been finalized or started this year with revalidation planned in 2023, e.g. IS4, IS5, IS18, IS19, IS35, IS40, IS51, PS17 and PS26.



## *Environmental Compliance*

Following the successful nearshore cable inspection at HA4 in the fourth quarter of 2021, the collaboration with the French Southern and Antarctic Lands technical team, French Southern Territories National Nature Reserve, the University of Burgundy and the French National Museum of Natural History on HA4 nearshore cable inspection and environmental studies continues. Following the diver inspection of cable sections of interest and environmental studies conducted by a French Southern and Antarctic Lands dive team in November 2022, the programme for yearly diver inspections and environmental surveys will continue until 2026 in collaboration with the French Alternative Energies and Atomic Energy Commission and the French Southern and Antarctic Lands for continued sustainment of the onshore component.

*Diver inspections of nearshore cable sections and environmental assessments were carried out at HA4 in the southern Indian Ocean and will continue until 2026.*



## *Engineering Solutions*

The engineering and development programme for IMS facilities aims to improve the overall availability and quality of data and the cost effectiveness and performance of the IMS network by designing, validating and implementing solutions. Systems engineering is implemented throughout the life cycle of an IMS station and relies on standardization of interfaces, equipment and modularity. Engineering and development solutions consider both end to end systems engineering of stations and optimized interaction with data processing by the IDC.

The Commission continued its work to optimize the performance of the IMS facilities and the monitoring technologies. Analysis of station incident reports and failures help identify the main causes of data loss and assist subsequent analysis of subsystem failures responsible for downtime.

In 2022, the Commission continued activities with the International Bureau of Weights and Measures (BIPM) on the basis of the arrangement signed between the Commission and the BIPM in 2021, which provides a framework for collaboration between the Commission and BIPM in the field of low frequency sound and vibration as well as radionuclide particulates and gases.

In 2022, the Commission concentrated its engineering efforts on the following:

- Sustainment and enhancement of the standard station interface (SSI) software. In order to better support station operators and PKI operators using the SSI software, the Commission conducted a survey to collect information and configuration files from all workstations running the SSI software at IMS SHI stations. The Commission uses the results of this survey to better understand how the SSI software is used across the network, and to refine the roadmap for its development and deployment. Development continued in 2022 to include the support of Digital Data Formatter Interface in the SSI configurator, enhance the support of calibration with Nanometrics Centaur equipment, improve resiliency through bug fixes and the investment in new regression tests and the continued involvement of external laboratories as beta testers. These improvements will be part of the next release of the SSI planned for the first half of 2023. Following the announcement by Red Hat that the CentOS Linux distribution would be discontinued by mid-2024, the Commission is assessing alternative Linux distributions.

- Enhancements to the internal Multi-Technology Integration Portal, including the visualization of data quality metrics and station parameters with the objective of supporting station troubleshooting and configuration activities.
- Development of the CalxPy software to support the calibration of IMS seismoacoustic stations against a reference system. This included the support of the scheduled calibration process for infrasound stations and packaging for both IDC and NDC in a box environments.
- Investigation of nearshore underwater cable sustainment solutions through conducting studies into: cable replacement options, underwater jointing options, system cathode options and the conduct and feasibility of horizontal directional drilling to protect cables from damage in the nearshore energetic surf zone.
- Development of the next generation of noble gas systems. Xenon International has completed IMS acceptance testing; MIKS is undergoing acceptance testing. The PTS will continue planning for the deployment of all new systems.
- Re-engineering and testing of the radionuclide SSI software, which will be phased in to operations in 2023.
- Continued evaluation of automated particulate radionuclide sampler Cinderella G2 and its integration into IMS station software and hardware environment.
- Evaluation of multi-sensor (dual detector) particulate stations: a prototype system is undergoing testing to improve robustness and reliability of the particulate IMS component.
- Hybrid modular design for hydroacoustic hydrophone stations: a prototype latch mechanism that makes it possible to readily disconnect a node from the trunk or internode cable any time after deployment has been developed. Initial testing was conducted in a water tank. A proposal has been received and evaluated regarding tension, mechanical and functional testing, which simulate mechanical stresses encountered during deployment at sea in harsh conditions. Specialized laboratory testing is to be conducted in 2023.
- Navigation buoy and nearshore cable inspection sustainment planning is underway in preparation for an IMS station visit to HA3/IS14 in the first quarter of 2023.



Recapitalization project at PS26.

- Following the outcome of the solicitation process for the re-establishment of the north cable and triplet of HA8, a proposal has been received and is to be technically evaluated by the IMS technical evaluation team.

These initiatives further improved the reliability and resilience of IMS facilities. They also enhanced the performance of the network and increased the robustness of IMS stations, thus contributing to the extension of their life cycles and containing the risks of data downtime. Moreover, these initiatives increased the data availability and the quality of data processing and of data products.

### *Auxiliary Seismic Network*

The Commission continued to monitor the operation and sustainment of auxiliary seismic stations in 2022.

In accordance with the Treaty, the regular O&M costs of each auxiliary seismic station, including the cost of physical security, are the responsibility of the State hosting it. However, practice has shown that this constitutes a significant challenge for auxiliary seismic stations in developing countries that do not belong to a parent network with an established maintenance programme.

The Commission has encouraged States that host auxiliary seismic stations with design deficiencies or with problems related to obsolescence to review their ability to cover the cost of upgrading and sustaining their stations. However, obtaining the appropriate level of technical and financial support remains difficult for several host States.

To address this, the European Union (EU) continued to support the sustainment of auxiliary seismic stations that are hosted by developing countries or countries in transition. This initiative includes action to return stations to an operational state and the provision of transportation and funds for additional PTS personnel to provide technical support. The Commission continued its discussions with other States whose parent networks include several auxiliary seismic stations in order to make similar arrangements.

*Fixing power lines at AS47.*



## *Quality Assurance*

In addition to improving performance at individual stations, the Commission accords great importance to ensuring the reliability of the IMS network as a whole. Hence, its engineering and development activities in 2022 continued to focus on measures for data surety and calibration.

QA/QC activities for seismoacoustic capability continued with:

- Technical collaboration with BIPM on measurement science for IMS monitoring technologies. The Commission gave an invited presentation to the General Conference for Weights and Measures, highlighting the progress made over the past few years under this collaboration aiming at achieving metrological traceability of IMS SHI measurements.
- Following the completion of measurements performed in the framework of the first intercomparison exercise for infrasound sensors, a report was drafted and finalized. Progress was made in the measurement uncertainties computation and in the establishment of reliable equivalence between participating laboratories for the testing of infrasound sensors. A third pilot study is ongoing focusing on the evaluation of infrasound sensor performance under environmental parameter variations.
- Development of the CalxPy software to support the calibration of IMS seismoacoustic stations against a reference system. This included the enhancement of the expert review page, the field test of the standalone version and packaging for both IDC and NDC in a box environments.

The PTS continued to develop new functionalities for software (Calibration Activities Management Tool, SSI calibration module and CalxPy) used to support the implementation of scheduled calibration activities at IMS seismoacoustic stations.

The PTS continues its effort to deploy and configure the SSI calibration module at seismic stations. The PTS also supports station operators in troubleshooting, upgrading, installing and configuring the SSI calibration module. This allowed yearly scheduled calibration activities to be performed including full frequency calibration results sent in IMS 2.0 format to the PTS.

# 7

## LABORATORY SURVEILLANCE ASSESSMENTS

Calibration plays a significant role in the verification system, as it determines and monitors parameters needed to properly interpret signals recorded by IMS facilities. This is achieved either by direct measurement or by comparison against a standard.

Under the QA/QC programme for radionuclide laboratories, the Commission assessed the 2021 particulate PTE, the 2021 noble gas PTE and undertook seven laboratory surveillance assessments at RL1, RL2, RL7, RL11, RL12, RL14 and RL15.

IMS configuration management was administered ensuring that proposed changes at IMS stations are assessed to determine their effect on cost, effort and performance including data availability. Configuration management provides verifiable records of station configurations and equipment ensuring that IMS monitoring facilities continue to meet IMS technical specifications and operational requirements.

# U4

## THE GLOBAL COMMUNICATIONS INFRASTRUCTURE

### HIGHLIGHTS

High GCI availability

An average of 36 gigabytes of data and products transmitted per day

Two additional links installed for the Netherlands' NDC and RN2



The GCI uses a combination of communications technologies including satellite, cellular, Internet and terrestrial communication links to enable the exchange of data between IMS facilities and States around the world and the Commission. The GCI first transports raw data from the IMS facilities in near real time to the IDC in Vienna for processing and analysis. It then distributes the analysed data to States Signatories along with reports relevant to verification of compliance with the Treaty. Increasingly, the GCI is also being used as a means for the Commission and station operators to monitor and control IMS stations remotely.

The current, third generation of the GCI began operation in 2018 under a new contractor. Its various communication links are required to operate with 99.5% availability and its terrestrial communication links with 99.95% availability. The GCI is required to send data from transmitter to receiver within seconds. It uses digital signatures and keys to ensure that the transmitted data are authentic and have not been tampered with.

## TECHNOLOGY

**208**  
PRIMARY VSAT LINKS

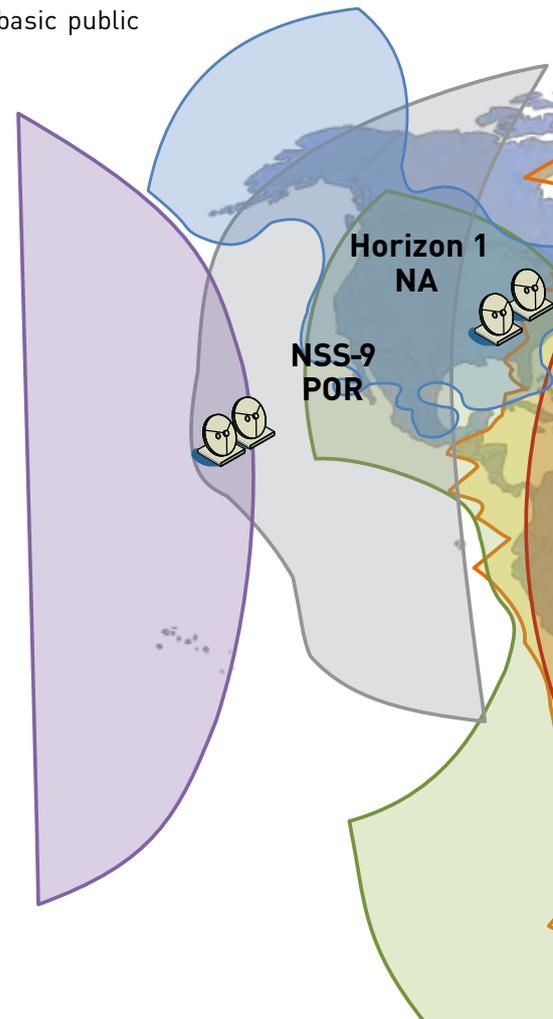
IMS facilities, the IDC and States Signatories can exchange data, via their local earth stations fitted with a very small aperture terminal (VSAT), through one of several commercial geostationary satellites. These satellites cover all parts of the world, other than the North and South Poles. The satellites route the transmissions to hubs on the ground, and the data are then sent to the IDC via terrestrial links. Complementing this network, independent subnetworks employ a variety of communications technologies to carry data from IMS facilities to their respective national communications nodes connected to the GCI, from where the data are routed to the IDC.

**78**  
BGAN LINKS

In situations where VSATs are not in use or are not operational, other technologies such as broadband global area networks (BGANs), 3G/4G or virtual private networks (VPNs) can provide alternative means of communication. A VPN uses existing telecommunications networks to transmit data privately. Most of the VPNs for the GCI use the basic public infrastructure of the Internet together with a variety of specialized protocols to support secure encrypted communications. VPNs are also used at some sites to provide a backup communication link in case of failure of a VSAT or terrestrial link. For NDCs with a viable Internet infrastructure, a VPN is the recommended medium for receiving data and products from the IDC.

**43**  
VPN LINKS WITH VPN  
OR 3G BACKUP

At the end of 2022, the GCI network included 268 redundant links. Of these, 208 are primary VSAT links backed up by 3G (118 links), BGAN (78 links), VPN (6 links) or VSAT (6 links). There are also 43 VPN links with VPN or 3G backup, 10 links with 3G primary and BGAN backup and 7 terrestrial multiprotocol label switching links. In addition, 71 independent subnetwork links and 6 Antarctic communication links were operated by 10 States Signatories to carry IMS data to a GCI connection point. In total, the combined networks have over 600 different communication links to transport data to and from the IDC.



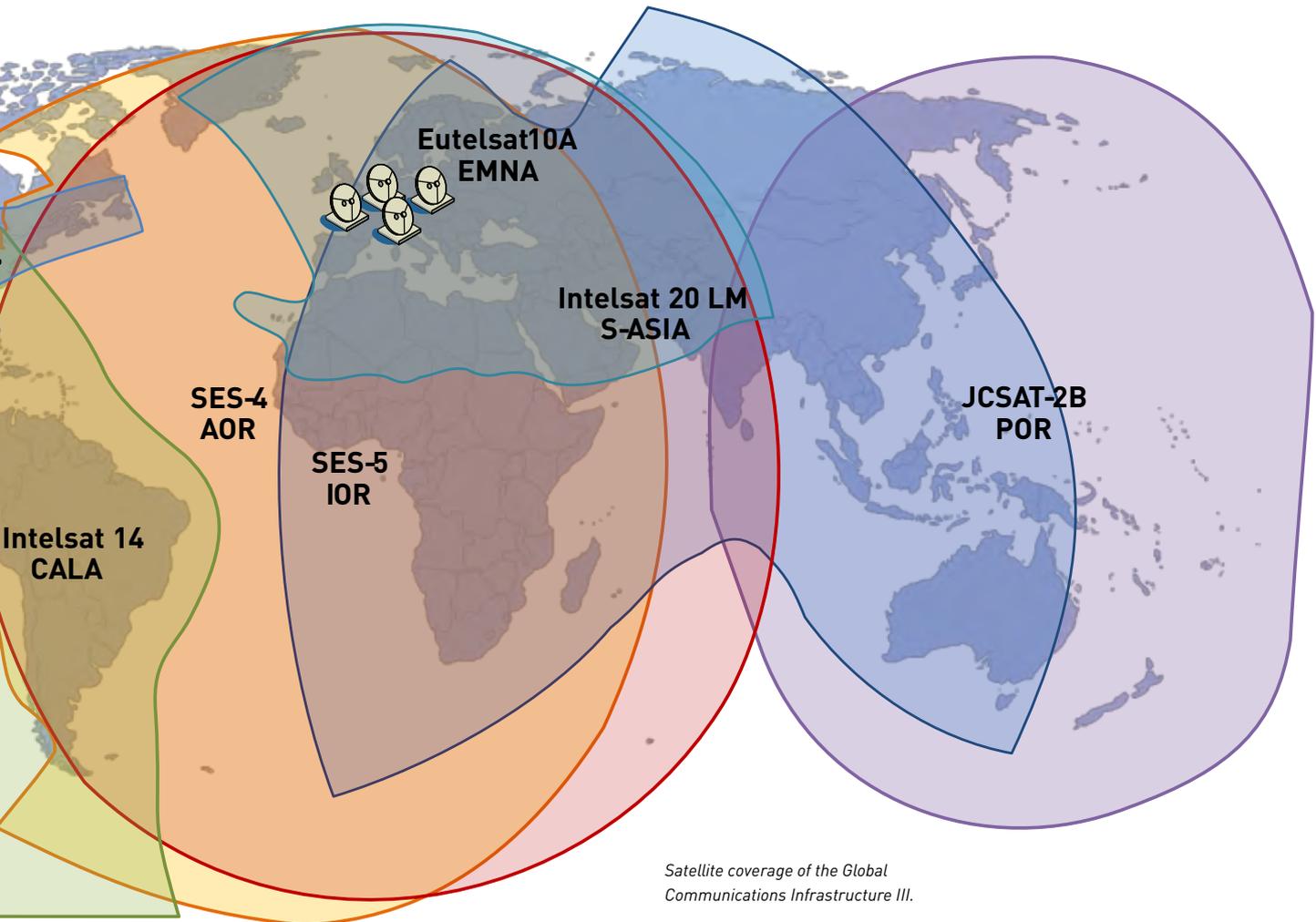
**71**  
INDEPENDENT  
SUBNETWORK LINKS

## OPERATIONS

MORE THAN  
**99%**  
 GCI III AVAILABILITY

The Commission measures the compliance of the GCI contractor against the operational target of 99.5% availability in 1 year using a rolling 12-month availability figure. In 2022, the absolute availability was 95.21%. The adjusted availability for GCI III was 99.98%.

The figure of 36 gigabytes data per day is calculated from GCI III monitoring systems on the basis of filtering all traffic to the receivers in the IDC by port and protocol used for the transmission of GCI data and products. It specifically excludes network management overhead and use of GCI links to transfer data directly between stations and NDCs.



Satellite coverage of the Global Communications Infrastructure III.

# U.S.

## THE INTERNATIONAL DATA CENTRE

### HIGHLIGHTS

Two simulation exercises on exceptional events were performed, resulting in an update to the relevant standard operating procedure (SOP)

IMS seismic, hydroacoustic and, for the first time, all 53 infrasound stations registered signals to a single event: the eruption of the Hunga Tonga–Hunga Ha’apai volcano

The National Data Centres for All (NDCs4All) initiative, which was launched by the Executive Secretary to ensure the benefits of the verification data are more equitably distributed among States Signatories, was met with great enthusiasm. Tangible progress was made in its first six months

The IDC operates the IMS and the GCI. It collects, processes, analyses and reports on the data received from IMS stations and radionuclide laboratories and then makes the data and IDC products available to States Signatories for their assessment. In addition, the IDC provides technical services and support to States Signatories.

The Commission has created full computer network redundancy at the IDC to ensure a high level of availability of its resources. A mass storage system provides archiving capacity for all verification data, which now cover approximately 22 years. Most of the software used in operating the IDC has been developed specifically for the Treaty verification regime.

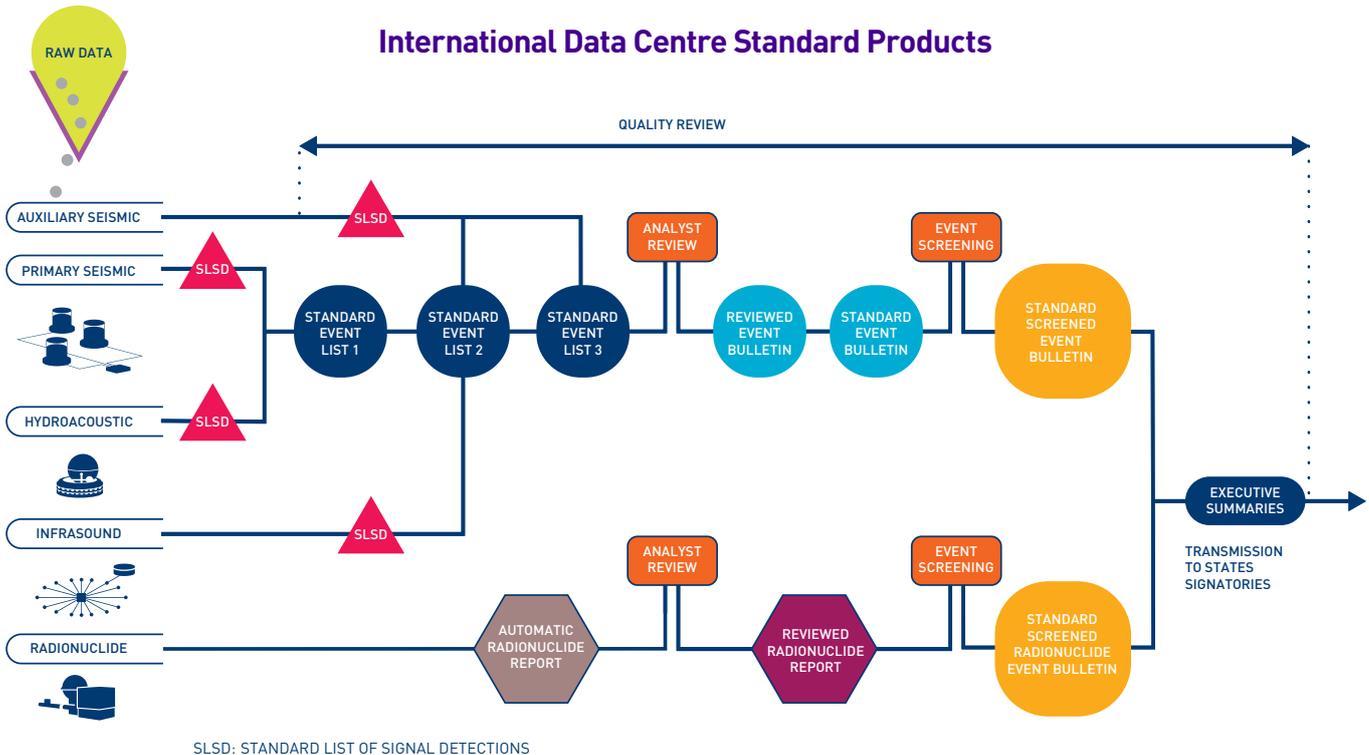
# OPERATIONS: FROM RAW DATA TO FINAL PRODUCTS

## *Seismic, Hydroacoustic and Infrasound Events*

The IDC processes the data collected by the IMS as soon as they reach Vienna. The first data product, known as Standard Event List 1 (SEL1), is an automated waveform data report that lists preliminary waveform events recorded by the primary seismic and hydroacoustic stations. It is completed within one hour of the data being recorded at the station.

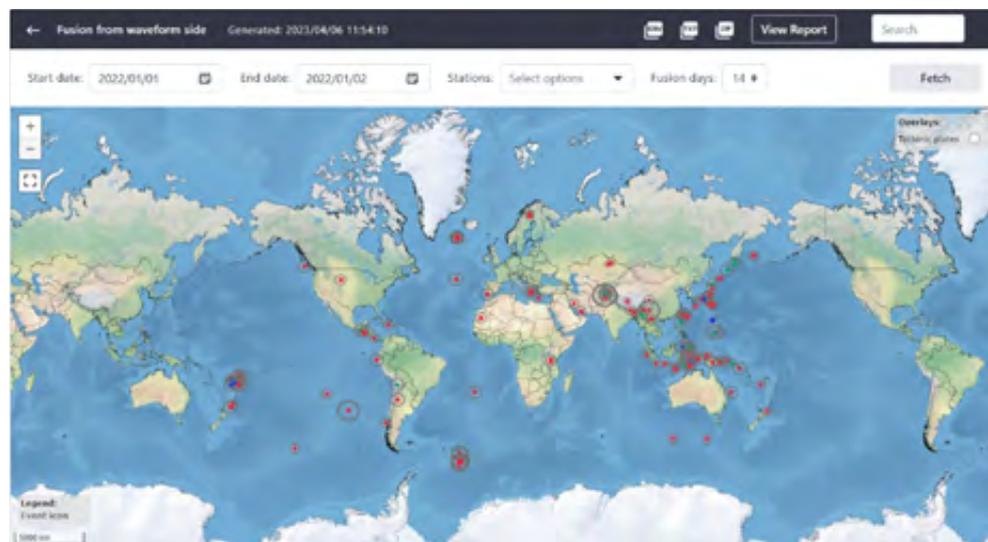
The IDC issues a more complete waveform event list, Standard Event List 2 (SEL2), four hours after first recording the data. SEL2 uses additional data requested from the auxiliary seismic stations along with data from the infrasound stations and any other waveform data that arrive late. After a further two hours have elapsed, the IDC produces the final, improved automated waveform event list, Standard Event List 3 (SEL3), which incorporates any additional late arriving waveform data. All of these automated products are produced according to the schedules that will be required when the Treaty enters into force.

### International Data Centre Standard Products



IDC analysts subsequently review the waveform events recorded in SEL3 and correct the automated results, adding missed events as appropriate to generate the daily Reviewed Event Bulletin (REB), aided by automatic scanning tools. The REB for a given day contains all waveform events that meet the required criteria. During the current provisional operating mode of the IDC, the REB is targeted to be issued within 10 days. After the Treaty enters into force, the REB will be released within two days.

An automatic stage of processing takes place after analyst review where additional characterization parameters are computed for REB events specifically to allow screening of natural events via a few screening criteria on these parameters. This results in the building of the Standard Event Bulletin which includes the characterization parameters and the Screened Standard Event Bulletin, a subset of the Standard Event Bulletin retaining events not screened out.



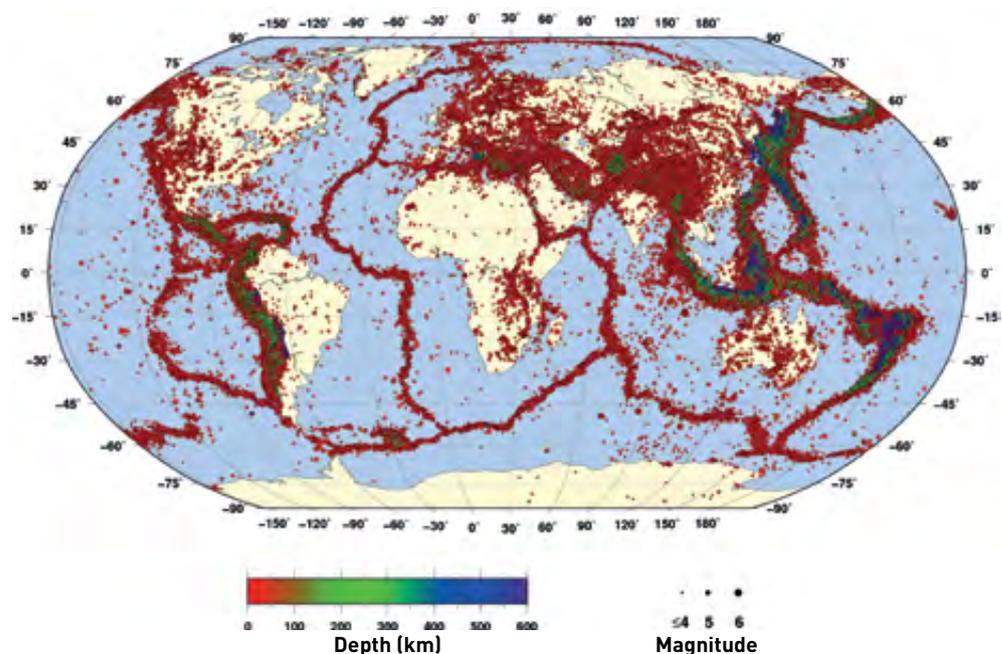
Screenshot of the waveform fusion feature of the secure web portal for 1 January 2022. Implementation of a concept of data fusion between Standard Event Bulletin waveform events and radionuclide samples. A waveform event is connected to a radionuclide sample if it overlaps with the relevant field of regard. In this presentation waveform events up to 14/60 days older than a radionuclide sample are considered.

## Radionuclide Measurements and Atmospheric Modelling

Spectra recorded by particulate and noble gas monitoring systems at IMS radionuclide stations typically arrive several days later than the signals from the same events recorded by the waveform stations. The radionuclide data are automatically processed to produce an Automatic Radionuclide Report within the schedules required after entry into force of the Treaty. After review by an analyst under the schedules for provisional operation, the IDC issues a Reviewed Radionuclide Report for each full spectrum received.

## 2000-2022 Reviewed Event Bulletin

# 741 563 EVENTS



The Commission performs daily atmospheric backtracking calculations for each of the IMS radionuclide stations with near real time meteorological data obtained from the European Centre for Medium-Range Weather Forecasts (ECMWF) and from the National Centres for Environmental Prediction. Images generated from calculations based on ECMWF data are appended to each Reviewed Radionuclide Report. Using software developed by the Commission, States Signatories can combine calculations from ECMWF and National Centres for Environmental Prediction with radionuclide detection scenarios and nuclide specific parameters to define regions in which sources of radionuclides may be located.

To corroborate the backtracking calculations, the Commission collaborates with the World Meteorological Organization through a joint response system. This system enables the Commission to send requests for assistance in the case of suspicious radionuclide detections to 10 regional specialized meteorological centres or national meteorological centres of the World Meteorological Organization located around the

world. In response, the centres aim to submit their computations to the Commission within 24 hours.

### *Distribution to States Signatories*

After these data products have been generated, they must be distributed in a timely way to States Signatories. The IDC provides subscription and Internet based access to a variety of products, ranging from near real time data streams to event bulletins and from gamma ray spectra to atmospheric dispersion models.

### *Further Development of the Integrated CTBTO Operations Centre*

Since the establishment of the integrated CTBTO Operations Centre (COPC), the facility has gradually become the central IMS performance monitoring and control hub, where preventive, condition based, planned and corrective maintenance is coordinated. As part of the PTS strategy regarding unforeseen operational situations and exceptional events, the COPC business continuity allows for mission critical O&M functions to be carried out when required.

The integrated COPC has also evidenced its important role in PTS outreach activities, by providing a high-tech graphical display of the complex technology engines employed for treaty verification. In 2022, numerous delegations from technical, scientific and diplomatic backgrounds were briefed in the COPC operations room on CTBT verification techniques, capacity building activities and civil and scientific use of PTS data through virtual Data Exploitation Centre access.

### *Services*

An NDC is an organization in a State Signatory that has technical expertise in the Treaty verification technologies and has been designated by the national authority of the State. Its functions may include receiving data and products from the IDC, processing data from the IMS and elsewhere, and providing technical advice to the national authority.

## BUILD-UP AND ENHANCEMENT

### *International Data Centre Commissioning*

The mandate of the IDC is provisional operation and testing of the system in preparation for operation after entry into force. The IDC Progressive Commissioning Plan provides milestones that mark progress in this endeavour and control mechanisms, including:

- The Progressive Commissioning Plan itself;
- Draft Operational Manuals, which set requirements;
- The validation and acceptance test plan (VATP);
- A review mechanism, which allows States Signatories to determine if their verification requirements can be met by the system.

Build-up, continuous enhancement, performance monitoring and testing of the IDC are essential to its commissioning. The activities of the Commission in this respect are guided by a framework for monitoring and testing performance that has been developed by the PTS.

The IDC continued to address the recommendations that were made in the evaluation reports of the first four experiments compiled by the Quality Management and Performance Monitoring (QMPPM) Section.

The Commission also continued drafting the VATP that will be used in phase 6 of IDC progressive commissioning. The activities in this area continue to involve technical meetings, interaction on the Experts Communication System (ECS) and discussions during sessions of Working Group B (WGB). Specifically, during 2022, the PTS conducted a technical meeting on the next revision of the draft VATP and discussed the assessment report on the first cycle of four experiments. In addition, participants were shown the newly developed Test Implementation Plans (TIPs) and the plans for the 2023 experiment. During the 2022 NDC workshop information was shared on the plans of the 2023 experiment, a demonstration of how the TIPs will be utilized throughout was provided and NDCs provided their comments on how they can be involved in future progressive commissioning experiments.

## Security Improvements

The Commission continued to identify and address risks to its operational environment and to strengthen security controls on information technology. Measures to safeguard information technology assets, including mitigating risks of malware attacks, were taken. New vulnerability assessment and penetration test solutions were tested and are in progress of being introduced to the Information Security Steering Committee for production roll-out. The Commission continued to make progress in security governance. The certification and accreditation process was improved and it was submitted to the Information Security Steering Committee for clearance and roll-out. The PTS information security policies and manual were revisited and reviewed by a joint working group of focal points and are currently undergoing the last phases of senior management review prior to deployment. The internal Administrative Directive on Information Security and its three related annexes (Policy, Manual and Baseline Security Requirements, respectively) were cleared in November 2022 and promulgated on 29 November 2022. The certification and accreditation process was cleared by the Information Security Steering Committee.

*The Commission improved on cyber awareness services delivered to PTS staff.*

To ensure an effective information security programme, the Commission improved on cyber awareness services delivered to PTS staff, in close cooperation with the United Nations International Computing Centre. The programme focuses on the key tenets of information security: protection of confidentiality, integrity and availability of information assets. The programme successfully ensures a high security posture of PTS staff and information assets. The programme is well received by PTS staff and metrics show high levels of completion and low levels of successful phishing.

The Commission continued to ensure high available rates of PKI services.

## Software Enhancements

Radionuclide software development efforts focused on moving toward open source, comprehensive software that will meet the needs of the future and be used both in IDC operations and NDCs. Software efforts are underway to improve capacities at several processing stages. Beginning with station data handling, the new automatic Software Tool for RADionuclide Data Analysis (autoSTRADA) is intended for the automatic processing of data from both IMS particulates stations and noble gas

systems. AutoSTRADA is a python language based, license-free application using shared libraries with the iNtegrated Software Platform for the Interactive Review (iNSPIRE). The initial release of autoSTRADA which handles data from beta-gamma coincidence based noble gas systems, including next generation technologies (SAUNA III, SPALAX, Xenon International and MIKS), has been used in the IDC operations since August 2021.

With the aim of replacing the current license-based code Virtual Gamma Spectroscopy Laboratory, the IDC initiated the development of a new, open source, Monte Carlo based simulation toolkit for detector systems (Geant4-based RAdioNuclide Detector Simulation (GRANDSim)). The new tool will cover high purity germanium (HPGe) and beta-gamma coincidence-based detection systems in use at IMS stations, including upcoming noble gas technologies making use of high resolution detectors. The software design includes a wide range of new features for more automated use in IDC

*A new version of RN Toolkit extending the functionalities to two key natural radionuclides ( $^7\text{Be}$  and  $^{212}\text{Pb}$ ) was released to NDC authorized users in September 2022.*

operations. A first version of GRANDSim with the functionality for particulates was released in the IDC and made available to NDCs in February 2022. Additional enhancements were implemented in the development environment over 2022. This includes (a) multithreading run which further boosts the software performance, (b) a new feature for batch mode simulation of the isotope response function and (c) an option for adding new radionuclides to the GRANDSim database.

iNSPIRE is a software application that was developed by the IDC, based on modern Python/Qt framework. A first release, which covers beta-gamma coincidence-based detection systems in use at IMS stations, was deployed in IDC operations and delivered to NDCs in late 2020. The first release covers current and next generation noble gas technologies.

Over 2021-2022, the IDC had developed phase 2 of the iNSPIRE project by extending the software functionalities to IMS particulate and HPGe SPALAX based noble gas systems, with the aim of completing the migration to open source and unifying the radionuclide analysis software tools for particulates and noble gas data at the IDC and in the NDC in a box package.

With the aim of further empowering NDCs, the IDC developed a novel Web based application, dubbed RN Toolkit. RN Toolkit offers several options that the user can customize for accommodating specific needs for in-depth spatial-temporal analysis of anthropogenic activity concentrations in radionuclide samples, at both the

particulate stations and the noble gas systems of the IMS, that might be released into the air by a nuclear test. A new version of RN Toolkit extending the functionalities to two key natural radionuclides ( $^7\text{Be}$  and  $^{212}\text{Pb}$ ) was released to NDC authorized users in September 2022, under the CTBTO single sign-on portal.

The implementation phase of the IDC SHI re-engineering project, which began in 2019, is progressing. The aim is to achieve a modern, maintainable, open source SHI processing system based on the deliveries of the Geophysical Monitoring System by the NDC in the United States of America. In 2022, the focus was on the development of a station SOH monitoring system which, when ready, will replace the current SOH system, which is old and difficult to maintain. The future system is developed using the SOH system from the Geophysical Monitoring System deliveries as a baseline, then adding the capabilities required to fit the SOH monitoring requirements of the Commission. Progress was made in the establishment of requirements to run Kubernetes applications in a private cloud environment. Additional software components from the Geophysical Monitoring System deliveries, such as the initial capabilities for the interactive analyst interface and the Oracle data bridge, are being evaluated. A new version of threshold monitoring, delivered by the Norwegian NDC, started being integrated as a prototype and tested by the IDC.

The re-engineering alpha testers group invites States Signatories and NDCs to support, assess and validate the progress of the IDC re-engineering project in a low barrier way. It is funded by the EU. The third alpha testers group took place in July 2022. The next session is planned for September 2023, with an in-person kick-off meeting in Vienna.

The PTS continued to develop advanced automatic and interactive software that uses state of the art machine learning and artificial intelligence techniques. This includes NET-VISA, a Bayesian approach to network processing of SHI data. An interactive module was developed and provides analysts with NET-VISA events upon demand in addition to the SEL3 automatic bulletin generated by the legacy system, global association. This functionality has been available to all analysts since 1 January 2018. Analysis of the provenance of the REB events shows that about 10% originate from NET-VISA, as expected from previous tests. A testing environment for a real time processing that reproduces the operational environment was built on a virtual machine. This environment includes the analyst review, and a special workstation was also set up. A 24-hour dataset was reviewed by a lead analyst who identified that the NET-VISA based Late Event Bulletin (LEB) includes 10% more events than that of the operational LEB, namely the Global Associator based LEB, although the

**10%**  
**OF REB EVENTS**  
**ORIGINATE FROM**  
**NET-VISA**

current operational LEB includes the NET-VISA origin seed events. This gives rise to expectations that the NET-VISA based full pipeline provides more accurate bulletins even after analyst review. To provide further evidence of the above expectation, a larger test that involves analyst review should be performed. Besides the test planning, additional features such as event definition criteria were implemented toward operational use.

The IDC continued meticulous testing of the updated set of source specific travel time corrections for IMS seismological network stations. This set of corrections includes corrections for the most recent stations for which corrections had not been available previously. It is based on the most recent version of the regional seismic travel time (RSTT) velocity model and the corrections are accompanied by corresponding uncertainties. Testing will continue in 2023.

Beam detection thresholds that maximize the automatic detections' association rate while keeping the miss rate below 20% were estimated using genetic algorithm. The method and results were presented at the American Geophysical Union international conference in December 2022 and feedback received is taken into account to compile the final report.

*Several releases of DTK-PMCC and DTK-(G)PMCC were released in 2022.*

Further development, testing and comparison with the REB and SEL3 of the prototype routine XSEL and Spot Check software, as based on waveform cross-correlation and using historical REB events as master events, has resulted in the quality improvement of the XSEL solutions and higher rate of match (P-arrivals at two stations) with the man-made REB (80-85%) and automatic SEL3 bulletins (~60%). The interactive Spot Check Tool was improved with new control parameters and flexible mapping/bulletin review for the front-end graphical user interface. The back-end Spot Check processing is enhanced with several algorithms for detection and local association/conflict resolution. In 2022, the XSEL routine processing has recovered numerous small events near the site of explosions in the Democratic People's Republic of Korea.

The Generalized F Detector is a signal detector for seismic array stations which uses prior station noise and signal information to optimize signal detection. It does this determining the weights of the individual array elements that form the beam with the highest signal to noise ratio. In order to assess the Generalized F Detector,

the IDC has released lists of detections on the secure web portal (SWP) for States Signatories experts to perform independent evaluations. These detections were made using a version of the Generalized F Detector appropriately modified so as to be integrated in the IDC pipeline.

The redesigned station processing and interactive review software, respectively DTK-PMCC and DTK-(G)PMCC, were introduced to IDC operations for infrasound technology on 1 July 2022. The milestone concludes the multiyear development effort to replace the legacy infrasound system in place since early 2010 with a modern, modular and improved suite of tools to enhance IDC analysis. This achievement was made possible thanks to the funding provided by the EU and the collaboration with the French Alternative Energies and Atomic Energy Commission, which developed the method. The IDC focused its multiyear effort on the development of software both for the IDC and for NDC users. The tools have been used in training for authorized

*The IDC focused its multiyear effort on the development of software both for the IDC and for NDC users.*

users since 2017, while they also continued to be prepared to reach the requirements for the IDC operational system. With its partner, the IDC maintains the software and also continues to develop new functionalities that are being released on a regular basis to IDC analysts in the IDC environment and to NDC users via NDC in a box. Several releases of DTK-PMCC and DTK-(G)PMCC were released in 2022. In addition to its use for infrasound technology both at the IDC and by multiple NDCs, the toolkit is also largely used by NDC users and PTS users for processing data from IMS hydrophone stations and analysing signals of interest from underwater sources as it

was demonstrated at the International Hydroacoustic Workshop 2022.

The IDC, also under EU funding, launched the project to upgrade the atmospheric transport modelling (ATM) pipeline by including the upgraded version of the Lagrangian particle dispersion model FLEXPART. Within the reporting period, the FLEXPART-CTBTO version was updated with the newest scientific enhancements implemented in the community version FLEXPART v10. The work on further acceleration of ATM simulations, by using graphics processing units, was initiated. These changes will provide computational performance gains and more reliable and robust processing.

In February 2021 the IDC initiated two successive projects funded by the EU. The first project, dubbed XeBET Evaluation Tool, aimed at generating a validation data set and a software system to evaluate xenon background estimators. During this project, a

*The user interface  
of WEB-GRAPE  
Internet based  
service was  
modernized.*

test data set was prepared with input from internationally recognized experts from the radionuclide/ATM community, consisting of real IMS observations with additional contributions from hypothetical nuclear test releases. A set of validation metrics was defined to measure the performance of background estimation to generate the best screening results with regard to the objective of identifying nuclear test signals in the second project. The second project, titled 1st Nuclear Explosion Signal Screening Open Inter-Comparison Exercise 2021, aimed at conducting an exercise to identify the best approach for a new method to estimate the xenon background concentration. Within the reporting period, the first project successfully ended on 28 February 2022. The second project subsequently launched and successfully ended on 10 December 2022. The results are described in the final report and will be presented at the CTBT: Science and Technology conference (SnT2023).

The work to enhance the WEB-GRAPE Internet based service is progressing according to schedule. The current version 3.1.4, available in production since October 2022, includes the following functional enhancements:

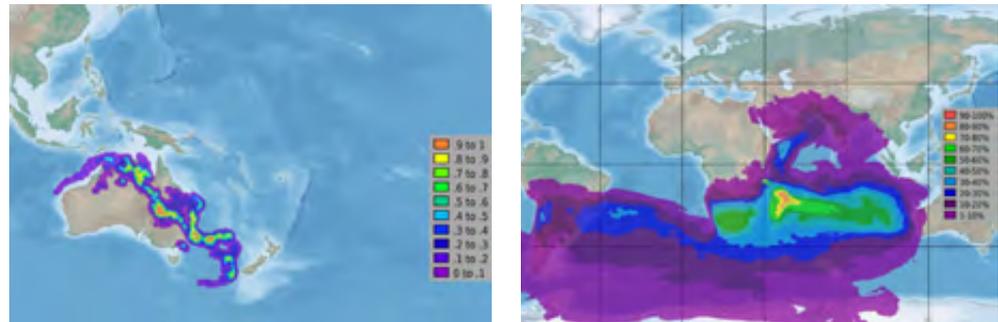
- The network coverage functionality was enhanced by taking into account the status of the radionuclide and noble gas stations (in or out of operations) and to calculate the network coverage for the actually operating stations only;
- The possible source region functionality was enhanced by adding the additional option of calculation based on the Spearman's rank correlation coefficient;
- The multiple model possible source region) functionality was added.

Furthermore, the user interface of WEB-GRAPE Internet based service was modernized and several stability and performance improvements were implemented.

### *NDC in a box*

A new NDC in a box radionuclide software package version 6 on CentOS 7 was released in February 2022 to NDC authorized users. The major highlight of the release is the integration, for the first time, of the novel IDC open source software dubbed GRANDSim. The first version of GRANDSim contains the functionality for particulates and covers both coaxial HPGe and planar detectors. Sample measurement geometries and shielding configurations of the three technologies (manual, radionuclide aerosol sampler and

An upgrade to WEB-GRAPE Internet based service includes enhancement of possible source region functionality (left image) and network coverage functionality (right image).



analyser and Cinderella) that are operated at IMS particulate stations are all handled. The software simulates efficiency calibration, isotopic response function along with coincidence summing correction factors for natural and anthropogenic radionuclides of interest. The physical model is automatically optimized by constraining simulation results against experimental calibration for non-summing energies. Simulated entities are used as support parameters in the automatic processing of daily spectra from IMS for:

- Improving the quality of efficiency calibration (by including coincidence summing corrections).
- Enhancing the nuclide identification results (by including summation peaks) which reduces the workload on analysts in interactive mode.
- Ensuring reliable activity concentration results by including required coincidence summing corrections when applicable.
- In addition, GRANDSim simulates gamma spectra for mixtures of radionuclides with any activity concentrations. The output is generated in IMS 2.0 format which allows further analysis.

Two options are available to end users for installing the new radionuclide software package: NDC in a box virtual machine; or installation from the IDC repository using the Yellowdog Updater, Modified package management tool.

For NDC in a box SHI, a new major version of Geotool, GeotoolQT, was released in October 2022 and discussed at the NDC workshop. GeotoolQT has a modern user interface, provides new data import functions from the Verification Data Messaging System and International Federation of Digital Seismograph Networks web services for non-IMS

stations, and comes with Python scripting capabilities. The old Motif based version of Geotool will remain part of NDC in a box until all NDCs have migrated to the new version.

Upgrades of SHI components of the NDC in a box software package, including SeisComP3 and DTK-(G)PMCC, were released throughout 2022. The NDC in a box version of SeisComP3 was enhanced with a new module that synchronizes the SeisComP3 archive with the NDC in a box database. As SeisComP3 has reached the end of support, NDC in a box will migrate to SeisComP version 5. The work related to the upgrade to SeisComP version 5 was completed and NDCs will be invited to perform alpha testing once internal quality assurance activities have been finished.

The Seedlink service, providing near real time waveform data for primary SHI stations to GCI connected NDCs, continued operations with three additional NDCs receiving data from the service. Implementation of International Federation of Digital Seismograph Networks web services compliant access to IMS data and IDC products was completed and GCI connected NDCs will be invited to perform alpha testing once internal quality assurance activities have been concluded.

### *International Noble Gas Experiment and Atmospheric Radioxenon Background*

The 28 IMS noble gas systems that are in provisional operation at IMS radionuclide stations continued to send data to the IDC in 2022. The noble gas system at Nouakchott, Mauritania, was certified in April 2022. Data from the 26 certified systems are processed in IDC operations, while data from the remaining 2 non-certified systems were processed in the IDC test bed. The Commission made significant efforts to ensure a high level of data availability for all systems through preventive and corrective maintenance and regular interaction with station operators and system manufacturers.

*The Commission made significant efforts to ensure a high level of data availability for all systems.*

Although the background levels of radioxenon are currently measured at 28 locations as part of the International Noble Gas Experiment, they are still not understood in all cases. A good understanding of the noble gas background is crucial for the identification of potential indications of a nuclear explosion.

*In 2022, the Commission continued operating two transportable noble gas systems in Horonobe and Mutsu, Japan.*

An initiative funded by the EU to improve understanding of the global radioxenon background, which started in December 2008, continued in 2022 with EU funding. The objective of this project is to characterize the global radionuclide background and to provide empirical data for validating the calibration and performance of the IMS verification system. In 2022, the Commission continued operating two transportable noble gas systems in Horonobe and Mutsu, Japan. The Commission plans to use the results from this campaign to develop and validate enhanced methods to better identify the source of events that cause the frequent radioxenon detections at radionuclide station RN38 in Takasaki, Japan. These methods will be applied to all IMS stations in order to enhance the capabilities to identify a radioxenon signal that might indicate a nuclear test. A third transportable noble gas system refurbished in 2019 was ready to be deployed to a new site in Fukuoka, Japan, but its deployment is currently kept on hold due to various reasons. All collected data are made available, together with analysis results, to the scientific community for scientific studies, significantly extending the scientific potential of the measurement campaign by reaching out to a large, worldwide, audience.

## CIVIL AND SCIENTIFIC APPLICATIONS OF THE VERIFICATION REGIME

**20**  
**AGREEMENTS WITH**  
**TSUNAMI WARNING**  
**ORGANIZATIONS TO**  
**PROVIDE CONTINUOUS**  
**IMS DATA**

In November 2006, the Commission agreed to provide continuous IMS data in near real time to recognized tsunami warning organizations. The Commission subsequently entered into agreements or arrangements with a number of tsunami warning centres approved by the United Nations Educational, Scientific and Cultural Organization to provide data for tsunami warning purposes. By the end of 2022, 20 such agreements or arrangements had been made to provide data to organizations in Australia, Chile, France, Greece, Honduras, Indonesia, Italy, Japan, Madagascar, Malaysia, Myanmar, the Philippines, Portugal, the Republic of Korea, the Russian Federation, Spain, Thailand, Türkiye and the United States of America.

IMS infrasound data and IDC products can provide valuable information on a global scale regarding bodies entering the atmosphere. The Commission pursues its collaboration with the University of Oldenburg in Germany with the involvement of

the Federal Institute for Geosciences and Natural Resources (the German NDC) on a near real time monitoring system for atmospheric impacts from small near-earth objects, with the involvement of the United Nations Office for Outer Space Affairs and its partners. The PTS participated in the workshop on near-earth object imminent impactors warning coordination, co-organized by the EU and the European Space Agency in December 2022 in Darmstadt, Germany.

Real time detection of a volcanic eruption can help reduce the air traffic hazard of ash clouds clogging jet engines. Eruptions around the world are recorded by IMS infrasound stations and reported in IDC products. It is now established that information obtained by infrasound technology is also useful to the civil aviation community. The

*Eruptions around the world are recorded by IMS infrasound stations and reported in IDC products.*

Commission continues its collaboration with the Volcanic Ash Advisory Centre in Toulouse, France, the World Meteorological Organization and the International Civil Aviation Organization. The Hunga Tonga–Hunga Ha’apai volcano in Tonga erupted dramatically on 15 January 2022 after years of regular and weak activity. This eruption is the largest of the twenty-first century and it was extensively recorded by IMS SHI stations,

and in particular by all 53 certified infrasound stations making it a unique event for the PTS. The eruption sequence has received a lot of attention from the general public and there are already several scientific publications with study utilizing IMS data, such as a publication in the journal Science.

The Commission contributes to radiological and nuclear emergency response in the framework of its membership in the Inter-Agency Committee on Radiological and Nuclear Emergencies. In 2022, the Commission participated in the ConvEx exercises and contributed to the evaluation report on the 36-hour international emergency exercise ConvEx-3 (2021) in which 77 countries and 11 other international organizations participated.

The range of scientific applications of IMS data is increasing, including to studies of marine life, the environment, climate change and other areas. Several new contracts for cost-free access to specific IMS data through the virtual Data Exploitation Centre were signed with academic institutions.

Following the 15 January 2022 event, and for the first time in the history of the PTS, signals were recorded by all 53 operational infrasound stations. Atmospheric waves travelled in the atmosphere over long distances and circled the globe up to at least four times. The Hunga Tonga–Hunga Ha’apai eruption is the most energetic event

*The Hunga Tonga–Hunga Ha’apai eruption is the most energetic event recorded by the infrasound component of the IMS.*

recorded by the infrasound component of the IMS. The volcano produced another large event recorded approximately four hours later, at 8:31 UTC, by both infrasonic and hydroacoustic components of the IMS. The examination of broadband seismic station recordings in the very low frequencies established that the Hunga Tonga–Hunga Ha’apai eruption triggered the type of long period free oscillations of the Earth that are characteristic of energetic sources located in the atmosphere. Hydroacoustic data from T phase and hydrophone stations across the Pacific Ocean highlighted high energy peaks of a continuum of relatively low frequency arrivals, or rumbling. A rare phenomenon of early arrival of a tsunami wave was also observed globally by the IMS in seismic and infrasound recordings. This tsunami is associated with an air wave propagating at the interface between atmosphere and ocean. The passage of the main tsunami generated by this event was also recorded at IMS hydroacoustic hydrophone stations in the Pacific, Indian and Atlantic Oceans with a signal lasting several days. In the context of the future verification of the Treaty, this event provides a prominent milestone for studying global infrasound propagation and for calibrating the performance of the IMS network.

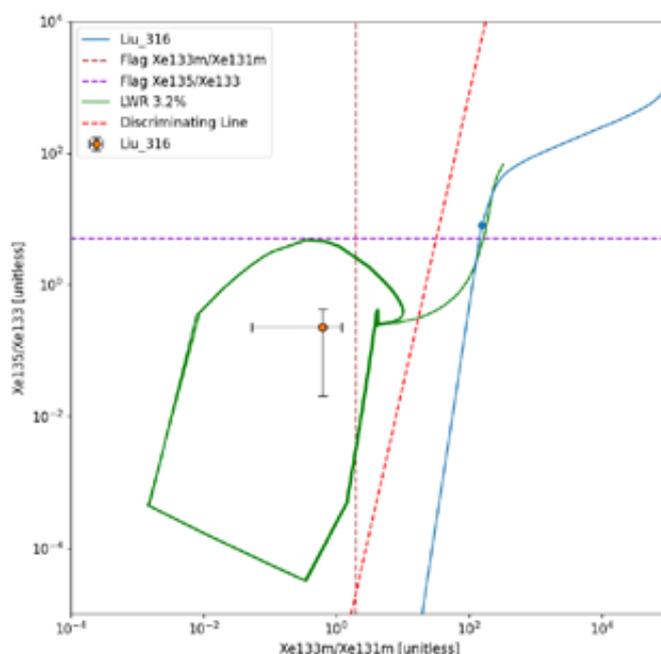
## ENHANCED HYDROACOUSTIC AND SEISMIC WAVEFORM MODELLING

The effort on the optimum seismoacoustic transfer function computations to estimate virtual sensor signals at IMS hydroacoustic stations project was concluded in February 2022 with the compilation of a final report. The objective of this project was to establish and validate an inversion framework based on the hybrid seismoacoustic propagation model specified in a previous project that allowed the estimation of a virtual signal (at a virtual hydrophone) from a physical one (recorded at a T phase station). The project outcome verified the complexity of the signal (arising mainly from the complexity of the recorded T phases) and although the inversion was successful, the expected benefit of such an inversion does not justify the effort and resources required to incorporate it in the operational IDC pipeline.

Work continues on developing a suite of acoustic models that accurately handle 3-D propagation effects and demonstrate that they can be used to improve the operator workflow and localization capabilities of the hydroacoustic network.

## DEVELOPMENT OF SPECIAL STUDIES AND EXPERT TECHNICAL ANALYSIS CAPABILITIES

Work continued in both gaining capabilities and clarifying procedures and processes for executing special studies and expert technical analysis (ETA). In October 2022 SHI and radionuclide experts joined in online meetings to present the latest research developments and discuss the practical aspects of executing a special study or ETA under the requirements laid out in the operational manual. Together the experts also continued developing a list of suitable methods, gave their feedback on the draft SOPs and the draft template for the State Requested Methods Report. Progress was made in developing the methods for ETA, creating Updated Radionuclide Report capabilities in IDC operations and implementing the Updated Event Bulletin on the test bed. In addition, the PTS created the Updated Event Bulletin schema and database tables to assist special studies analysis of seismoacoustic events.



Screenshot of a "Four Xenon" plot from the pre-release version of the expert technical analysis radionuclide tool. Two isotopic ratios are plotted, and a discriminating line used to divide ratio combinations indicative of civil (reactor) sources of xenon (left of line) from those suggestive of a CTBT-relevant event (right of line).

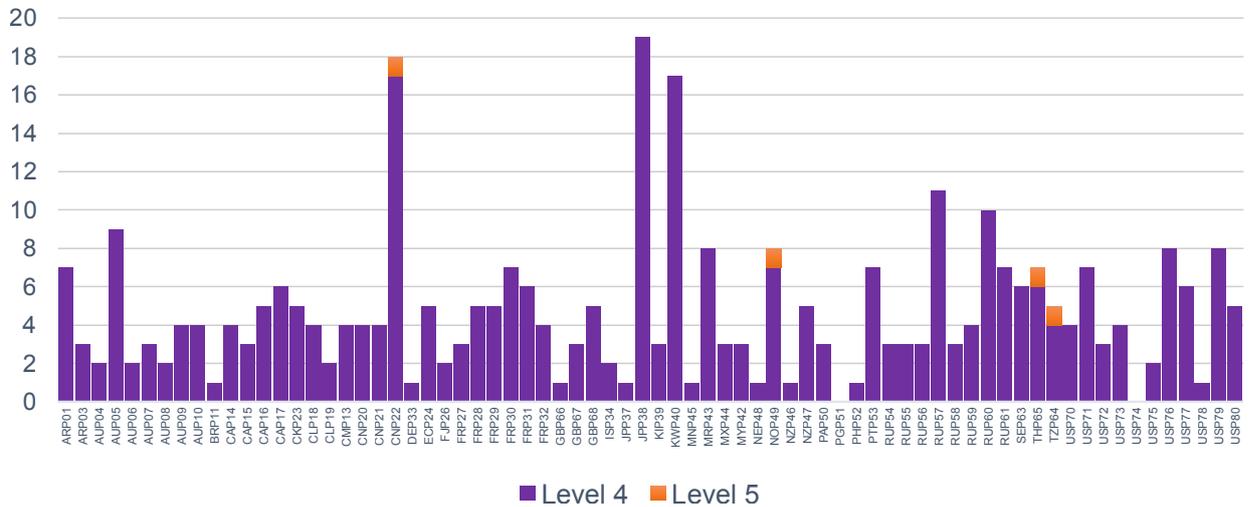
Treaty Relevant Radionuclides Detected in 2022

3739 EVENTS

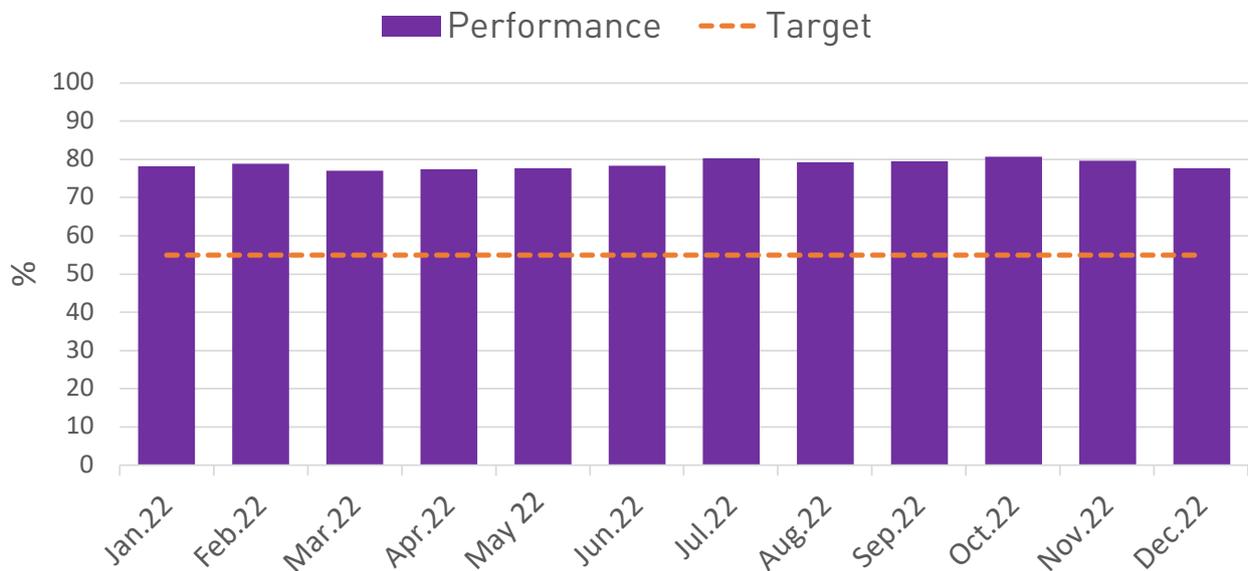


- NA-24(1560)
- CS-137(1468)
- I-131(350)
- CO-60(173)
- CS-134(60)
- TC-99M(56)
- MN-54(19)
- I-133(8)
- ZN-69M(7)
- CO-58(6)
- ZN-65(5)
- FE-59(4)
- RU-106(4)
- CR-51(4)
- CE-144(3)
- NB-95(2)
- ZR-95(2)
- I-130(1)
- SC-46(1)
- PM-149(1)
- IR-192(1)
- PD-112(1)
- K-42(1)
- SB-122(1)
- AS-74(1)

Radionuclide Events Recorded by IMS Particulate Stations in IDC Operations in 2022



### Correctly Categorized Automatically Processed Radionuclide Sample Spectra



## UPDATING DOCUMENTATION OF BASIC IDC ANALYSIS PROCEDURES

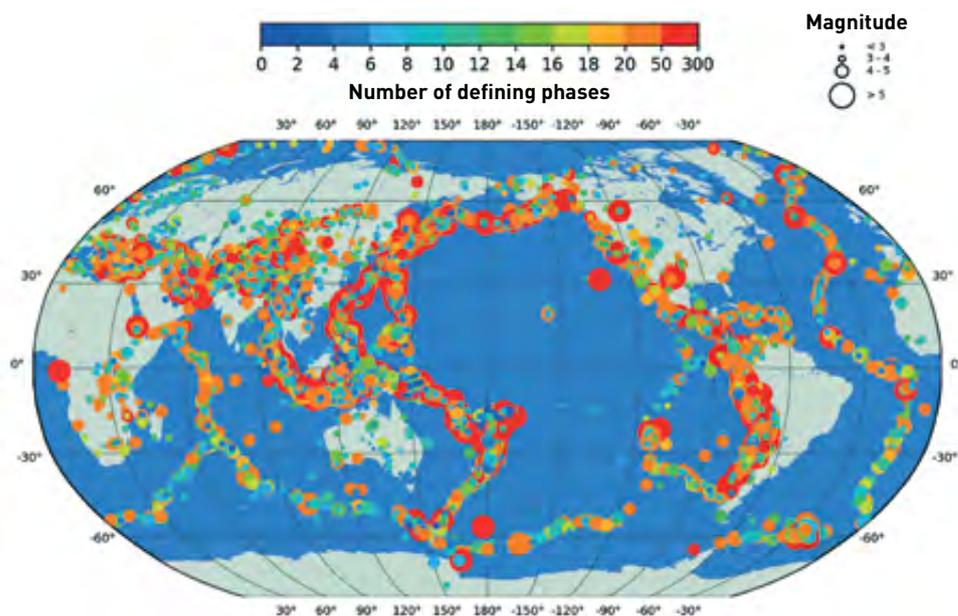
In line with the responsibilities of the IDC set forth in the draft IDC Operational Manual Rev. 7, and particularly the provision of implemented methods and algorithms to all States Parties, efforts were made to update technical documents with transparency about changes. This ensures open and convenient tracking of individual changes in the documents.

Revision 8 of the Formats and Protocols for Messages specification (IDC-ENG-SPC-103) was concluded and made available to authorized users via the SWP. Major changes since the previous revision (Rev.7.3) are: format descriptions of new products

for noble gas (both  $\beta$ - $\gamma$  coincidence and HPGe) Radionuclide Laboratory Reports; plain text formats (in addition to html formats) for the Automatic Radionuclide Reports, Reviewed Radionuclide Reports and Standard Screened Radionuclide Event Bulletin for noble gas samples; updated examples, which are available via the SWP and/or Verification Data Messaging System; addition of glossary, lists of acronyms, abbreviations, listings (message examples and software code), country, station, instrument and certified laboratories.

Revision 3 of the IDC processing of SHI data user guide (IDC/OPS/MAN/001) was concluded and made available to authenticated users via the SWP. Major changes included updates to the maximum likelihood body wave magnitude description, the Ms:mb criterion, source specific station corrections, and amplitude and period measurement to reflect current practice.

## 37419 EVENTS



## CTBT: SCIENCE AND TECHNOLOGY CONFERENCES

The report on the SnT2021 conference was completed and published on the conference portal, which can be accessed via CTBTO's official website. For the first time, the Executive Summary of the report was translated into all official languages of the United Nations. The report summarizes materials presented at the sixth event in the SnT series that took place from 28 June to 2 July 2021. A special issue of the *Pure and Applied Geophysics* journal highlighting presentations made at SnT2021 is under preparation to be published in early 2023, while most papers were already published online in 2022. Building on presentations made on the topic of the 25th anniversary of the CTBT, a compilation of papers on key technical accomplishments of the verification regime in the past 25 years is under preparation.

The SnT2023 preparations started with an online meeting of the Scientific Programme Committee from 30 May to 1 June 2022. The conference goals, themes and topics were updated during the meeting.

The SnT2023 conference brochure was prepared, and the event was announced and broadly advertised to the CTBTO community and beyond. Conference registration continues while abstract submission concluded on 30 November 2022. Over 830 abstracts were submitted and 950 registrations had been received by mid-December 2022. Preparations were progressing at the end of 2022 with a strong focus on the highlight elements of the programme. For the first time, the conference is planned to be held fully in hybrid format. It will take place again in the Hofburg Palace in Vienna, Austria, from 19 to 23 June 2023.



## THE NATIONAL DATA CENTRES FOR ALL INITIATIVE

The Executive Secretary officially presented the NDCs4All initiative during the Fifty-Eighth Session of the Preparatory Commission to enhance and expand the CTBT and its verification regime ownership experience. At the launch of the initiative, 43 States Signatories had not yet designated a Secure Signatory Account (SSA) to communicate with IDC, and eight States Signatories that had an SSA, did not have their NDCs. The initiative focuses on assisting these countries to create their SSAs and/or establish their NDCs, to enable them to use the data collected by the IMS for national purposes,

including civil and scientific applications. Additionally, the initiative is assisting States Signatories, focusing on the least developed countries, landlocked developing countries, and Small Island Developing States to receive a capacity building system (CBS).

*The NDCs4All initiative prioritizes capacity building activities and scales up PTS efforts.*

The NDCs4All initiative prioritizes capacity building activities and scales up PTS efforts in four years, so the PTS will intensify the strategic and proactive outreach to encourage and support States Signatories to establish and nominate their NDC.

As a result of the outreach activities deployed by the task force created to implement the NDCs4All initiative, two States Signatories created their SSA, two States Signatories established their NDCs and 15 States Signatories requested a CBS.

# ON-SITE INSPECTION

## HIGHLIGHTS

Execution of the OSI programme of work for 2022-2023 and the OSI exercise programme for 2022-2025

Review of the first comprehensive draft list of equipment for use during OSIs jointly with experts from States Signatories during OSI Workshop 25

Implementation of the next generation surrogate inspector training programme (the linear training programme)

The IMS and IDC monitor the world for evidence of a nuclear explosion. If such evidence were to be detected, the Treaty provides for concerns about possible non-compliance with the Treaty to be addressed through a consultation and clarification process. After the Treaty enters into force, States can request an OSI, which is the ultimate verification measure under the Treaty.

The purpose of an OSI is to clarify whether a nuclear explosion has been carried out in violation of the Treaty and to gather facts that might assist in identifying any possible violator.

Since any State Party can request an OSI at any time, the capability to conduct such an inspection requires policies and procedures to be established and inspection techniques to be developed and validated before the Treaty enters into force. In addition, OSIs require adequately trained personnel, approved and available inspection equipment, appropriate logistics, field operations support and related infrastructure to sustain a team of up to 40 inspectors in the field for a maximum of 130 days, while enforcing the highest standards of health, safety and confidentiality.

Over the years, the Commission has continuously strengthened its OSI capabilities through the preparation and development of OSI elements, the conduct of field tests and exercises and the evaluation of its OSI activities. With the conclusion of the OSI action plan 2016-2019, the third training cycle and the OSI exercise plan 2016-2020, the Commission has developed the new OSI programme of work for 2022-2023 and the exercise programme for 2022-2025, with 2022 being the first year of their execution.

## PROGRAMME OF WORK FOR 2022-2023

The OSI Division programme of work for 2022-2023 (CTBT/PTS/INF.1612) was published in January 2022 in response to the cancellation of OSI build-up exercises due to the COVID-19 pandemic in order to provide structure and transparency regarding the expected work of the OSI Division in the short term. It includes activities over the course of 2022 and 2023 aimed at supporting the further development of OSI capabilities towards the establishment of a balanced, coherent and robust verification regime at entry into force.

The programme of work was elaborated in coordination with the OSI exercise programme for 2022-2025. The implementation of the programme of work should remain flexible in light of changing circumstances in uncertain times. The OSI Division has nevertheless largely commenced, and is continuing to execute, activities in line with the proposed schedule.

## POLICY PLANNING AND OPERATIONS

OSI policy planning and operations efforts during 2022 were predominately focused on implementation of relevant activities outlined in the programme of work for 2022-2023 and of designing, publishing and subsequently executing the initial activities in the OSI exercise programme for 2022-2025.

As a follow up to the Technical Report on the Operationalization of OSI in Different Environments, the OSI Division organized an expert meeting on OSIs in mountainous environments in May 2022 at the CTBTO TeST Centre. Thirty-five experts from States Signatories, the Organization for the Prohibition of Chemical Weapons and the PTS participated in the event. The event generated recommendations for improving capability to successfully conduct OSIs in mountainous environments and discussed and recorded observations on concrete challenges that the inspection team would face in conducting an OSI in mountainous areas via a tabletop exercise scenario. The report for the event was published in Information Paper CTBT/PTS/INF.1631.

The development of Geospatial Information Management for OSI (GIMO) continued throughout the year with focus mostly on the field laboratory applications, data and metadata flow between individual applications and on data processing at the inspection team working area. The OSI Division conducted two operational tests, one in June and one in November. Both activities aimed at testing new developments and

the parts of GIMO not tested before. The status report of the GIMO test was published for the Fifty-Ninth Session of WGB in Information Paper CTBT/PTS/INF.1630.

In April 2022, the OSI Division organized an expert meeting on OSI communications at the CTBTO TeST Centre. The primary objectives were to demonstrate the current OSI communications system, to evaluate its technical performance and to propose updates and maintenance. A thorough assessment of the current communications equipment was conducted, its feasibility assessed and the need to replace/upgrade the equipment with a different standard identified. Procurement actions were initiated with a view to obtaining new equipment and spare parts by mid-2023. The entire upgraded OSI communications system is expected to be tested during the planned field exercises and other activities in 2023 and 2024.



*Deployment and testing of the VSAT during the course of the expert meeting on OSI communications.*

The OSI programme of work outlined the intention of the PTS to further develop PTS preparedness for efficient conduct of pre- and post-inspection activities. As part of the project, the OSI Division organized an expert meeting on point of entry and point of exit activities in November 2022 in order to present the results of the project and to discuss how to increase efficiency and effectiveness of the processes, primarily the checking of inspection equipment. Twenty-eight experts from States Signatories, the Organization for the Prohibition of Chemical Weapons and the PTS participated in the event. The event generated recommendations for improvement of the processes to be applied in the OSI Division Quality Management System (QMS) documentation to be considered by experts from States Signatories during WGB discussions.

The OSI Division continued to support the health and safety initiatives of the PTS during the COVID-19 pandemic with the distribution of protective equipment and other materials. Assistance was provided across the Organization to facilitate a return to normal operations, including in-person activities. This included the development of a PTS COVID-19 protocol to manage activities in light of the pandemic. Further developments were made at the CTBTO TeST Centre to develop and enhance the safety management system at this location. Work continued within the OSI programme to develop arrangements, procedures and infrastructure for effective health and safety management in the context of an OSI.

A number of QMS documents were reviewed and updated, notably the SOP on OSI data and information management and the use of GIMO, which was approved. The SOP on point of entry procedures and work instruction on the final inspection report are under review.

## ON-SITE INSPECTION EXERCISE PROGRAMME

Following extensive consultations with the Consultative Group of Experts, a forum established in 2021 with a view to leveraging the expertise of States Signatories and obtain guidance and advice on strategic, technical and substantive matters for the PTS on its development and implementation of future OSI exercises, the PTS published the OSI exercise programme for 2022-2025 in January 2022.

That document outlines a series of ambitious, yet achievable, OSI exercises designed to progressively test, validate and demonstrate enhanced OSI capabilities, taking into account the limitations imposed by the challenging COVID-19 environment, extended absence of OSI field activities and finite financial resources. It includes a variety of exercise formats including an Integrated Field Exercise (IFE) to be conducted in 2025 designed to illustrate the application of OSI techniques, mechanisms, systems and procedures in an integrated manner and provide a platform to review policy, operational, operations support, logistical and technical capabilities from a holistic, cross-cutting perspective.

In May 2022 the OSI Division organized a tabletop exercise on OSI in mountainous environments. Experts were presented with a pre-prepared scenario and asked to explore technical and operational challenges, with the aim to find out potential solutions mitigating negative impacts on the inspection conduct. A number of innovative ideas, comments, useful suggestions and recommendations on further development of OSI capabilities in mountainous environments were generated. In particular, OSI equipment field deployment strategies, data processing and analysis workflows and software solutions, the potential of remotely controlled measurement platforms, tailored logistic and operation support training were thoroughly discussed at the event.

In June 2022 the OSI Division organized a tabletop exercise on the role of senior management during an OSI. The aim was to improve the understanding of PTS senior management of an OSI and its intricacies by presenting a series of challenging



*The OSI tabletop exercise on the role of senior management was held in June 2022.*

situations following the detection of an anomalous event and subsequent receipt of a request for an OSI. This successful one-day exercise served to demonstrate an Organization-wide commitment to OSI development and generate further support for building OSI capability, including through participation in upcoming OSI exercises. At the request of the Executive Secretary, a follow-up tabletop exercise for senior management is being organized in 2023.

Following the approval by the Preparatory Commission at its Fifty-Eighth Session in June 2022 of the OSI exercise programme for 2022-2025, the PTS invited all States Signatories to submit an expression of interest in hosting an IFE in 2025. The OSI Division established a cross-Divisional internal assessment team to conduct a rigorous assessment of the two expression of interests received from technical, operational, health and safety, security, financial and legal perspectives. This process is expected to conclude in the first half of 2023.

Initial preparations were undertaken for the conduct of three directed exercises in 2023 as outlined in the exercise programme. A concept paper was elaborated, project teams established, detailed exercise specifications prepared, cost estimates finalized, exercise locations secured and a framework for the selection of participants, scenario development and exercise related procurements put in place.

A draft concept paper for the build-up exercise in 2024 was elaborated and contact established with selected States Signatories on the possibility of hosting this three-week exercise aimed at testing key elements of an OSI in an integrated manner in preparation for the IFE in 2025.

## EQUIPMENT PROCEDURES AND SPECIFICATIONS

As a part of the execution of the OSI programme of work 2022-2023, two field tests and one expert meeting were carried out in 2022 to enhance OSI capabilities in the area of equipment development and testing.

A field test on gamma imaging was conducted at the military base in Korneuburg, Austria, and the CTBTO TeST Centre during the week of 23 to 27 May 2022. The scope of the field test was to perform an assessment of the current development status of

*Field test on geophysical techniques  
for deep applications in Rotmoos near  
Mariazell, Austria.*





*Resonance seismometry and active seismic surveys were some of the geophysical techniques tested during the field test.*

selected gamma imaging capabilities for use as an OSI method, as well as to assess their current deployment readiness. Results of the field test are furnished in an electronic technical report that was made available to experts from States Signatories on the Alfresco platform. This was followed by an expert meeting on radionuclide measurement restrictions on 7 and 8 June 2022 that aimed to provide an updated assessment of the development status of measurement restriction capabilities. The results of the expert meeting were provided in an electronic technical report.

A field test on geophysical techniques for deep applications was conducted in Rotmoos, Austria, from 5 to 16 September 2022. The scope of the field test was to assess the geophysical imaging capabilities for deep applications, established thus far in an integrated manner at a mountainous site with a number of deep geophysical observables of OSI interest. Resonance seismometry, active seismic surveys, magnetic field mapping, gravitational field mapping and electrical conductivity measurements were tested. The field test included testing the completeness of the software solutions and products available within GIMO for the implementation of the data flow processes for geophysical techniques. A comprehensive technical report that covers technical and operational aspects of the field test, with an emphasis on the challenging, mountainous nature of the field test site, is currently being prepared by the OSI Division.

The first comprehensive draft list of equipment for use during OSIs was published as CTBT/PTS/INF.1573 in 2021. The draft contains proposed specifications relating to the equipment for the conduct of inspection activities and techniques specified in paragraph 69, Part II, Protocol to the CTBT, with the exception of drilling

(paragraph 69 (h)), and also specifications for data and information handling equipment. The document was the subject of in-depth technical discussion with experts from States Signatories during the OSI Workshop 25 that was held online in October 2022 and in-person from 7 to 11 November 2022. The results of the workshop will be reported to the Sixtieth Session of WGB.

Detailed technical reporting on OSI technology development was advanced in order to preserve and institutionalize current OSI capabilities. A series of eight technical reports documenting the history of equipment development, chronicling the design, testing and validation steps for each technique was reviewed by an external editing company.

The CTBTO TeST Centre regained all its main functions with respect to the OSI equipment maintenance after the COVID-19 pandemic. The workshops and the maintenance area benefit from high engineering tools such as 3-D scanners, 3-D printers and high precision milling cutters.

A number of supporting tools are now in place to ensure that OSI deployable equipment is calibrated, maintained and protected. The Equipment and Instrumentation Management for OSI (EIMO) is now used on a daily basis, facilitating work at the CTBTO TeST Centre where it is the central database for all OSI deployable equipment. Among the new features incorporated in EIMO in 2022 is the introduction of radio-frequency identification tags and checks. The custom browser based application was further expanded with the creation of new instances: a training instance for capacity building and another for the testing and development of new functionalities. To further protect deployable equipment, a two-factor authentication key cabinet was obtained, with access assigned on a key-by-key basis. Similar access control is also being considered for use during OSI deployment.

A desk study and demonstrations were ongoing to understand the limitations and strengths of remotely controlled platforms. The scope is also to identify what, if any, changes would be required to make such platforms compliant with the Treaty and other legal structures, as well as meeting the operational needs of the inspection team. Demonstrations of such platforms in 2022 included the use of platforms for the acquisition of near surface magnetic, gamma radiation and optical data.

## *Airborne Techniques*

To enhance OSI airborne configurations, testing of equipment on an expanded range of airframes continued with power and external fittings installed on a Bell 412 helicopter. For ground testing and training of OSI airborne configurations, the OSI airborne simulator is being enhanced with the design and installation of a projection system that will provide a real world view for trainees seated in the cockpit and cabin.

## *Geophysical Inspection Techniques*

A contract to update and maintain the processing software for passive seismological monitoring for aftershocks was concluded. This contract will facilitate the availability the latest version of the software, including the ability to accommodate for topographic changes, for the whole exercise programme for 2022-2025.

To maintain the capability to transmit data acquired for passive seismological monitoring for aftershocks between the inspection area and the base of operations (BOO), the OSI Division performed an upgrade of equipment and software with delivery and testing of the system in September 2022.

A new recording system for active seismic surveys was obtained. The system currently includes 300 nodes, is scalable for the future and represents an enhancement of the capabilities in the field of seismic geophysical techniques. It was used for the first time in the field conditions during the field test of geophysical techniques for deep applications in Rotmoos, Austria, in September 2022.

Two approaches proposed in the current concept of operations for resonance seismometry using ambient noise and earthquake recordings were tested by processing existing publicly available data from Source Physics Experiments 5 and 6 at the Nevada National Security Site. The results of the processing are available to experts from States Signatories in electronic reports on the Alfresco platform.

## *Measurements of Radioactivity and Radionuclide Particulate Related Inspection Techniques*

OSI field laboratory software development focused on the streamlining of data flow for the chain of custody and sample measurement and integration with GIMO. A field laboratory workflow was demonstrated during the November 2022 operational test of the GIMO system. The feedback collected and lessons learned were documented in an electronic report that is available on the Alfresco platform.

## *Noble Gas Related Inspection Techniques*

Noble gas sampling configurations were upgraded in line with specifications set out in Information Paper CTBT/PTS/INF.1573. The degassing system to extract noble gases from water was redesigned, constructed and delivered in 2022. This completes the current cycle of noble gas sampling acquisitions. Sampling capabilities will be tested in house in 2023.

To ensure short and long term capability to process and measure samples for  $^{37}\text{Ar}$ , procurement processes were initiated to ensure availability of the  $^{37}\text{Ar}$  equipment for OSI exercises and for beyond 2025.

The upgrade of the SAUNA system continued with the aim to further increase and standardize sample throughput and improve sample chain of custody. The design manufacturer of the system, the Swedish Defense Research Agency, was contracted to design, construct and deliver a multi-sample inlet and radio-frequency identification tags, along with the necessary software to operate this new hardware.

## FIELD OPERATIONS SUPPORT

A study for the real time deployment for OSI was performed. The scope of the study was to understand decision points for rapid deployment of OSI equipment to the point of entry following the submission of a simulated OSI request and taking into account Treaty timelines. The study was performed as a real time planning with a contracted air broker for a prepared scenario of deployment to a real site. Key decision points were identified for interaction with an air broker.

The managed replacement of BOO infrastructure with modularized units commenced in 2021 with the delivery of accommodation modules. This was the first set of standardized and interoperable modules. The phased replacement continued in 2022 with further accommodation modules followed by other areas of the BOO.

The testing of the redesigned Intermodal Rapid Deployment System containers in a field laboratory configuration was performed, including an on-site visit by the container design engineers. Several areas were identified to improve the field functionality of the containers. The procurement of an amended design was concluded to resolve these deficiencies.

## ON-SITE INSPECTION DOCUMENTATION

Activities during 2022 involved providing support to WGB in its elaboration of the draft OSI Operational Manual, organizing OSI Workshop 25, coordinating revision of OSI QMS documents and maintaining the OSI document repository, both the OSI e-Library and the documentation rooms at the VIC and the CTBTO TeST Centre.

The OSI Division continued to provide substantive, technical and administrative assistance to WGB in its third round of elaboration of the draft OSI Operational Manual. Support has been provided to the Task Leaders in preparing the new Model Text for the draft OSI Operational Manual to consolidate the results from discussions in WGB up to its Fifty-Ninth Session on the basis of the Model Text (CTBT/WGB/TL-18/64) which was issued in July 2019.

OSI Workshop-25 was held from 3 to 7 and 17 to 21 October 2022 (online) and 7 to 11 November 2022 (in person) in Vienna, Austria. Over 80 participants from 41 States Signatories and PTS staff conducted in-depth technical discussions on the first comprehensive draft list of equipment for use during OSIs with a view to planning its review and further development. The result of the workshop will be the basis for the further discussion of the OSI equipment list.

The existing OSI QMS documents were continuously revised and drafted based on the lessons learned from the implementation of previous the OSI action plan for 2016-2019 and exercises. The SOP on establishing and managing a BOO was revised. The work instruction on the developing and handling of the final inspection report



*OSI Workshop 25 took place in October and November 2022 with over 80 participants from 41 States Signatories and PTS staff.*

was developed. Documents on topics of health and safety, equipment certification, storage and maintenance are currently under review.

OSI QMS documents in hard copy, both at the VIC and in the documentation room at the CTBTO TeST Centre, were maintained and updated. Full sets of OSI QMS documents were prepared for the participants of in-person activities, including the expert meeting on OSIs in mountainous environments and OSI Workshop 25. Documentation kits in electronic version were prepared for relevant OSI training sessions and exercises.

*Participants at OSI Workshop 25 discussed the first comprehensive draft list of equipment for use during OSIs.*



The maintenance and enhancement of the OSI e-Library continued in 2022. The synergies with the GIMO system were greatly improved, with OSI QMS documents related to inspection techniques being accessible through the GIMO platform. The synchronization of the e-Library from headquarters to the field was maintained, and the underlying software of the e-Library updated throughout the year. The PTS is currently exploring the technical options of providing external access to the OSI e-Library through a secure and reliable method.

Efforts were made to further consolidate the OSI QMS documentation system. Support was provided in updating the glossary of verification related terms at the PTS level.

## ON-SITE INSPECTION TRAINING COURSES

The OSI Division conducted its first face-to-face training activity since 2019, when the COVID-19 pandemic forced the cancellation of all on-site training events.

An important development in the interim was the OSI remote training programme, which focused on the deployment of a series of Web based software training courses on OSI operational software that can be accessed remotely by trainees. This initiative provided remote access to functional versions of processing and analytical software used in OSI techniques and field data management tools.

From January to December 2022, a series of remote software training sessions on EIMO and GIMO were delivered to all surrogate inspectors. This course provided hands-on remote training on essential EIMO and GIMO functionalities using simulated mission environments. Altogether, the Division conducted 30 remote software training sessions with 155 surrogate inspectors.

Three e-learning modules consisting primarily of step by step tutorial videos on passive seismic monitoring, airborne multispectral and infrared monitoring and subsurface noble gas sampling were produced and deployed by the Division. These e-learning modules represent the next generation of online training assets that will be paired with their remotely accessed software training, thereby providing a trainee with all the available skills and maintenance training achievable before the face-to-face training.

**30**  
**REMOTE SOFTWARE**  
**TRAINING SESSIONS**  
**CONDUCTED WITH**  
**155 SURROGATE**  
**INSPECTORS**



The Division conducted its first face-to-face training since the start of the pandemic from 17 to 25 November. The in-field operations support course of the linear training programme was conducted as a refresher course for surrogate inspectors specializing in field deployment support and focused on the installation, sustainment and decommissioning of the BOO infrastructure, including the working, receiving and joint areas, the field laboratory as well as the health and safety infrastructure. Fourteen surrogate inspectors representing 13 States Signatories participated in this training event.



*In-field operations support course of the linear training programme.*

A package of new introductory e-learning modules was developed and published for the regional introductory course audience. Topics in the series include communications, navigation, environmental sampling, radiation protection and decontamination and a virtual field exercise. These resources provide trainees with built-in instant feedback mechanisms, interactive videos and immersive 360-degree high resolution visualizations.







# IMPROVING PERFORMANCE AND EFFICIENCY

## HIGHLIGHTS

Further development and consolidation of the QMS

Consolidation and enhancement of sustainable performance monitoring tools and refinement of key performance indicators

Technical evaluation of IDC progressive commissioning and progress in the operationalization of OSI capability

At all stages of the process of establishing the Treaty's verification system, the Commission aims for effectiveness, efficiency, sustainability and client orientation (i.e. States Signatories and NDCs). This requires fostering a quality culture across the Organization. The QMS of the PTS is essential to guarantee a robust and sustainable verification system.

Continual improvement is central for the QMS. Together with rigorous performance monitoring and evaluations, it ensures that the work to establish the verification system complies with the requirements of the Treaty, its Protocol and the guidance of the Commission.

## EVALUATION

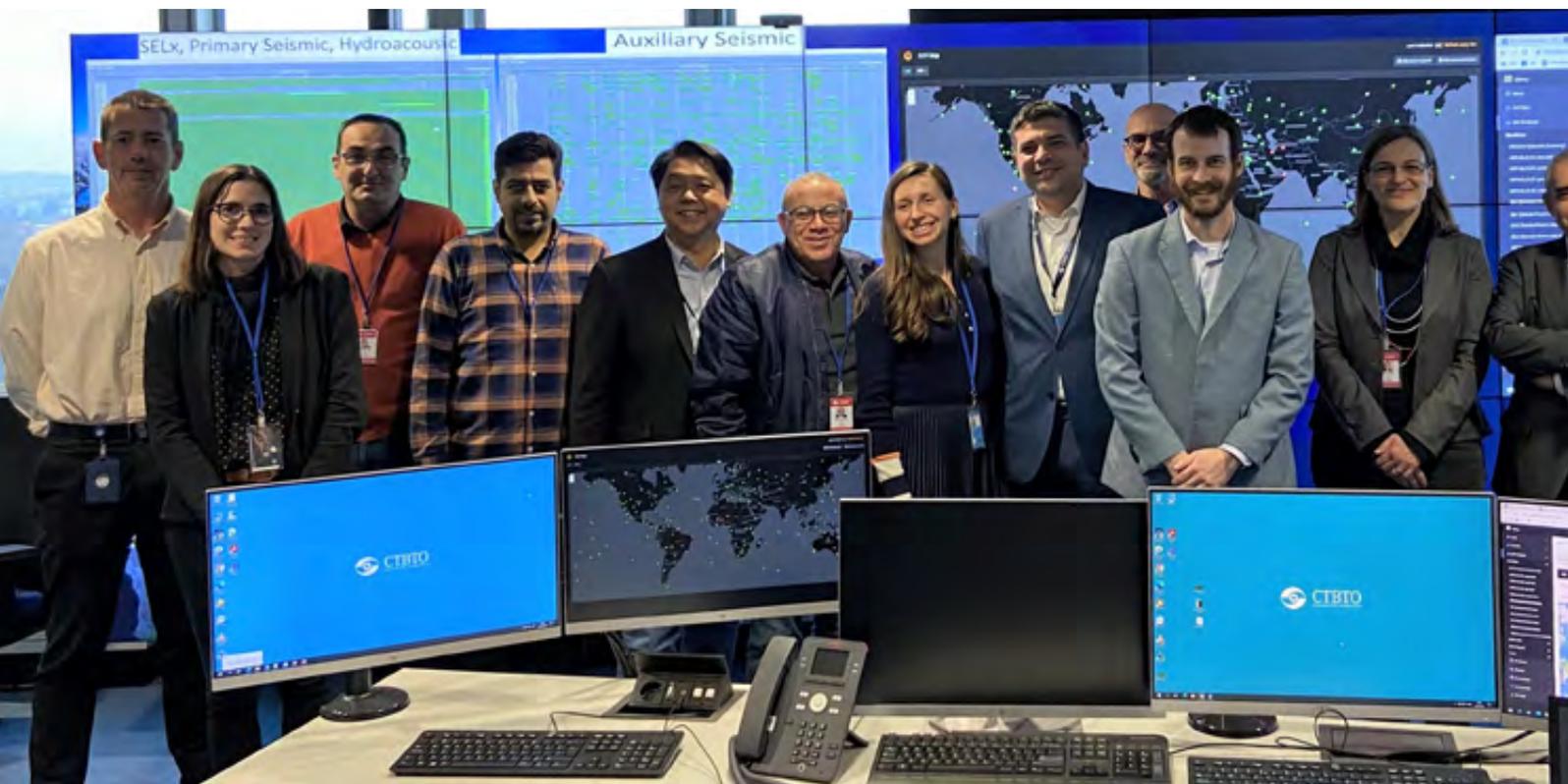
Based on the results of the evaluations of the first cycle of experiments performed over the last five years, the way forward for the progressive commissioning of the IDC has been established.

In order to ensure continual improvement of the verification system, the follow-up on the status of implementation of recommendations and improvements resulting from the evaluation of the first cycle of experiments continues in close cooperation with the IDC.

A new series of experiments is being prepared with the introduction of the TIPs focusing on specific quality aspects of the verification system and the development of related performance indicators.

A sustainable independent evaluation methodology is consolidated. The evaluations are to be performed by teams composed of experts from States Signatories, assisted by QMPM, up to the elaboration of the final evaluation reports to be presented to States Signatories.

The process of evaluation of the Experiment 2023 was initiated. In accordance with the plan, in-person training for the evaluators on the methodology and tools to be used was completed in October 2022, before the conduct of the experiment itself, in person in February 2023.



The Evaluation Information Management System prepared for the OSI exercises was maintained in preparation for the evaluation of the future build-up exercise and the IFE, based on lessons learned from past exercises.

## PERFORMANCE MONITORING

The PTS continues to enhance performance monitoring, including the performance reporting tool (PRTool) accessible to experts from States Signatories, primarily focusing on the quality of processes, data and products related to the development and provisional operation of the verification system. A technology refreshment of the PRTool was carried out to provide evidence of long term sustainability of the verification system beyond the life cycle of its various components.

A quality assurance process established for validation of metrics and performance indicators is formalized as part of the configuration management of the performance monitoring software, ensuring the reliability and sustainability of the performance monitoring tools of the PTS.

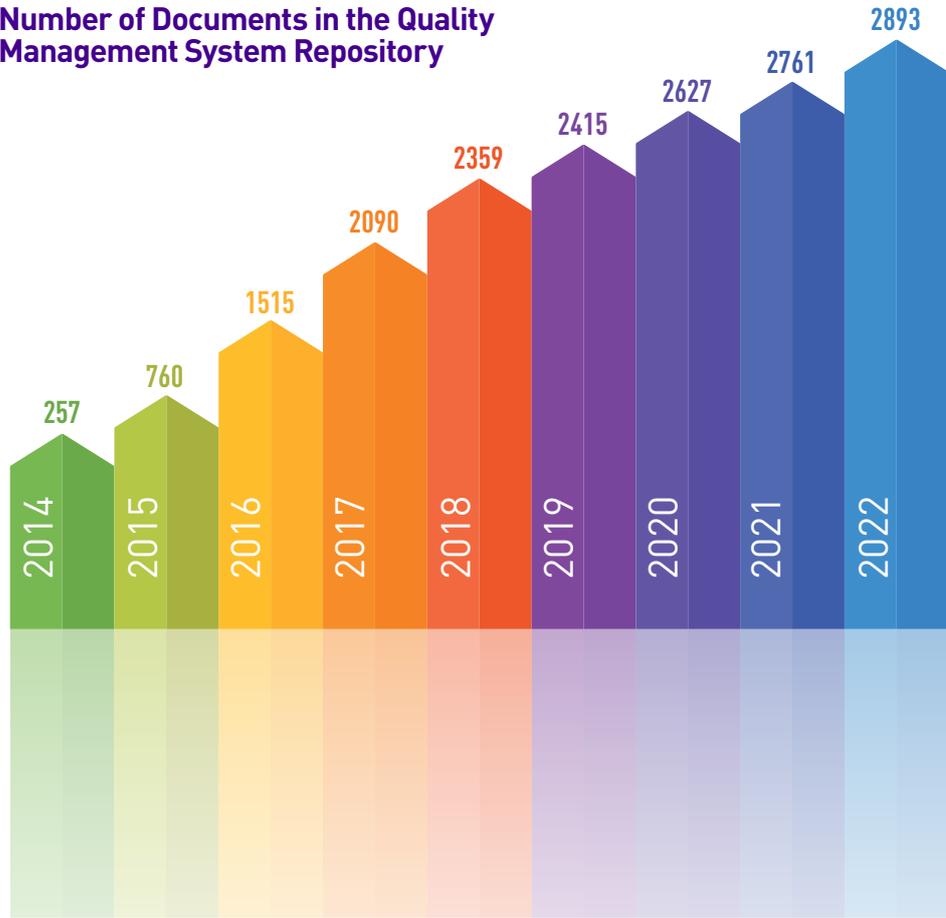
Specific metrics and performance indicators are being developed in preparation for future experiments within the IDC Progressive Commissioning Plan in association with the TIPs specific to each experiment.

The implementation and closure of recommendations and improvements resulting from evaluations of past experiments of the IDC progressive commissioning are formally tracked, as part of the continual improvement process of the QMS applied to the verification system.

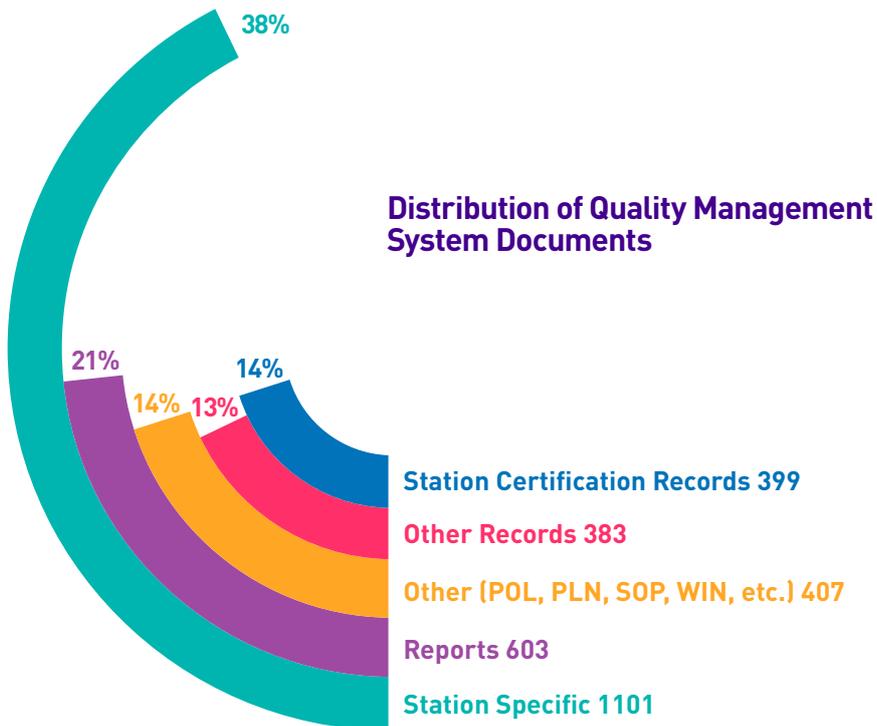
*IDC progressive commissioning. Training of the evaluation team.*



### Number of Documents in the Quality Management System Repository



### Distribution of Quality Management System Documents



## QUALITY MANAGEMENT

The continued development of a QMS is instrumental in providing States Signatories and the Commission with the necessary confidence in the functioning of the PTS and in its products and services.

The foremost quality objectives of the PTS are to provide States Signatories with data and products of the highest quality and to continuously improve efficiency and effectiveness in all its activities.

The PTS continued to develop its QMS, fostering a quality culture amongst PTS staff focusing on continual improvement and for a shared understanding and commitment to the PTS mission and its quality objectives.

*The number of documents currently filed continued to grow, reaching almost 3000.*

The use of the QMS document management system continues to increase. The number of documents currently filed continued to grow, reaching almost 3000, with a significant effort on formalizing procedures.

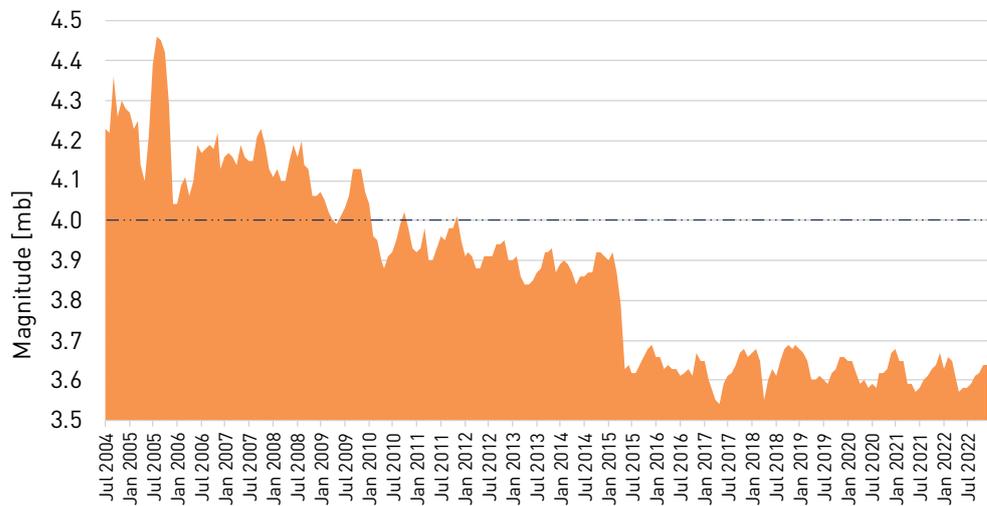
In order to continue consolidating the reliability of data and products of the verification system, QMPM is collaborating with the IMS, IDC and OSI Divisions to progressively align, as appropriate, the ongoing practices related to the production of data and products to ISO 17025 requirements.

Satisfaction of stakeholders is an essential principle of the QMS. Therefore the Commission continued to prioritize feedback from NDCs, which are the main users of its data, products and services, and to encourage them to actively contribute through the established channels to review the implementation of their recommendations. The tracking of recommendations resulting from evaluations is being used to support closing and reporting on the status of implementation of NDC recommendations.

2004-2022 Continuous Assessment of Global Seismic Detection Capacity

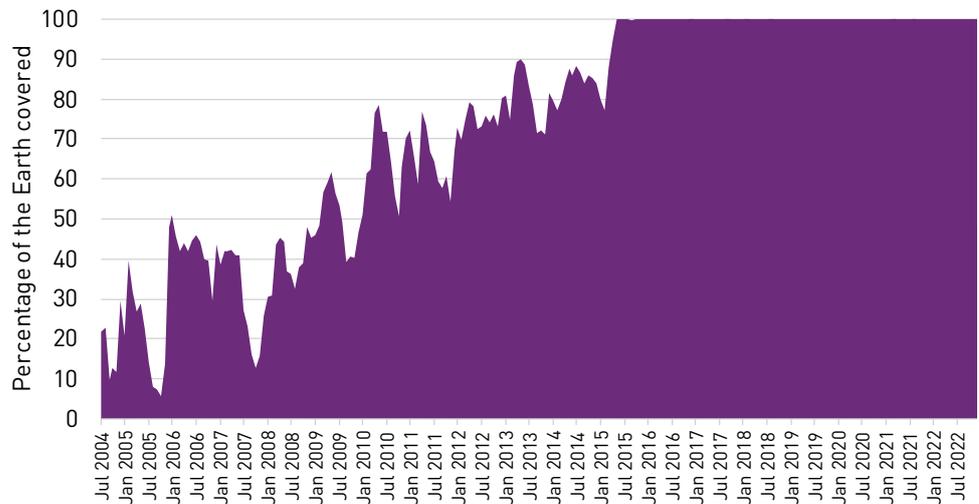
Worldwide Magnitude Detection Thresholds

Time evolution of worldwide magnitude detection thresholds.

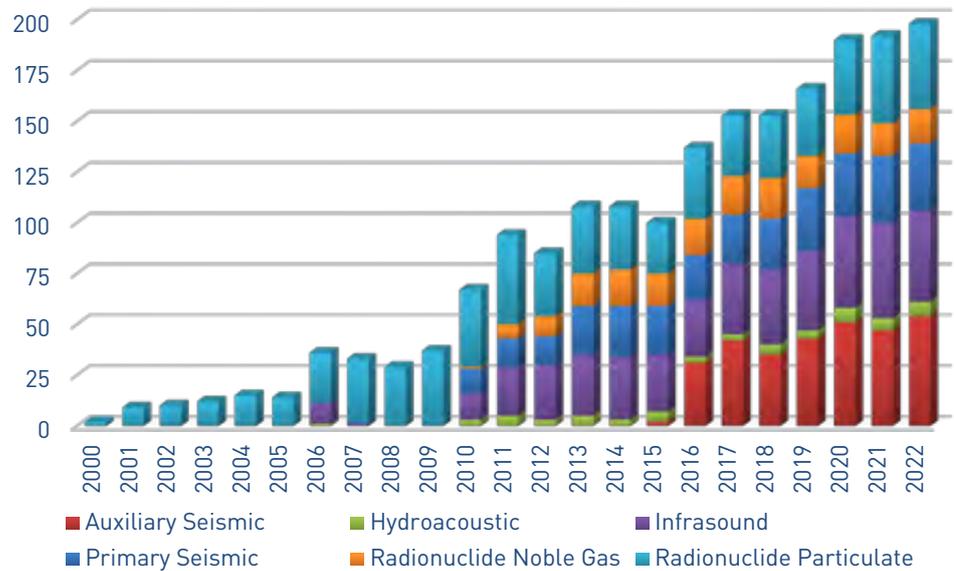
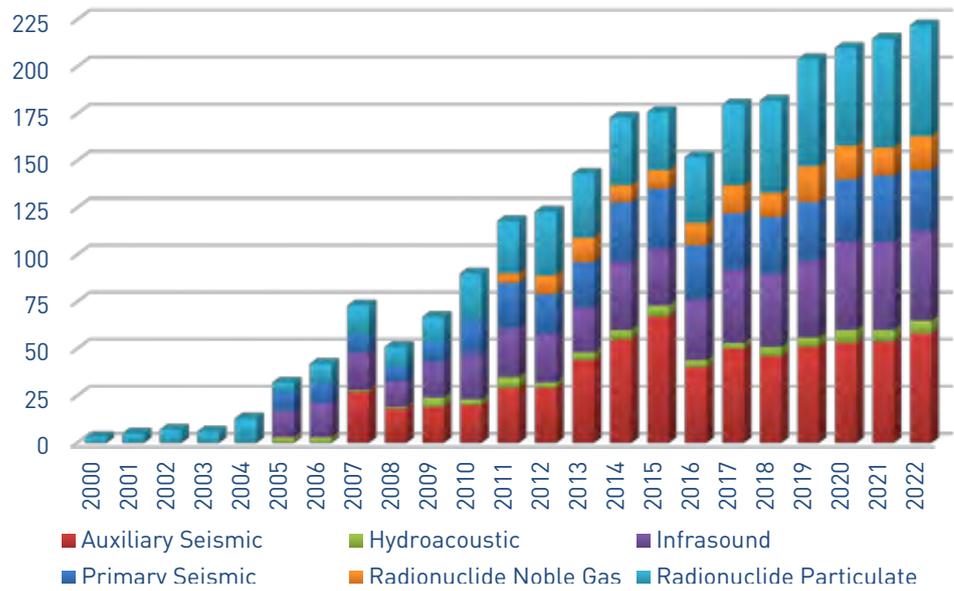


Earth Coverage

Time evolution of the percentage of the total surface of the earth for which events of magnitude  $m_b=4.0$  can be detected at 90% confidence level.



### Facilities Meeting Data Availability and Timeliness Objective Over Calendar Years



Number of IMS primary and auxiliary seismic, hydroacoustic, infrasound and radionuclide stations (particulate and noble gas systems) that meet the objective of data availability (top) and timeliness (bottom) set in the draft IMS operational manuals, calculated over calendar years.

# INTEGRATED CAPACITY DEVELOPMENT

## HIGHLIGHTS

Continued capacity development activities

Ensuring integration of NDC capacity building with policy and educational outreach activities

Further development of online events and e-learning



The Commission offers States Signatories training courses and workshops on technologies associated with the three pillars of the verification regime – the IMS, the IDC and OSI – as well as on the political, diplomatic and legal aspects of the Treaty. These courses help to strengthen national scientific and decision making capabilities in relevant areas and assist in developing capacities in States Signatories to effectively confront the political, legal, technical and scientific challenges facing the Treaty and its verification regime.

In some cases, the Commission provides equipment to NDCs to increase their capacity to participate actively in the verification regime by accessing and analysing IMS data and IDC products. There is a need to update the knowledge and experience of national experts as technologies expand and improve. By enhancing the technical capabilities of States Signatories, these activities empower all stakeholders to participate in the implementation of the Treaty and to enjoy the civil and scientific benefits of its verification regime.

Training courses are held in person at the Commission headquarters in Vienna and at other locations, often with the assistance of host States, as well as virtually via videoconferencing. The capacity building programme is funded through the Regular Budget of the Commission and through voluntary contributions. All training activities have a well-defined target group, offer detailed content, and are complemented by the educational platform and other outreach activities to the broader scientific community and civil society.

## ACTIVITIES

The Commission offered States Signatories a wide range of training courses and workshops aimed at strengthening capacities in areas relevant to the Treaty. Capacity development activities also included the provision of hardware and software to NDCs, especially those in developing countries, enabling them to access and analyse IMS data and IDC products. They also included training courses and workshops on various OSI activities.

### 9

#### NATIONAL DATA CENTRE TRAINING COURSES

Due to the COVID-19 pandemic, many of the capacity development events of the Commission continued to be hosted online in 2022. Through videoconferencing, the Commission was able to provide and conduct online training courses, expert meetings and workshops. The Commission is building upon experiences gained in the past from hosting events virtually. Some recordings of these technical virtual events are being archived in order to engage the next generation for use as future training material and for reference purposes. In addition, the number of experts on scientific and technical issues related to the verification regime attending workshop and expert meetings significantly increased due to online attendance, despite the challenges of maintaining audience engagement during such activities.

### 10

#### TRAINING COURSES FOR STATION OPERATORS

#### INTERNATIONAL DATA CENTRE AND NATIONAL DATA CENTRE TRAINING COURSES AND WORKSHOPS

Integrated capacity development and training activities in 2022 continued online and in person. In 2022, NDC technical staff, station operators and experts from States Signatories participated in 30 events: nine NDC training courses; ten training courses for station operators; six technical and expert meetings; one technology workshop; two NDC regional workshops; one NDC workshop; and a workshop on the O&M of the IMS.

Nine training courses on NDC capacity building took place during the reporting period. The objectives were to understand the roles of NDCs in the verification regime, to build and/or to improve NDC capabilities, to provide participants with sufficient knowledge for accessing and using IMS and IDC data as well as for Treaty verification and civil and scientific application purposes, including using NDC in a box and SeisComP3 software. The NDC capacity building courses and events included:

# 6

## TECHNICAL AND EXPERT MEETINGS

# 5

## WORKSHOPS

- An online training course on access and analysis of waveform IMS data and IDC products, which took place from 31 January to 4 February 2022 with 40 participants from 22 countries.
- An online introductory training course on radionuclide IMS data and IDC products (particulates and noble gas), which took place from 7 to 18 March 2022 with 37 participants from 20 countries and the PTS.
- An online training course for advanced WEB-GRAPE users, which took place from 28 to 29 March 2022 with 37 participants from 21 countries.
- An online training course on access and analysis of waveform IMS data and IDC products, which took place from 30 May to 3 June 2022 with 31 participants from 20 countries.
- A waveform training course using SeisComP, which took place at the VIC from 13 to 17 June 2022 with 14 participants from 14 countries.
- An online advanced training course on radionuclide particulates data analysis, which took place from 13 to 24 June 2022 with 17 participants from 12 countries.
- A waveform training course using SeisComP, which took place at the VIC from 24 to 28 October 2022 with 14 participants from 14 countries.
- An online advanced training course on radionuclide noble gas data analysis, which took place from 14 to 25 November 2022 with 20 participants from 17 countries and the PTS.
- A waveform training course using SeisComP, which took place at the VIC from 28 November to 2 December 2022 with 14 participants from 14 countries.

Six technical and expert meetings were organized to address particular and customized issues related to improvements and/or testing of the CTBT verification systems in coordination with and under the guidance of States Signatories.

- An online technical meeting on the IDC VATP took place from 25 to 27 May 2022. Fifty-eight participants from 24 countries and the PTS attended the technical meeting. The objectives of the meeting were to discuss further work on the draft VATP and to review the plans for the next experiment.

- An online SnT2023 Scientific Programme Committee meeting took place from 30 May to 1 June 2022. Twenty-three participants from 20 countries attended the meeting. The objectives of the meeting were to ensure the success of the SnT2023 meeting, and to ensure that the scientific agenda reflects the latest developments and initiatives in the field of nuclear test-ban verification.
- An online technical meeting on IDC SHI re-engineering alpha testers group took place from 30 June to 1 July 2022. Twenty-two participants from 20 countries and the PTS attended the technical meeting. The main objective of the technical meeting was to enhance the engagement of the NDC community towards the IDC re-engineering project. All meeting participants were actively engaged to validate the results of the system and provide feedback on the system design and usability.
- An online technical meeting on SHI software engineering at the IDC took place from 6 to 7 July 2022. Twenty-nine participants from 11 countries and the PTS attended the meeting. The technical meeting this year was focused on reviewing the current status of work, including progress updates, discussion of the project plan, projected milestones and updating deliverables.
- A virtual expert meeting on advances in waveform processing and special studies took place from 17 to 21 October 2022. Fifty-three experts from 20 countries and the PTS attended the meeting. The objective of this technical expert meeting was twofold. Part of the meeting was dedicated to exploring advances to waveform processing that may improve the IDC waveform pipeline processing, including tools and methodologies for testing and validation. The second part of the meeting was dedicated to discussing waveform special studies and ETA.
- A virtual expert meeting on special studies and ETA with radionuclide and ATM methods took place from 17 to 21 October 2022. Thirty-eight experts from 19 countries and the PTS attended the meeting. The objectives of this technical expert meeting were to review methods that may be suited for special studies and ETA, explore the potential use of various non-IMS data for the State Requested Methods Report and advance common understanding of procedures and methods to be developed.



*Fifty-eight participants from 24 countries and the PTS attended the IDC VATP online technical meeting.*

Ten training sessions and programmes for station operators and managers took place during the reporting period. The objectives were to facilitate interaction with the PTS on matters related to the O&M of IMS facilities; the ongoing development of digital modules for station operation; SOH and data monitoring; and hardware and software configuration. The technical training sessions and programmes included:

- An online session for station managers of IMS stations operating under PCA contracts, which took place from 4 to 6 April 2022. Twenty-four participants from 11 countries attended this training session. The objectives were to provide station managers with the knowledge and technical understanding of the PTS procurement process, how to initiate a change in the station budget and how to plan for O&M activities at IMS stations under PCA contracts.
- An online session for PKI operators for radionuclide and waveform stations, which took place from 6 to 10 June 2022. Forty-one participants from 15 countries and the PTS attended this training session. The objectives were

to provide PKI operators with basic knowledge and technical understanding about data authentication, PKI concepts and terminology and data surety.

- A session for radionuclide station operators with SAUNA equipment, which took place in Sweden from 27 June 2022 to 1 July 2022. Six participants from four countries and the PTS attended this training session. The objective of the technical training programme was to provide IMS station operators with the required knowledge and technical understanding of SAUNA noble gas monitoring systems in order to perform operations and maintenance tasks.
- A session for radionuclide station operators with SPALAX equipment, which took place in France from 27 to 30 June 2022. Eight participants from five countries and the PTS attended this training session. The objective of the technical training programme was to provide IMS station operators with the required knowledge and technical understanding of SPALAX noble gas monitoring systems in order to perform operations and maintenance tasks.
- A session for training new station operators at Tristan da Cunha, which took place at the VIC from 1 to 3 August 2022. Two participants attended this training session. The objectives were to provide new station operators with knowledge about the three IMS stations located on the island as well as the technical understanding about the operation, maintenance and management of the stations.
- A session for radionuclide station operators using Cinderella equipment, which took place in Iceland from 5 to 8 September 2022. Four participants from three countries and one PTS staff attended this training session. The objectives were to enhance and develop the knowledge and skills of station operators regarding the operational and maintenance aspects of radionuclide stations using the Cinderella system.
- A session for radionuclide station operators with Canberra equipment, which took place in Belgium from 7 to 10 November 2022. Five participants from four countries and two PTS staff attended this training session. The main objective was to provide the participants with the required knowledge and technical understanding of the gamma detector system, manufactured by Canberra Industries Inc., in order to perform necessary operations and maintenance tasks.
- A session for station operators of IMS infrasound/seismic stations with Quanterra Q330M+ equipment, which took place at the CTBTO TeST Centre

in Seibersdorf from 14 to 18 November 2022. This was the first face-to-face technical training session for IMS station operators conducted at the CTBTO TeST Centre. Twelve participants from seven countries attended this training session. The main objective was to provide station operators with operational knowledge, technical understanding and relevant hands-on training on operation, maintenance and troubleshooting of IMS infrasound and seismic stations using Quanterra Q330M+ equipment.

- A session for Russian-speaking station operators of IMS radionuclide monitoring stations, which took place in the Russian Federation from 14 to 18 November 2022. Fifteen participants attended this training session. The objectives were to provide station operators with the knowledge and technical understanding on the operations, maintenance and management of a manual radionuclide station and, more specifically, to provide hands-on training for the various operational and maintenance procedures.
- A programme for radionuclide station operators with ORTEC equipment, which took place United States of America from 5 to 7 December 2022. Seven participants from seven countries and the PTS attended this training programme. The objectives of the programme were to provide hands-on training and practical lessons to station operators on the operation, maintenance and repair of the ORTEC gamma detector system manufactured by AMETEK.

Two regional workshops for improving RSTT models took place during the reporting period. Their main objectives were to understand and learn how the RSTT model can help regional networks achieve more precise event locations and to demonstrate the importance of ground truth event locations in defining regional seismic velocity structures and models. These were:

- An NDC capacity building workshop on RSTT in combination with data sharing and integration training for the Middle East and South Asia region, which took place in Oman from 4 to 8 September 2022. Forty-nine participants from 22 countries and the PTS attended this workshop.
- A workshop for improved seismic event location using the RSTT method, which took place in Nepal from 7 to 11 November 2022. Fifty-four participants from 19 countries and the PTS attended this workshop.



*A workshop for improved seismic event location using the RSTT method took place from 7 to 11 November.*

One technology workshop took place during the reporting period: the International Hydroacoustics Workshop 2022, which took place at the VIC from 5 to 7 September 2022. Thirty-one participants from 12 countries and the PTS attended this workshop. The objective of the workshop was to support the CTBTO verification regime by creating a forum for scientific knowledge exchange on three main topics: a) technological advancements in marine engineering pertinent to the sustainability and improvement of the hydroacoustic component of the IMS; b) data analysis and signal processing methods for CTBT verification purposes; c) 3-D modelling for long range hydroacoustic signal propagation. The workshop included a hands-on training demonstration of NDC in a box software for processing hydroacoustic data.

The NDC workshop took place in Spain from 3 to 7 October 2022. Eighty-seven participants from 46 countries and the PTS attended this workshop. The objectives of the workshop were to provide a forum for NDC experts to share their experience in fulfilling their verification responsibilities and to provide NDC feedback to the PTS on all aspects of the data, products, services and support NDCs in their work.

The workshop on the O&M of the IMS took place at the VIC from 28 November to 2 December 2022. One hundred and twenty-seven participants from 52 countries and the PTS attended this workshop. The objectives of this workshop were to facilitate interaction between station operators and the PTS, to highlight major achievements in the O&M of IMS stations while focusing on the necessary steps to be taken to ensure their long term sustainment and to focus on a way forward to enhance IMS station data availability, quality and its authentication.

*The O&M workshop took place at the VIC from 28 November to 2 December.*



In the first half of the year, due to continued travel restrictions related to the COVID-19 pandemic, two CBSs were successfully installed and commissioned at the NDCs of Venezuela and Cuba by their technical staff with remote assistance from the PTS. Both systems began to receive and process IMS data in real time mode from March and May 2022, respectively.

*Three new CBS sets were installed and commissioned at NDCs in Montenegro, Oman, and Uzbekistan.*

The distribution of eight new sets of CBS equipment procured in 2021 started from July 2022. With the lifting of COVID-19 travel restrictions in the second half of the year, three new CBS sets were installed and commissioned with on-site support from PTS staff at the NDCs of Oman and Montenegro in September, and at the NDC of Uzbekistan in December 2022. The CBS sets installed in Montenegro and Uzbekistan were procured using funds provided by the EU. In addition, the staff of these three NDCs was trained on step by step waveform analysis using the NDC in a box applications and assisted in establishing the sustainable routine use of IMS data and IDC products to fulfil their verification responsibilities.

Approximately 43 participants subscribed to the NDC e-learning course on access to and application of IMS data and IDC products in 2022.

## OTHER CAPACITY BUILDING ACTIVITIES

From 17 to 18 March 2022, in Vienna, the External Relations, Protocol and International Cooperation Section received a delegation from France as part of the French non-proliferation training course organized by the Permanent Mission of France in Vienna. The delegation consisted of representatives from the Ministry of Foreign Affairs, Defence, Ministry of Environment, Ministry of Interior, Ministry of Finance, Ministry of Economy and special advisors to the French Authorities, Électricité de France and the French Alternative Energies and Atomic Energy Commission. The delegation attended presentations about the Organization on political and technical issues and also visited the COPC as well as the stations.

On 22 March 2022, the External Relations, Protocol and International Cooperation Section organized a visit by Norwegian Seismic Array board members to the PTS.

The board members attended presentations about the Organization on political and technical issues and also visited the COPC as well as the stations.

The External Relations, Protocol and International Cooperation Section received a delegation from the US-Black Sea Nonproliferation Exchange Initiative (organized by the Permanent Mission of the United States in Vienna) on 28 April 2022 in Vienna.

On 17 May 2022, the External Relations, Protocol and International Cooperation Section, in collaboration with the Vienna Center for Disarmament and Non-Proliferation and the International Atomic Energy Agency organized the short course on nuclear non-proliferation and disarmament. The short course was composed of around 20 diplomats and practitioners in the field of nuclear non-proliferation and disarmament.

*The third Science Diplomacy Symposium gathered over 250 participants from 76 countries.*



A visit of the United Nations Disarmament Fellows to the PTS was organized from 12 to 13 September. It included a briefing by the Executive Secretary on 12 September 2022.

The third Science Diplomacy Symposium was held in Vienna from 6 to 9 December 2022. The event gathered over 250 participants from 76 countries, including academics, diplomats, members of civil society and the next generation of non-proliferation and disarmament experts. The symposium attracted high level speakers, such as the President of the United Nations General Assembly (by video), the United Nations Under-Secretary-General and High Representative for Disarmament Affairs (by video), the Foreign Secretary of Sri Lanka, the Secretary General of the Inter-Parliamentary Union (IPU), Permanent Representatives of States Signatories and other experts.

EXPERTS FROM  
**22**  
STATES WERE  
SELECTED

## PARTICIPATION OF EXPERTS FROM DEVELOPING COUNTRIES

The project for the participation of technical experts from developing countries in official technical meetings of the Preparatory Commission was established in 2006, initially for a period of three years and subsequently extended. During its Fifty-Seventh Session, the Preparatory Commission extended the project for another three years.

The project selected experts from the following 22 States, including 6 women, in 2022: Algeria, Armenia, Bolivia, Cuba, the Dominican Republic, Iran (Islamic Republic of), Iraq, Kazakhstan, Kenya, Libya, Malaysia, Mauritania, Morocco, Nepal, Nicaragua, Nigeria, Panama, Senegal, Tajikistan, Thailand, Tunisia and Uzbekistan. All supported experts are representatives of national authorities for Treaty related issues, NDCs or relevant academic institutions.

*All supported experts are representatives of national authorities for Treaty related issues, NDCs or relevant academic institutions.*

During 2022, experts supported under the project participated virtually at the Fifty-Eighth Session of WGB due to the COVID-19 pandemic restrictions introduced by several countries, including the host country. Nineteen experts out of 22 attended the Fifty-Ninth Session of WGB in person. Participation in the project provided the experts with a broader understanding

of the verification related work of the PTS and the benefits of access to IMS data and IDC products. The project also gave the experts and the PTS an opportunity to further develop cooperation between the Commission and the respective States on verification related matters, including specific technical issues or projects related to IMS stations and NDCs.

# U7

## OUTREACH

# U7

### HIGHLIGHTS

Growing high level engagement with States and active youth outreach activities

Comprehensive public and media outreach strategy

Increased virtual outreach activities



The outreach activities of the Commission aim to encourage the signature and ratification of the Treaty, to enhance understanding of its objectives, principles and verification regime and of the functions of the Commission, and to promote the civil and scientific applications of the verification technologies. These activities entail interaction with States, international organizations, academic institutions, the media and the general public.

Political support for the Treaty, for its urgent entry into force and for the work of the Commission, continued to be strong in 2022. This was shown by the emphasis placed on the Treaty at numerous high level events, including the 10th Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in August 2022 and by many senior governmental officials and non-governmental leaders in other fora.

## INTERACTING WITH STATES

The Commission continued efforts to facilitate the establishment of the verification regime and to promote participation in its work. It also maintained a dialogue with States through bilateral contacts in capitals and interaction with Permanent Missions in Berlin, Geneva, New York and Vienna. A major focus of this interaction was on States that host IMS facilities and States that have not yet signed or ratified the Treaty, in particular those listed in Annex 2.

The Executive Secretary increased his proactive, high level engagement with States to promote the Treaty, advance its entry into force and universalization, and promote the use of the verification technologies and data products.

The Executive Secretary participated in several bilateral meetings and other high level events at which he met several heads of State and Government as well as foreign ministers. These included the President of Austria, the Prime Minister of Dominica, the President of Kiribati, the President of Madagascar, the President of the Swiss Confederation, the President and Prime Minister of São Tomé and Príncipe, the Prime Minister of Timor-Leste, the Minister of Foreign Affairs and Worship of Argentina, the Minister of Foreign Affairs and Foreign Trade of Barbados, the Under-Secretary of Foreign Affairs of Chile, the Minister for Foreign Affairs of the Republic of Cuba, the Vice-Minister of Multilateral Affairs of Costa Rica, the Under-Secretary of Foreign Affairs of Honduras, the Permanent Secretary of the Ministry of Foreign and European Affairs of Malta, the Minister of Disarmament and Arms Control of New Zealand, the Deputy Minister of International Relations and Cooperation of South Africa, the Minister of Foreign Affairs and Cooperation of Timor-Leste and the Foreign Minister of Gabon.

*The Executive Secretary increased his proactive, high level engagement with States.*

Promoting parliamentary engagement, the Executive Secretary interacted with a number of parliamentarians from States Signatories, including the Speaker of the National Parliament of the Solomon Islands. From 20 to 24 March 2022, the Executive Secretary participated in the 144th Assembly of the IPU held in Nusa Dua, Indonesia. The Executive Secretary had meetings with several parliamentary delegations attending the IPU Assembly, including Bhutan, Equatorial Guinea, Nepal, South Sudan and Timor-Leste. The Executive Secretary also met with both the Secretary General and President of the IPU.



*The Executive Secretary met with the President of Kiribati in October 2022.*

During his mission to the Latin American and Caribbean region from 4 to 14 February 2022, the Executive Secretary met with the Minister of Foreign Affairs and Foreign Trade of Barbados in Bridgetown. On 7 February 2022 in Roseau, the Executive Secretary met with the Prime Minister of Dominica, the Minister of Foreign Affairs, International Business and Diaspora Relations and the Minister of National Security and Home Affairs. On 10 February 2022, in San José, Costa Rica, the Executive Secretary held a meeting with the Minister of Foreign Affairs and Worship of Costa Rica and had exchanges with two Deputy Ministers. On 14 February 2022, the Executive Secretary met with the Minister of Foreign Affairs of Mexico in Mexico City.

From 22 to 24 February 2022, the Executive Secretary undertook a mission to Sweden. During his visit, the Executive Secretary met with the Minister for Foreign Affairs. On this occasion, the Executive Secretary also met with the Swedish ambassador-designate to the Democratic People's Republic of Korea. The Executive Secretary also had an exchange with Swedish parliamentarians during his visit.

The Executive Secretary undertook a mission to Geneva on 1 March 2022 and delivered a speech at the high level segment of the Conference on Disarmament. He also met with the EU Special Envoy for Non-Proliferation and Disarmament and several resident ambassadors.

On 7 March 2022, the Executive Secretary met with the Deputy Minister of Foreign Affairs of Egypt during a mission to Cairo to explore opportunities for further cooperation between the CTBTO and Egypt. On 9 March 2022, on the margins of the ministerial meeting of the Council of the League of Arab States, he held bilateral meetings with the Minister of Foreign Affairs of Jordan, the Minister of Foreign Affairs, African Cooperation and Moroccan Expatriates of Morocco and the Minister of Foreign Affairs of Tunisia. He further held a meeting with the Somali Minister of Foreign Affairs and International Cooperation.

On 25-27 March 2022, during his visit to Timor-Leste, the Executive Secretary had a meeting with the Prime Minister, the Minister for Foreign Affairs and Cooperation and the Minister of Defence to discuss the status of Timor-Leste's ratification process. He also met with the President of Commission B of the National Parliament.

The Executive Secretary undertook a mission to Rome, Italy, from 6 to 7 April 2022, where he delivered a keynote lecture at the XXII Edoardo Amaldi conference on nuclear risks and arms control at the Accademia Nazionale dei Lincei. On the margins of the conference, the Executive Secretary met with Italian officials.

On 19 and 20 April 2022, the Executive Secretary undertook a mission to São Tomé and Príncipe. During the visit he met with the President, Prime Minister, Minister of Defence and President of the National Assembly.

From 15 to 17 June 2022, the Executive Secretary undertook a mission to Finland where he met with the Minister for Foreign Affairs and other high ranking government officials. He visited IMS facilities PS17 and RL7 and delivered a lecture at the University of Helsinki.

From 4 to 6 July 2022, the Executive Secretary led a mission to Malabo, Equatorial Guinea upon the invitation of the Government and met with the Minister for Foreign Affairs and Cooperation. The Executive Secretary also met with the President of the Chamber of Deputies and the Minister of Mines, Industry and Energy.

On 29 August 2022, the Executive Secretary undertook a mission to Montevideo, Uruguay and met with a range of officials.

From 30 August to 2 September 2022, the Executive Secretary led a mission to Brazil. The mission included engagements with a range of officials and experts in São Paulo, Brasília and Rio de Janeiro.

*The Argentine Minister of Foreign Affairs and Worship welcomed the Executive Secretary to Buenos Aires in September 2022.*



On 5 September 2022, the Executive Secretary met with the Minister of Foreign Affairs and Worship of Argentina, during a mission to Buenos Aires.

From 3 to 5 October 2022, the Executive Secretary went on a mission to Spain where he opened the NDC workshop in Toledo before meeting with officials.

The Executive Secretary undertook a mission to the United States of America from 23 to 28 October 2022. In Washington DC he met with a range of senior officials. He also visited the Air Force Technical Applications Center, the US National Data Centre and the Pacific Northwest National Laboratory, which runs RL16.

From 7 to 9 November 2022, the Executive Secretary led a mission to the Solomon Islands to encourage the country's ratification of the CTBT. During the mission, he met a range of high ranking officials.

The Executive Secretary led a mission to Port Moresby, Papua New Guinea from 10 to 11 November to similarly advance ratification by the country. During the mission, he was received by the Attorney General and Minister of Justice. The ES also visited and had extensive discussions with the Minister for Foreign Affairs and Trade.

The Executive Secretary led a mission to Mauritius from 30 November to 2 December 2022 during which he met with the Prime Minister.

## OUTREACH THROUGH THE UNITED NATIONS SYSTEM, REGIONAL ORGANIZATIONS, OTHER CONFERENCES AND SEMINARS

The Commission continued to take advantage of global, regional and subregional conferences and other gatherings to enhance understanding of the Treaty and to advance its entry into force and the build-up of the verification regime.

The Executive Secretary held meetings with educational institutions in Costa Rica and Mexico. On 10 February 2022, the Executive Secretary held a meeting at the National University of Costa Rica led by the Dean and the Director of the Volcanological and Seismological Observatory Research Institute of Costa Rica. On 11 February 2022, the Executive Secretary participated in a discussion with students at the University of Peace. On 14 February 2022, the Executive Secretary participated in a podcast interview with the Matías Romero Institute in Mexico City.

On 14 February 2022, the Executive Secretary addressed the commemorative event held in Mexico City by the Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean on the occasion of the 55th anniversary of the Treaty of Tlatelolco.

The Executive Secretary attended the Munich Security Conference from 18 to 20 February 2022, which provided a good platform to connect on the margins with the Ministers for Foreign Affairs and Secretaries of State of Bosnia and Herzegovina, Finland, Germany, Mongolia and Norway.

On 24 February 2022, the Executive Secretary delivered a keynote speech at an event hosted by the Stockholm International Peace Research Institute in Stockholm, Sweden. On the same day, the Executive Secretary delivered a keynote speech at an event hosted by the Swedish Institute of International Affairs and participated in a panel discussion on 25 years of the CTBT.

On 1 March 2022, in Geneva, the Executive Secretary delivered a statement at the high level segment of the Conference on Disarmament.

On 8 March 2022, the Executive Secretary held an informative exchange of views with the Secretary General of the League of Arab States on mutual cooperation in Cairo, Egypt.

To promote the CTBT ahead of the 10th NPT Review Conference, from 9 to 11 June 2022, the Executive Secretary participated in the James Martin Center for Nonproliferation Studies workshop on the NPT in Annecy, France as well as the Vienna Center for Disarmament and Non-Proliferation workshop on the NPT in Vienna.

*The Executive Secretary delivered an address to the 10th NPT Review Conference in New York.*



The Executive Secretary attended the 10th NPT Review Conference from 30 July to 8 August 2022 in New York. In his address to the conference he highlighted the success of the CTBT in delivering on its stated object and purpose, and emphasized the achievements that have been made in further universalizing the Treaty during its 25th anniversary year. On the margins of the conference, the Executive Secretary held a range of bilateral meetings. The Executive Secretary also met with representatives from international and regional organizations to discuss support for the CTBT, including the EU, United Nations Office for Disarmament Affairs, the African Commission on Nuclear Energy and the Chef de Cabinet to the United Nations Secretary-General. The Executive Secretary also participated in a side event on the CTBT, organized by the EU, on 4 August 2022.

On 11 August 2022, the Executive Secretary spoke at the NPT Review Conference side event, organized by the United Nations Office for Disarmament Affairs, the BASIC countries and the Republic of Korea, reiterating support for increased youth engagement and a greater female role in the nuclear disarmament and non-proliferation field.

On 31 August 2022, the Executive Secretary delivered a keynote lecture at the Rio Branco Institute in Brasília, Brazil.

During his mission to Spain from 3 to 5 October 2022, the Executive Secretary delivered a lecture at the International Affairs and Foreign Policy Institute.

On 24 October 2022, the Executive Secretary attended the Advisory Board panel of the James Martin Center for Nonproliferation Studies in Washington DC on the future of nuclear arms control and delivered a keynote speech.

On 3 December 2022, the Executive Secretary participated virtually in the Moscow Nonproliferation Conference held in the Russian Federation, addressing the conference participants on the CTBT session.

From 12 to 14 December 2022, the Executive Secretary participated in the Wilton Park Conference on the NPT after the 2022 Review Conference in Steyning, United Kingdom, addressing the conference participants on the CTBT session.

On 15 December 2022, the Executive Secretary participated in a virtual high level closing session of the CTBTO-Center for Energy and Security Studies Research Fellowship, alongside the United Nations Under-Secretary-General and High Representative for Disarmament Affairs and CTBTO Youth Group members.

At the invitation of the African Union Peace and Security Council, the Executive Secretary visited Addis Ababa, Ethiopia and briefed the Council on 16 December 2022 on the activities of the CTBTO.

## THE CTBTO YOUTH GROUP

The CTBTO Youth Group, the Organization's flagship next generation outreach programme, continued its active engagement in support of the Treaty. Having passed the 1000 member milestone, the group had reached 1295 members from 125 countries by December 2022. Its activities in 2022 focused on advocacy for the CTBT, its universalization and entry into force during events such as Friends of the CTBT Ministerial Meetings in New York, capacity building (CTBTO-Center for Energy and Security Studies Research Fellowship), attendance of the CTBTO Youth Group at the Science Diplomacy Symposium as speakers, and a pilot mentoring programme for early career women in science, technology, engineering and mathematics (STEM).

*Members of the CTBTO Youth Group  
and the Executive Secretary at the 2022  
Science Diplomacy Symposium.*



## PUBLIC INFORMATION

*The new CTBTO website offers an immersive user experience, showcasing developments in the verification regime over the last 26 years.*

The reporting period offered an opportunity to re-engage with key stakeholders as we marked several achievements, and relaxed COVID-19 restrictions allowed for the resumption of in-person meetings. A range of key events throughout the year, including the ratification of the CTBT by six countries (Dominica, Equatorial Guinea, São Tomé and Príncipe, The Gambia, Timor-Leste and Tuvalu), the Long Night of Research, the 10th NPT Review Conference, the International Day against Nuclear Tests (IDANT), the high level ministerial meeting of Friends of the CTBT chaired by the Prime Minister of Japan on the margins of the seventy-seventh United Nations General Assembly (UNGA), the Lower Austria Research Festival, the hybrid Science Diplomacy Symposium, and numerous Executive Secretary missions offered varied opportunities to promote the CTBT and the work of the CTBTO to diverse audiences. The PTS ensured extensive coverage of these and other events, anniversaries and stories on its social media accounts (Twitter, Facebook, YouTube, Flickr and LinkedIn) as well as through the public website. Wherever possible, video streaming of significant interventions by the Executive Secretary was made available via the website.

The CTBTO corporate website was completely redesigned and launched on 19 September 2022. The new website offers a richer, more immersive user experience, with an easier to navigate information architecture that showcases the IMS and the verification regime that has been built over the last 26 years, while highlighting the latest news and information on the Treaty and the Organization. The new website also has dedicated resource areas for a range of stakeholders (delegates, journalists, civil society, researchers and scientists). Multilingual capacity has been built into the new site and the PTS plans to build it out in all six official CTBTO languages as resources become available.

The number of Twitter followers rose to 25 750 by early December 2022, an increase of 2525 since the end of 2021. Total impressions for 2022 were more than 1 300 000 with over 385 000 visits to CTBTO's Twitter profile. Events in August and September, including the 10th NPT Review Conference, IDANT, several ratifications and the high level ministerial meeting of Friends of the CTBT proved to be of particular interest to our Twitter audience with 213 000 impressions, 41 700 profile visits and 668 mentions in August, while September saw 288 000 impressions, 63 400 profile visits and 430 new followers.

The CTBTO Facebook page had over 15 500 likes by late 2022, an increase of 1550 followers. Fourteen videos were uploaded to the YouTube channel, seven of them related to the third Science Diplomacy Symposium, and there were 132 100 views of the channel's content (an 87% increase compared to 2021). The CTBTO website had 704 761 visitors, of which more than half (349 680) were new visitors.

*The CTBTO Facebook page.*



# CTBTO

## The Comprehensive Nuclear-Test-Ban Treaty Organization

15K followers · 176 following

Message

Following

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The PTS participated in several host country initiatives to raise awareness about the work of VIC based international organizations (VBOs), including the Long Night of Research on 20 May 2022 and the Lower Austria Research Festival on 30 September. The Long Night of Research opened 280 scientific institutions across Austria to the public. The event at the VIC welcomed over 1400 science enthusiasts of all ages who had the opportunity to interact with 30 CTBTO staff members who explained the work of the Organization in English and German. The Lower Austria Research Festival featured over 80 exhibits, as well as a colourful array of games, interactive quizzes and performances to showcase the science shaping our present and future.

*The PTS organized a visit for young professionals to the CTBTO Technology Support and Training Centre.*

At the CTBTO exhibition booth staff outlined how the verification regime detects nuclear tests round the clock. Staff also engaged with attendees, mostly in German, about the civil and scientific applications of IMS data. The festival attracted over 5000 people of all ages, predominantly from the provinces of Vienna and Lower Austria.



The PTS also conducted public outreach utilizing guided tours, both virtual and in-person, offered by the United Nations Information Service Vienna. In the latter half of 2022 when the service resumed its in-person guided tours, CTBTO staff conducted fourteen briefings on the work of the Organization, reaching more than 300 participants ranging from students to delegates and military personnel. This was in addition to various tours and briefings of facilities provided to institutions upon request. The PTS also supported the United Nations Office in Vienna Virtual



*PTS staff welcomed over 1400 science enthusiasts to the Long Night of Research event at the VIC.*

Shadowing Programme 2022 that took place from 24 October to 24 November by designating staff members who virtually mentored the programme's student participants. CTBTO also took part in the Vienna International Centre Sustainable Development Goals exhibit on 20 October 2022 at the Westfield shopping centre Donau Zentrum in Vienna.

The PTS helped raise awareness around IDANT with a social media video, a video message from the Executive Secretary, extensive online coverage of the Executive Secretary and other speakers at the UNGA plenary session and prominent coverage on the CTBTO website.

The importance of gender empowerment, equity and inclusion in advancing nuclear non-proliferation and disarmament remained a focus of communications efforts in 2022. The PTS participated in Daughters' Day on 28 April at the VIC, a city-wide event organized by the City of Vienna each year to introduce girls to careers in STEM. Over 100 girls between the ages of 11 and 16 had the opportunity to learn about careers at CTBTO and the work of the Organization as well as participate in hands-on exhibits and activities. A social media campaign was implemented to promote the CTBTO Youth Group Mentorship Programme for women in STEM from under-represented countries, and activities of the International Gender Champions network in Vienna, of which the Executive Secretary is a prominent member, were highlighted on social media.

## GLOBAL MEDIA COVERAGE

Extensive media coverage of the CTBTO and the engagements by the Executive Secretary was ensured by liaising proactively with media outlets, as well as promoting news and engagements of the Executive Secretary on social media, press releases and media advisories.

The PTS engaged the support of the United Nations Department of Global Communications to offer a media briefing from the Executive Secretary in New York and to conduct press outreach in local languages when he travelled on mission, as well as the placement of an op-ed. As a result, extensive media coverage of the CTBTO was achieved. Highlights included interviews with the Executive Secretary in Agence France Presse, NBC Radio in Papua New Guinea, El Universal in Mexico (Spanish) and Globo in Brazil (Portuguese).

*An op-ed to close out the 25th anniversary year of the Treaty with a milestone of six ratifications was picked up by 12 outlets.*

On the margins of the 10th NPT Review Conference, the Executive Secretary held a press briefing and was quoted in an article by the Associated Press (English), which was picked up by several outlets in the United States, including ABC News, USA Today and The Washington Post.

An op-ed to close out the 25th anniversary year of the Treaty with a milestone of six ratifications was picked up by 12 outlets, think tanks and NGOs and printed in English, Hungarian, Portuguese, Slovak, Slovenian and Spanish. The year was capped off by the third edition of the Science Diplomacy Symposium, which generated press coverage in several media outlets in Sri Lanka as well as Radio Free Asia.

The Organization, the Treaty and its verification regime featured in a wide range of articles, blogs and broadcast pieces around the world. Outlets included (in alphabetical order): 1420 WBSM, 19FortyFive, 24/7 Wall St., 38 North, 3 YonNews, ABC News, Acustik Noticias, Afkarjadida, Agence France Presse, AhoraEG, AICA, Akhbarak, Akhbar el-Yom, Al-Ahram Gate, Al Dawl News, AllAfrica, The Alkamba Times, Al-Masry Al-Youm, America Magazine, The America Times, Ammon News, Ana Paula Ordorica, Andrew S. Erickson, APO Group Africa Newsroom, Arab News, Arms Control Association, The Asahi Shimbun, Asia Media International (Loyola Marymount University's Asia Pacific Center in Los Angeles), Asia News Network,

Asia-Pacific Leadership Network, Associated Press, Associates Times, The Astana Times, Auburn Examiner, The Australian Financial Review, Barbados Today, BBC, Beirut Press, BelTA, Bharat Express News, Big News Network, Borna News, Brisbane Times, Bulletin of the Atomic Scientists, Cairo 24, El Capitalino, La Capital, Carnegie Endowment for International Peace, The Cascadia Advocate, CCO Noticias, Centre Daily Times, The Chicago Sun-Times, China Daily, CNN, CNSNews, Cosmos Magazine, Council of the EU, CounterPunch, Crux, Cuba Debate, Daily Nation, Daily News Egypt, Daily Sabah, Debate, Defense News, Diario del Sur, Diario Marca, Diario de Xalapa, The Diplomat, The Diplomatic Insight, domain-B, Dominica News Online, The Edwardsville Intelligencer, Efecto10 Noticias, EIN News, eKAI, El 19 Digital, Eldyar, Elmogaz, Elwatan News, Embajada de Mexico, Eos - Science News by the American Geophysical Union, Epoch Times, Eslmagen, The Ettinger Report, EU-Today, The EurAsian Times, Eurasia Review, EurekAlert!, European Leadership Network, Excelsior, Exilio, EXPRESS, The Express Tribune, Foreign Policy, Fox News, France 24, Fremont News-Messenger, Friends Committee on National Legislation, The Geopolitics, Global Village Space, Granma, Greensboro News and Record, German Federal Foreign Office, The Goa Spotlight, Guinea Ecuatorial, Gulf News, Gulf Times, El Heraldo, El Heraldo de Tabasco, The Hill, The Hill Times, The Hindu, History of Yesterday, Homeland Preparedness News, IBG News, The Independent, InDepthNews, India Education Diary, India Today, The Indian Express, Infocielo, Instick Media, International Business Times, Iowa City Press-Citizen, The Irrawaddy, IPU, Irish Examiner, The Island Online, Jim Inhofe, James Martin Center for Nonproliferation Studies, The Japan Times, Jiji Press, The Jordan Times,



La Jornada, Julio Astillero, Just Security, Kazinform, Kenooz Arabia, Kerala Kaumudi, Kompas.com, The Korea Times, The Korea JoongAng Daily, KTAR News, Kyodo News, Lampung7Com, Legal Insurrection, Libération, The Libya Observer, Lieber Institute - West Point, Loop Caribbean News, Mail & Guardian, The Mainichi, Mansfield News Journal, Malabo Newspaper, Malaysian Digest, Medafrica Times, Media Indonesia, Manohar Parrikar Institute for Defence Studies and Analyses, Milenio (Televised News Report), Mehr News Agency, Memri TV, Ministère de l'Europe et des Affaires Étrangères, Mobtada, Modern Ghana, Money Control, Money Inc, Montana Talks, Morning Star Online, My Joy Online, MyRepublica, Nasional Tempo, National Geographic, NationNews Barbados, National Parliament TV, Népszava, New Age, Newswise, The Nation Thailand, The National Interest, The National Tribune, Nature, Nature World News, News Ghana, The News International, The New Republic, Newsroom, Newsweek, NHK World Japan, Nikkei Asia, Nippon.com, Noticias del Mundo, Noticias Verspertinas, Nouse, National Press Authority Egypt, NPR News, NTCD, NTD Television, Nuclear Threat Initiative, Nuom News, O Globo, El Occidental,

*The Organization, the Treaty and its verification regime featured in a wide range of articles, blogs and broadcast pieces around the world.*

Observer Research Foundation, Once Noticias, Oneindia, Onultalia.com, OPANAL, OpIndia, Pacific Scoop, Pakistan Observer, Paris Beacon, The Parliament Magazine, Pasantes DF, Patheos, People's World, Penn Live, Popular Science, PR Newswire, Pravda, La Prensa, Prensa Latina, ThePrint, PRIO Blogs, Prospect Magazine, The Poetry of Science, The Point, Politico, Popular Science, Pressenza, El Quehacer Político, Real Clear Defense, The Teal Mango, ReliefWeb, Responsible Statecraft, Reuters, Republika.co.id, Radio Free

Asia, RFI, RRI, Sabq News, Saigon Online, Scientific American, ScienceDaily, Scoop, Schwäbische Post, The Siasat Daily, Sixteenth Air Force, SkyNews, El Sol del Bajío, El Sol de Acapulco, El Sol de Córdoba, El Sol de Cuautla, El Sol de Hermosillo, El Sol de Irapuato, El Sol de la Laguna, El Sol de León, El Sol de Mazatlán, El Sol de México, El Sol de Orizaba, El Sol de Puebla, El Sol de San Juan del Río, El Sol de San Luis, El Sol de Sinola, El Sol de Tijuana, El Sol de Tlaxcala, El Sol de Toluca, El Sol de Tulancingo, South China Morning Post, Space.com, SpaceWatch.GLOBAL, Sputnik International, The Statesman, El Sudcaliforniano, Sunday Guardian Live, SupChina, swissinfo.ch, Tasnim News Agency, TDPel Media, Telegraph Nepal, Televisión de Guinea Ecuatorial, teleSUR English, Temas de Cafe, Times-Call Longmont, Tribuna de San Luis, Turkish Journal, UCA News, Ukrinform, El Universal, UN, UN Brazil, UN Equatorial Guinea, UN News, UN Press, UN Watch, Union of Concerned Scientists, USA Today, US Department of Defense, US Department of State, US National Nuclear Security Administration, Vatican News, Večer, Verve Times, Vice, Vietnam Net, VietnamPlus, Vindobona, Voa Korea, The Voice Gambia, Voice of Vietnam, Wall Street

Journal, War History Online, Washington Examiner, The Washington Post, WBKO, WIC News, The Wire, WNBF, World Nation News, Wprost, Writeups 24, Xinhua, Yomiuri Shimbun, Youm7, Yonhap News Agency and YubaNet.

## NATIONAL IMPLEMENTATION MEASURES

Part of the mandate of the Commission is to facilitate the exchange of information between States Signatories on the legal and administrative measures for implementation of the Treaty and, when requested, to provide related advice and assistance. Some of these implementation measures will be required when the Treaty enters into force and some may already be necessary during the provisional operation of the IMS and to support activities of the Commission.

In 2022, the Commission continued to promote the exchange of information between States Signatories on national implementation measures. It also made presentations on aspects of national implementation at workshops, seminars, training courses, external events and academic lectures.

# 2020

## PROMOTING THE ENTRY INTO FORCE OF THE TREATY

### HIGHLIGHTS

Six States ratified the Treaty in an unprecedented renewal of momentum, these were: Dominica, Equatorial Guinea, São Tomé and Príncipe, The Gambia, Timor-Leste and Tuvalu

The CTBTO and its States Signatories held a range of events to mark the 25th anniversary year of the Treaty and to reaffirm the importance of the nuclear test ban

The Friends of the CTBT held their biennial meeting to promote the entry into force of the Treaty in September, alongside the continued work of the Foreign Ministers of Italy and South Africa as coordinators of the Article XIV process

Every two years, the States that have ratified the Treaty convene a Conference on Facilitating the Entry into Force of the CTBT (also known as an Article XIV conference). In the years between Article XIV conferences, the Friends of the CTBT Ministerial Meeting is held in the margins of the UNGA in New York in September. The aim of these Ministerial Meetings is to sustain and increase political momentum and public support for entry into force. To aid this, the ministers adopt and sign a joint statement that is open for adherence by other States. The initiative for these meetings was taken by Japan in cooperation with Australia and the Netherlands, which organized the first Friends of the CTBT Ministerial Meeting in 2002.

## TOWARDS ENTRY INTO FORCE AND UNIVERSALIZATION

The CTBT will enter into force when it is ratified by the 44 States listed in Annex 2 of the Treaty. These are States that formally participated in the final stage of the negotiation of the Treaty in the Conference on Disarmament in 1996 and possessed nuclear power reactors or nuclear research reactors at that time. As of 31 December 2022, 186 States had signed and 176 States had ratified the Treaty, including 36 of the 44 Annex 2 States. Of the eight Annex 2 States that had yet to ratify the Treaty, three still had not signed it.

*These new ratifications make the CTBT one of the most adhered to international instruments.*

Adherence to the Treaty witnessed an exceptional renewal of the pace of ratifications in 2022, with six new ratifications: Tuvalu; The Gambia; Dominica; Timor-Leste; Equatorial Guinea and São Tomé and Príncipe. The Gambia ratified the Treaty on 25 March 2022, Tuvalu ratified the Treaty on 1 April 2022, Dominica signed the Treaty on 25 May 2022 and deposited its ratification instrument on 30 June 2022, Timor-Leste ratified the Treaty on 1 August 2022, Equatorial Guinea ratified the Treaty on 22 September 2022 and São Tomé and Príncipe ratified the Treaty on 22 September 2022. These new ratifications make the CTBT one of the most adhered to international instruments in the field of disarmament, bringing it even closer to universality. This reinvigoration of the pace of ratification was celebrated at a special event with representatives of the six countries in New York in September 2022.

In 2022 an increasing number of States, key decision makers, international and regional organizations, and representatives of civil society participated in activities aimed at advancing further ratifications of the Treaty, including by the remaining Annex 2 States. The Commission conducted consultations with many of the States that had not yet ratified or signed the Treaty.

## ARTICLE XIV PROCESS

Article XIV of the Treaty concerns its entry into force. The article foresees a series of regular conferences to facilitate entry into force (commonly referred to as Article XIV conferences) if this has not taken place three years after the Treaty opened for signature. The first Article XIV conference took place in Vienna in 1999. Subsequent conferences were held in New York in 2001, 2005, 2009, 2011, 2013, 2015, 2017, 2019 and 2021, and in Vienna in 2003 and 2007.

The Secretary-General of the United Nations convenes the Article XIV conferences at the request of a majority of States that have ratified the Treaty. Both ratifying and signatory States participate in these conferences. Decisions are taken by consensus of the ratifying States, taking into account views expressed at the conference by signatory States. Non-signatory States, international organizations and NGOs are invited to attend as observers.

Article XIV conferences discuss and decide on what measures, consistent with international law, may be undertaken to accelerate the ratification process in order to facilitate entry into force of the Treaty.

In the years where Article XIV conferences are not held, the Friends of the CTBT convenes a high level meeting to promote the entry into force of the Treaty on the margins of the UNGA. The Friends of the CTBT was established in 2002 by Japan, Australia and the Netherlands with a view to maintaining and strengthening the momentum to promote the entry into force of the CTBT. (Member countries are Japan, Australia, the Netherlands, Canada, Finland and Germany). The group has to date held ten meetings of foreign ministers.

*The Tenth Friends of the CTBT  
Ministerial Meeting called for the  
entry into force of the Treaty.*



## TENTH FRIENDS OF THE CTBT MINISTERIAL MEETING

The Tenth Friends of the CTBT Ministerial Meeting was held on 21 September 2022 in the margins of the opening of the seventy-seventh session of the UNGA.

Coinciding with the end of the 25th anniversary year of the CTBT's opening for signature, the meeting presented an opportunity to take stock of the achievements towards completion of the verification regime of the Treaty, and express the sustained political commitment and support of the international community for the entry into force of the Treaty and its universalization.

The Tenth Friends of CTBT Ministerial Meeting, convened by the six member countries, was co-chaired by the Prime Minister of Japan and Minister for Foreign Affairs of Australia. Remarks were also delivered by: the President of Finland; the President of the Union of the Comoros; the Prime Minister of New Zealand; the Minister of Foreign Affairs of Canada; the Secretary of State of the Holy See; Vice Minister of Foreign Affairs of the Netherlands; the Director General for East Asia, Southeast Asia and the Pacific at the German Federal Foreign Office; the Director-General of the Department of International Relations and Cooperation of South Africa; the United Nations Under-Secretary-General and High Representative for Disarmament Affairs; and the CTBTO Executive Secretary. Further representatives from the co-chairs of the CTBT Article XIV Conference (Italy and South Africa) also participated.

During the ministerial meeting, the Prime Minister of Japan stressed the importance of the universalization of the CTBT and its early entry into force, as well as the strengthening of the verification system. The meeting concluded with the adoption of a joint statement which acknowledged the "significant contribution to international peace and security" of the CTBT and called for "its entry into force for the benefit of all states" as soon as possible.



*On the sidelines of the ministerial meeting, the Executive Secretary met with several prominent political leaders.*



# no

## POLICY MAKING

# U /

### HIGHLIGHTS

**An increased number of meetings of the Commission and its subsidiary bodies despite COVID-19 restrictions**

**Appointment of the Chairperson of WGA**

**Appointment of the Chairperson of the Advisory Group**

The plenary body of the Commission, which is composed of all States Signatories, provides political guidance and oversight to the PTS. The plenary is assisted by two Working Groups.

Working Group A (WGA) deals with budgetary and administrative matters, while WGB considers scientific and technical issues related to the Treaty. Both Working Groups submit proposals and recommendations for consideration and adoption by the plenary meeting of the Commission.

In addition, an Advisory Group of experts serves in a supporting role, advising the Commission and its subsidiary bodies on financial, budgetary and associated administrative issues.

## MEETINGS IN 2022

The Commission and its subsidiary bodies each met in two regular sessions in 2022. The Commission also held several resumed sessions.

Among the major issues addressed by the Commission during 2022 were the promotion of the entry into force of the Treaty; the 25th anniversary of the opening for signature of the CTBT; adherence to the moratorium on nuclear testing; progress made on the completion of the IMS network; capacity building activities of the Commission; business continuity; the 2023 Budget update; developing guidelines for holding non-scheduled sessions of the Commission; appointment of the Chairperson of WGA and Chairperson of the Advisory Group.

### Meetings of the Commission and Its Subsidiary Bodies in 2022

Body	Session	Dates	Chairperson
Preparatory Commission	Resumed Fifty-Seventh	17 February	Ambassador Darío Ernesto Chirú Ochoa (Panama)
	Fifty-Eighth	27-29 June 19 October	
	Fifty-Ninth	21-23 November, 2 and 12 December	
Working Group A	Sixty-First	2-3 June	Ambassador Nguyen Trung Kien (Viet Nam)
	Sixty-Second	19-21 October	
Working Group B	Fifty-Eighth	21 February - 3 March	Mr Erlan Batyrbekov (Kazakhstan)
	Fifty-Ninth	22 August - 1 September	
Advisory Group	Fifty-Eighth	9-12 May	Acting Chairperson Mr Pedro Alexandre Penha Brasil (Brazil)
	Fifty-Ninth	27-28 September	Ms Rashmi Rajyaguru (UK)

## SUPPORTING THE COMMISSION AND ITS SUBSIDIARY BODIES

The PTS is the body that executes the decisions adopted by the Commission. It is multinational in composition: staff are recruited from States Signatories on as wide a geographical basis as possible. The PTS provides substantive and organizational support for the meetings of the Commission and its subsidiary bodies and in the periods between sessions, thus facilitating the decision making process.

With tasks ranging from organizing conference facilities and arranging interpretation and translation to drafting the official documents of the various sessions, planning the annual schedule of sessions, and providing substantive and procedural advice to the Chairpersons, the PTS is a vital element in the work of the Commission and its subsidiary bodies.

*The Preparatory Commission held an increased number of meetings in 2022.*



In 2022, due to COVID-19 restrictions, most of the sessions of the Commission and its subsidiary bodies were held in a hybrid format with in-person and remote participation.

### *Virtual Working Environment*

In addition to the ECS, which serves as the working environment for those unable to attend the regular sessions of the Commission and of its subsidiary bodies, through which proceedings are recorded and transmitted live, the PTS, in view of COVID-19 restrictions, used the Interpretrefy platform for all sessions of the Commission and its subsidiary bodies, and the Webex platform for all informal and technical briefings.

The ECS is a single sign-on infrastructure that provides a platform for continuous and inclusive discussion among States Signatories and experts on scientific and technical issues related to the verification regime, as well as information and access to all official documents issued.

As part of the virtual paper approach, through which the Commission is seeking to limit its output of printed documentation, the PTS continued to provide a print on demand service at all sessions of the Commission and its subsidiary bodies.

### *Information System on Progress in Fulfilling the Mandate of the Treaty*

The Information System with Hyperlinks on Tasks Assigned by the Resolution Establishing the Preparatory Commission monitors progress made in meeting the mandate of the Treaty, the Resolution establishing the Commission and the guidance of the Commission and its subsidiary bodies. It uses hyperlinks to the official documentation of the Commission to provide up to date information on the tasks that remain to be completed in preparing for the establishment of the CTBTO at entry into force and the first session of the Conference of the States Parties. The system is available to all ECS users.

## APPOINTMENT OF THE CHAIRPERSON OF WORKING GROUP A

The Commission appointed Ambassador Nguyen Trung Kien (Viet Nam) as the Chairperson of WGA through a silence procedure which expired on 10 May 2022, in accordance with the procedures for appointment of the Chairpersons and Vice-Chairpersons of the subsidiary bodies of the Commission (CTBT/PC-45/2, Annex IV) for a term expiring on 31 December 2023.

## APPOINTMENT OF THE CHAIRPERSON OF THE ADVISORY GROUP

The Commission at its Fifty-Eighth Session appointed Ms Rashmi Rajyaguru (United Kingdom of Great Britain and Northern Ireland) as the Chairperson of the Advisory Group in accordance with the decision contained in CTBT/PC-52/2, Annex III.

## DESIGNATION OF A FACILITATOR FOR DEVELOPING GUIDELINES FOR NON-SCHEDULED SESSIONS OF THE COMMISSION

In order to improve the work of the Commission and reach consensus, the Chairperson of the Commission designated Ambassador Carlos Sérgio Sobral Duarte, Permanent Representative of Brazil, as facilitator for developing guidelines for holding non-scheduled sessions of the Commission.

# 10 MANAGEMENT 10

## HIGHLIGHTS

Effective administrative support to ensure business continuity

Improving administrative and human resources policies, procedures and processes

Allocation of 81.2% of the budget to verification related activities

The PTS ensures effective and efficient management of its activities, including support of the Commission and its subsidiary bodies, mainly through the provision of administrative, financial, procurement and legal services.

The PTS also provides a wide variety of services including general services arrangements concerning shipments, customs, visas, identity cards, laissez-passer, tax, travel, low value purchases for telecommunication services, standard office and information technology support and human resource management. Services provided by external entities are continuously monitored to ensure that they are being provided in the most efficient, effective and economical manner.

Management is also involved in coordinating with the other VBOs over planning of office and storage space, usage of common space, maintenance of the premises, common services and security.

Throughout 2022, the Commission continued to focus on smart planning to streamline its activities and to increase synergy and efficiency. It also prioritized results based management.

## OVERSIGHT

Internal Audit is an independent and objective internal oversight mechanism. Through the provision of assurance, advisory and investigation services, it contributes to the improvement of the governance, risk management and control processes of the PTS.

To maintain its organizational independence, Internal Audit, through its Chief, reports directly to the Executive Secretary and has direct access to the Chairperson of the Commission. The Chief of Internal Audit also independently prepares and submits to the Commission and its subsidiary bodies an annual report on internal audit activities.

The internal audit assignments performed in 2022 were conducted in accordance with the International Standards for the Professional Practice of Internal Auditing and were based on its approved risk based work plan with a focus on identifying opportunities to mitigate risks and strengthen the overall control environment of the PTS. To this end, Internal Audit provided several recommendations to management.

In addition, Internal Audit undertook periodic follow-up exercises on the status of implementation of its recommendations and submitted relevant progress reports to the Executive Secretary, including specific analyses regarding the prioritization and chronology of all the recommendations.

In line with its mandate, Internal Audit continued to perform management support activities, such as providing advice on processes and procedures and participating as an observer at various PTS committee meetings. Furthermore, Internal Audit acted as the PTS focal point for the External Auditor.

In order to further support the efficient planning, execution and reporting of its audit work, Internal Audit commenced the process for the acquisition of a suitable audit software. The installation and full implementation of this automated solution is planned for 2023.

Internal Audit continued to improve the quality of its services through specific activities. These included continuous monitoring according to its quality assurance and improvement programme, in line with the International Standards for the Professional Practice of Internal Auditing, as well as exchanging methodologies and best practices through participation in periodic surveys and regular meetings of the Representatives of Internal Audit Services of United Nations Organizations and those of the network of the United Nations Representatives of Investigative Services.



## FINANCE

### *2022-2023 Programme and Budget*

The Budget for 2022 amounted to \$72 746 500 and €53 171 200, corresponding to slightly less than zero real growth. The Commission uses a split currency system to lessen its exposure to fluctuations in the value of the US dollar against the euro. At the budget exchange rate of €1 to \$1, the total US dollar equivalent of the 2022 Budget was \$125 917 700. In summary, the Budget for 2022 was prepared and implemented against the background of a difficult operational environment and financial constraints and reflects an overall price adjustment of 1.75%. It should be highlighted that the November 2022 harmonized index of consumer prices for the euro area was 10.0%.

On the basis of the actual average exchange rate in 2022 of €0.9486 to \$1, the final total US dollar equivalent of the 2022 Budget was \$128 856 464. Of the total 2022 Budget, 81.2% was originally allocated to verification related activities, including \$14 931 000 for the Capital Investment Fund, which is dedicated to the build-up and sustainment of the IMS, and \$8 890 800 for the multiyear funds that are dedicated to other long term verification related projects.

The Budget for 2023 totalled \$75 503 700 and €53 739 500, corresponding to slightly less than zero real growth. At the budget exchange rate of €1 to \$1,

the total US dollar equivalent of the 2023 Budget is \$129 243 200. The overall weighted average price adjustment for 2023 is 3.17%.

### *Ensuring Financial Resilience*

Ensuring financial sustainability and resilience of the Organization, in the aftermath of the COVID-19 crisis and the ongoing challenging macroeconomic environment, remained a key priority. The year was marked by extreme economic volatility and unpredictability, a marked decrease in purchasing power driven by sharp increases in energy prices and inflation reaching historical highs at two digit levels. Along with unstable foreign exchange fluctuations, navigating the uncertainty appeared to become the norm. A major step forward had been achieved in 2021 through the agreement by all States Signatories to approve an additional Working Capital Fund allotment (totalling \$9 647 292) as part of the 2022-2023 Programme and Budget to cover approximately four weeks of expenditures if needed.

#### **Distribution of the 2022-2023 Budget by Area of Activity**

<b>Area of Activity</b>	<b>2022 Budget (US\$ millions)<sup>a</sup></b>	<b>2023 Budget (US\$ millions)<sup>b</sup></b>
International Monitoring System	40.0	41.7
International Data Centre	49.1	50.0
On-Site Inspection	10.8	11.0
Evaluation and Audit	2.3	2.2
Policy Making Organ Support	3.8	3.9
Administration, Coordination and Support	15.4	15.9
Legal and External Relations	4.5	4.5
<b>Total</b>	<b>125.9</b>	<b>129.2</b>

a) To convert the euro component of the 2022 Budget, the budgetary exchange rate of €1 to \$1 was used.

b) To convert the euro portion of the 2023 allotment, the budgetary exchange rate of €1 to \$1 was used.

### *Assessed Contributions*

As of 31 December 2022, the collection rates of the assessed contributions from States Signatories for 2022 were 92.9% of the US dollar portion and 93% of the euro portion. The number of States that had paid their 2022 assessed contributions in full as of 31 December 2022 was 107.

### *Expenditure*

The expenditure for the Programme and Budget in 2022 amounted to \$112 884 710, of which \$12 804 720 was from the Capital Investment Fund, \$6 896 393 was from the multiyear funds, and the remainder from the General Fund. For the General Fund, the unused budget was \$11 074 756, as reported in the financial statements for 2022.

### *Automation*

The Finance Process Automation and Streamlining Project was successfully implemented in 2021 and further finetuned in 2022 to increase operational efficiency in vendor payment processing and reporting – with the number of days from invoice receipt to payment reduced to 13 days. The PTS replaced manual typing of invoice data into the Enterprise Resource Planning module and paper archives with modern technical digital solutions and an electronic data storage system.

In 2022, approximately 3000 invoices were processed through the e-invoicing system. Support was also provided to process travel which reached a record high of over 200 participants per month in the fourth quarter of the year. To support travel administration in 2022, the PTS introduced automated air ticket reconciliation and initiated further automation of forms for registers, advances and consultancy payments of participants.

### *Vienna International Centre Based International Organizations Finance Conference*

The CTBTO hosted the VBO finance conference. This annual event provides a forum for the exchange of best practices among the VBO community of

**3000**  
INVOICES WERE  
PROCESSED THROUGH  
THE E-INVOICING  
SYSTEM

finance professionals. For 2022, the agenda of the conference included keynote speakers from academia, individual experts, other United Nations System Organizations and duty stations. Topics covered included those of cross-cutting interest, such as digital transformation and the future of finance, blockchain technology applications, challenges and opportunities in the area of treasury and investments, upcoming changes in financial reporting standards, audit and compliance, automation of finance processes, challenges in forecasting and budget preparation, energy prices, mutual recognition within the United Nations system and updates from the United Nations Joint Staff Pension Fund. The sharing of experiences and lessons learned provides for enhanced efficiencies and process improvements for all stakeholders involved.

### *Statutory Compliance*

In 2022, the PTS onboarded a new external auditor and prepared and provided a series of presentations and walkthroughs of all finance, procurement and other administration related processes.

The PTS was also positively assessed in the EU pillar assessment exercise which focused on the following pillars: pillar 7 - exclusion from access to funding; pillar 8 - publication of information on recipients; and pillar 9 - protection of personal data.

## GENERAL SERVICES

During the reporting period, the cooperation and dialogue with the other VBOs continued in an uninterrupted manner. The PTS actively participated in all inter-VBO committees, both decision making and advisory. During the reporting period, the PTS continued to seek the best value for money from the respective service providing VBO, using existing contracts for the supply of different goods and services and shifting to more efficient and cost effective service schemes.

In 2022, General Services continued work on the development of PTS-wide procedures for the management of documents, including their electronic handling and signature and the automation of document management processes. In addition, the PTS further consolidated cross-Divisional arrangements to

optimize the use of available space and accommodate pressing archiving needs to ensure safe storage of the records and documentation of the Commission.

General Services also continued to perfect working modalities aimed at ensuring a timely and uninterrupted provision of support and services in all areas of its work, including the processing, issuance and renewal of documents required to support the continuity of official PTS functions as well as staff needs.

During the reporting period, General Services provided the necessary support related to travel and booking arrangements.

General Services also continued to facilitate and support the activities and needs of the CTBTO TeST Centre at Seibersdorf, Austria, and made further progress in modernizing its transport fleet, as required by the administrative regulations in place.

All customs declarations for the release of CTBTO equipment were processed and submitted to the customs clearing agents in a timely manner.

# 838

**PROCUREMENT  
CONTRACTS**

## PROCUREMENT

As of 31 December 2022, the PTS completed major milestones in the project implementation of streamlining Enterprise Resource Planning processes in the areas of several additional functionalities. These included a catalogue solution for call-off contracts, a new procure-to-pay cycle report, and the roll-out of procurement plans in SAP. The latter has notably provided significant benefits, allowing the PTS to streamline processes, realize efficiencies, achieve increased transparency, address audit recommendations and optimize its resources.

Furthermore, in 2022 the Procurement Services Section received the EU final complementary pillar assessment letter, which enabled the PTS to continue receiving EU extrabudgetary funding based on the provided reasonable assurance to the European Commission that the PTS fulfils the requirements set out in the EU Financial Regulation.

Despite restrictions to on-site work due to the COVID-19 pandemic in place until August 2022, the PTS sustained its operations in a flexible and agile manner and

continued its procurement support to meet the programmatic needs of the PTS in a remote working environment.

The Commission obligated \$57 741 013 through 838 procurement contracts and \$827 773 through 514 low value purchases for an overall aggregated total of \$58 568 786 in procurement implementation as at 31 December 2022.

As of 31 December 2022, 149 IMS stations, 29 noble gas systems, 14 radionuclide laboratories and 5 radionuclide laboratories with noble gas capability were under contractual arrangements for testing and evaluation or for PCAs.

## RESOURCE MOBILIZATION

In a zero real growth budget environment, raising extrabudgetary resources for projects that converge with the strategic goals of the Commission is of increasing importance.

In 2022, the Commission received voluntary contributions from notable country donors (Austria, France, Germany and the United States of America). Additionally, the Commission received funds from the Richard Lounsbery Foundation for support for early career women in STEM with particular focus on the Global South. Finally the PTS continued to receive national contributions to fund PCAs for some certified stations, operation, maintenance and equipment support, technical assistance for radionuclide analysis and noble gas systems and cost-free experts.

**92**  
COUNTRIES

## HUMAN RESOURCES

**296**  
REGULAR FIXED TERM  
STAFF MEMBERS

Throughout 2022, the PTS continued its efforts to improve human resources policies, procedures and processes. The Organization secured the human resources for its operations by recruiting high calibre candidates and retaining highly competent and committed staff, empowered to contribute at their best. Recruitment was based on obtaining the highest standards of transparency, efficiency, professional expertise, experience, competence and integrity. Full attention was paid to the principle of diversity and inclusion, equal employment

### Fixed Term Staff Members by Field of Work as of 31 December 2022

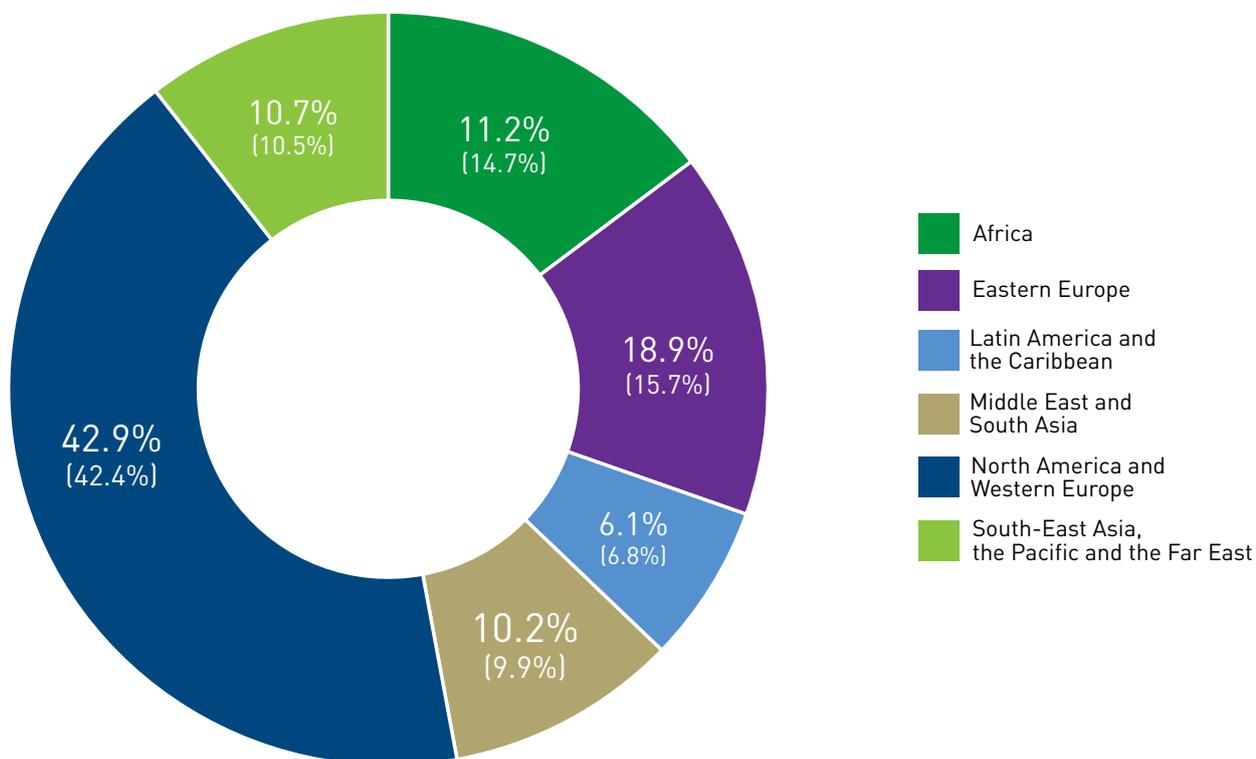
Field of Work	Professional	General Service	Total
QMPM Section	3	1	4
IMS Division	39	28	67
IDC Division	79	17	96
OSI Division	19	7	26
<i>Subtotal, verification related</i>	<i>140</i>	<i>53</i>	<i>193</i>
<i>Share, verification related</i>	<i>71.4%</i>	<i>53.0%</i>	<i>65.2%</i>
Office of the Executive Secretary	6	3	9
Internal Audit	4	1	5
Human Resources Services	4	8	12
Division of Administration	22	19	41
Legal and External Relations Division	20	16	36
<i>Subtotal, non-verification-related</i>	<i>56</i>	<i>47</i>	<i>103</i>
<i>Share, non-verification-related</i>	<i>28.6%</i>	<i>47.0%</i>	<i>34.8%</i>
<b>Total</b>	<b>196</b>	<b>100</b>	<b>296</b>

opportunities, to the importance of recruiting staff on as wide a geographical basis as possible and to other relevant criteria in the Treaty and the Staff Regulations.

As of 31 December 2022, there were 296 regular fixed term staff members of the PTS from 92 countries, compared with 286 staff members from 92 countries on 31 December 2021. In 2022, there were 196 staff members in the Professional and higher categories, while in 2021 there were 191. By the end of 2022, 39.3% of staff at the professional or higher level were women compared to 36.6% at the end of 2021.

### Fixed term Professional staff and higher category by geographical region as of 31 December 2022

(Percentages as of 31 December 2021 are shown in brackets)



### Fixed Term Staff Members by Grade, 2021 and 2022

Grade	2021		2022	
	Count	Percentage	Count	Percentage
D1	6	2.1%	5*	1.7%
P5	32	11.2%	33	11.1%
P4	59	20.6%	58	19.6%
P3	62	21.7%	70	23.6%
P2	32	11.2%	30	10.1%
<i>Subtotal</i>	<i>191</i>	<i>66.8%</i>	<i>196</i>	<i>66.2%</i>
G7	1	0.3%	1	0.3%
G6 <sup>†</sup>	3	1%	6	2.0%
G6	27	9.4%	28	9.5%
G5	44	15.4%	44	14.9%
G4	20	7%	21	7.1%
<i>Subtotal</i>	<i>95</i>	<i>33.2%</i>	<i>100</i>	<i>33.8%</i>
<b>Total</b>	<b>286</b>	<b>(100%)</b>	<b>296</b>	<b>(100%)<sup>‡</sup></b>

\* Figures reported are as at 31 December for each year. Note that one Director's term expired on 30 November 2022.

† Internationally recruited.

‡ Subtotal percentages are determined by the calculation of the subtotal number divided by the total number reported.

### Fixed Term Staff Members by Grade and Gender, 2021 and 2022

Grade	Male				Female			
	2021		2022		2021		2022	
D1	3	1.9%	3	1.9%	3	2.4%	2*	1.5%
P5	20	12.4%	18	11.1%	12	9.6%	15	11.2%
P4	40	24.8%	37	22.8%	19	15.2%	21	15.7%
P3	44	27.3%	48	29.6%	18	14.4%	22	16.4%
P2	14	8.7%	13	8.0%	18	14.4%	17	12.7%
<i>Subtotal</i>	<i>121</i>	<i>75.2%</i>	<i>119</i>	<i>73.5%</i>	<i>70</i>	<i>56%</i>	<i>77</i>	<i>57.5%</i>
G7	-	-	-	-	1	0.8%	1	0.7%
G6 <sup>†</sup>	3	1.9%	6	3.7%	-	-	-	-
G6	18	11.2%	18	11.1%	9	7.2%	10	7.5%
G5	14	8.7%	14	8.6%	30	24%	30	22.4%
G4	5	3.1%	5	3.1%	15	12%	16	11.9%
<i>Subtotal</i>	<i>40</i>	<i>24.8%</i>	<i>43</i>	<i>26.5%</i>	<i>55</i>	<i>44%</i>	<i>57</i>	<i>42.5%</i>
<b>Total</b>	<b>161</b>	<b>100%</b>	<b>162</b>	<b>100%<sup>‡</sup></b>	<b>125</b>	<b>100%</b>	<b>134</b>	<b>100%</b>

\* Figures reported are as at 31 December for each year. Note that one Director's term expired on 30 November 2022.

† Internationally recruited.

‡ Subtotal percentages are determined by the calculation of the subtotal number divided by the total number reported.



# 176

## SIGNATURE AND RATIFICATION



# 186

STATES SIGNATORIES

# 176

RATIFIED

# 10

SIGNED BUT NOT RATIFIED

AS OF 31 DECEMBER 2022

# STATES WHOSE RATIFICATION IS REQUIRED FOR THE TREATY TO ENTER INTO FORCE

## ANNEX 2

### 44 States

- 36 Ratified
- 5 Signed But Not Ratified
- 3 Not Signed

State	Date of Signature	Date of Ratification
Algeria	15 Oct. 1996	11 Jul. 2003
Argentina	24 Sep. 1996	4 Dec. 1998
Australia	24 Sep. 1996	9 Jul. 1998
Austria	24 Sep. 1996	13 Mar. 1998
Bangladesh	24 Oct. 1996	8 Mar. 2000
Belgium	24 Sep. 1996	29 Jun. 1999
Brazil	24 Sep. 1996	24 Jul. 1998
Bulgaria	24 Sep. 1996	29 Sep. 1999
Canada	24 Sep. 1996	18 Dec. 1998
Chile	24 Sep. 1996	12 Jul. 2000
China	24 Sep. 1996	
Colombia	24 Sep. 1996	29 Jan. 2008
Democratic People's Republic of Korea		
Democratic Republic of the Congo	4 Oct. 1996	28 Sep. 2004
Egypt	14 Oct. 1996	
Finland	24 Sep. 1996	15 Jan. 1999
France	24 Sep. 1996	6 Apr. 1998
Germany	24 Sep. 1996	20 Aug. 1998
Hungary	25 Sep. 1996	13 Jul. 1999
India		
Indonesia	24 Sep. 1996	6 Feb. 2012
Iran (Islamic Republic of)	24 Sep. 1996	

State	Date of Signature	Date of Ratification
Israel	25 Sep. 1996	
Italy	24 Sep. 1996	1 Feb. 1999
Japan	24 Sep. 1996	8 Jul. 1997
Mexico	24 Sep. 1996	5 Oct. 1999
Netherlands	24 Sep. 1996	23 Mar. 1999
Norway	24 Sep. 1996	15 Jul. 1999
Pakistan		
Peru	25 Sep. 1996	12 Nov. 1997
Poland	24 Sep. 1996	25 May 1999
Republic of Korea	24 Sep. 1996	24 Sep. 1999
Romania	24 Sep. 1996	5 Oct. 1999
Russian Federation	24 Sep. 1996	30 Jun. 2000
Slovakia	30 Sep. 1996	3 Mar. 1998
South Africa	24 Sep. 1996	30 Mar. 1999
Spain	24 Sep. 1996	31 Jul. 1998
Sweden	24 Sep. 1996	2 Dec. 1998
Switzerland	24 Sep. 1996	1 Oct. 1999
Türkiye	24 Sep. 1996	16 Feb. 2000
Ukraine	27 Sep. 1996	23 Feb. 2001
United Kingdom	24 Sep. 1996	6 Apr. 1998
United States of America	24 Sep. 1996	
Viet Nam	24 Sep. 1996	10 Mar. 2006

# SIGNATURE AND RATIFICATION OF THE TREATY BY GEOGRAPHICAL REGION

## AFRICA

### 54 States

<span style="color: green;">■</span>	50 Ratified
<span style="color: orange;">■</span>	1 Signed But Not Ratified
<span style="color: red;">■</span>	3 Not Signed

State	Date of Signature	Date of Ratification
Algeria	15 Oct. 1996	11 Jul. 2003
Angola	27 Sep. 1996	20 Mar. 2015
Benin	27 Sep. 1996	6 Mar. 2001
Botswana	16 Sep. 2002	28 Oct. 2002
Burkina Faso	27 Sep. 1996	17 Apr. 2002
Burundi	24 Sep. 1996	24 Sep. 2008
Cabo Verde	1 Oct. 1996	1 Mar. 2006
Cameroon	16 Nov. 2001	6 Feb. 2006
Central African Republic	19 Dec. 2001	26 May 2010
Chad	8 Oct. 1996	8 Feb. 2013
Comoros	12 Dec. 1996	19 Feb. 2021
Congo	11 Feb. 1997	2 Sep. 2014
Côte d'Ivoire	25 Sep. 1996	11 Mar. 2003
Democratic Republic of the Congo	4 Oct. 1996	28 Sep. 2004
Djibouti	21 Oct. 1996	15 Jul. 2005
Egypt	14 Oct. 1996	
Equatorial Guinea	9 Oct. 1996	22 Sep. 2022
Eritrea	11 Nov. 2003	11 Nov. 2003
Eswatini	24 Sep. 1996	21 Sep. 2016
Ethiopia	25 Sep. 1996	8 Aug. 2006
Gabon	7 Oct. 1996	20 Sep. 2000
Gambia	9 Apr. 2003	25 Mar. 2022
Ghana	3 Oct. 1996	14 Jun. 2011
Guinea	3 Oct. 1996	20 Sep. 2011
Guinea-Bissau	11 Apr. 1997	24 Sep. 2013
Kenya	14 Nov. 1996	30 Nov. 2000
Lesotho	30 Sep. 1996	14 Sep. 1999

State	Date of Signature	Date of Ratification
Liberia	1 Oct. 1996	17 Aug. 2009
Libya	13 Nov. 2001	6 Jan. 2004
Madagascar	9 Oct. 1996	15 Sep. 2005
Malawi	9 Oct. 1996	21 Nov. 2008
Mali	18 Feb. 1997	4 Aug. 1999
Mauritania	24 Sep. 1996	30 Apr. 2003
Mauritius		
Morocco	24 Sep. 1996	17 Apr. 2000
Mozambique	26 Sep. 1996	4 Nov. 2008
Namibia	24 Sep. 1996	29 Jun. 2001
Niger	3 Oct. 1996	9 Sep. 2002
Nigeria	8 Sep. 2000	27 Sep. 2001
Rwanda	30 Nov. 2004	30 Nov. 2004
São Tomé and Príncipe	26 Sep. 1996	22 Sep. 2022
Senegal	26 Sep. 1996	9 Jun. 1999
Seychelles	24 Sep. 1996	13 Apr. 2004
Sierra Leone	8 Sep. 2000	17 Sep. 2001
Somalia		
South Africa	24 Sep. 1996	30 Mar. 1999
South Sudan		
Sudan	10 Jun. 2004	10 Jun. 2004
Togo	2 Oct. 1996	2 Jul. 2004
Tunisia	16 Oct. 1996	23 Sep. 2004
Uganda	7 Nov. 1996	14 Mar. 2001
United Republic of Tanzania	30 Sep. 2004	30 Sep. 2004
Zambia	3 Dec. 1996	23 Feb. 2006
Zimbabwe	13 Oct. 1999	13 Feb. 2019

*EASTERN EUROPE***23 States****23 Ratified**

State	Date of Signature	Date of Ratification
Albania	27 Sep. 1996	23 Apr. 2003
Armenia	1 Oct. 1996	12 Jul. 2006
Azerbaijan	28 Jul. 1997	2 Feb. 1999
Belarus	24 Sep. 1996	13 Sep. 2000
Bosnia and Herzegovina	24 Sep. 1996	26 Oct. 2006
Bulgaria	24 Sep. 1996	29 Sep. 1999
Croatia	24 Sep. 1996	2 Mar. 2001
Czech Republic	12 Nov. 1996	11 Sep. 1997
Estonia	20 Nov. 1996	13 Aug. 1999
Georgia	24 Sep. 1996	27 Sep. 2002
Hungary	25 Sep. 1996	13 Jul. 1999
Latvia	24 Sep. 1996	20 Nov. 2001
Lithuania	7 Oct. 1996	7 Feb. 2000
Montenegro	23 Oct. 2006	23 Oct. 2006
North Macedonia	29 Oct. 1998	14 Mar. 2000
Poland	24 Sep. 1996	25 May 1999
Republic of Moldova	24 Sep. 1997	16 Jan. 2007
Romania	24 Sep. 1996	5 Oct. 1999
Russian Federation	24 Sep. 1996	30 Jun. 2000
Serbia	8 Jun. 2001	19 May 2004
Slovakia	30 Sep. 1996	3 Mar. 1998
Slovenia	24 Sep. 1996	31 Aug. 1999
Ukraine	27 Sep. 1996	23 Feb. 2001

*LATIN AMERICA AND THE CARIBBEAN***33 States****33 Ratified**

State	Date of Signature	Date of Ratification
Antigua and Barbuda	16 Apr. 1997	11 Jan. 2006
Argentina	24 Sep. 1996	4 Dec. 1998
Bahamas	4 Feb. 2005	30 Nov. 2007
Barbados	14 Jan. 2008	14 Jan. 2008
Belize	14 Nov. 2001	26 Mar. 2004
Bolivia (Plurinational State of)	24 Sep. 1996	4 Oct. 1999
Brazil	24 Sep. 1996	24 Jul. 1998
Chile	24 Sep. 1996	12 Jul. 2000
Colombia	24 Sep. 1996	29 Jan. 2008
Costa Rica	24 Sep. 1996	25 Sep. 2001
Cuba	4 Feb. 2021	4 Feb. 2021
Dominica	25 May 2022	30 Jun. 2022
Dominican Republic	3 Oct. 1996	4 Sep. 2007
Ecuador	24 Sep. 1996	12 Nov. 2001
El Salvador	24 Sep. 1996	11 Sep. 1998
Grenada	10 Oct. 1996	19 Aug. 1998
Guatemala	20 Sep. 1999	12 Jan. 2012
Guyana	7 Sep. 2000	7 Mar. 2001
Haiti	24 Sep. 1996	1 Dec. 2005
Honduras	25 Sep. 1996	30 Oct. 2003
Jamaica	11 Nov. 1996	13 Nov. 2001
Mexico	24 Sep. 1996	5 Oct. 1999
Nicaragua	24 Sep. 1996	5 Dec. 2000
Panama	24 Sep. 1996	23 Mar. 1999
Paraguay	25 Sep. 1996	4 Oct. 2001
Peru	25 Sep. 1996	12 Nov. 1997
Saint Kitts and Nevis	23 Mar. 2004	27 Apr. 2005
Saint Lucia	4 Oct. 1996	5 Apr. 2001
Saint Vincent and the Grenadines	2 Jul. 2009	23 Sep. 2009
Suriname	14 Jan. 1997	7 Feb. 2006
Trinidad and Tobago	8 Oct. 2009	26 May 2010
Uruguay	24 Sep. 1996	21 Sep. 2001
Venezuela (Bolivarian Republic of)	3 Oct. 1996	13 May 2002

## MIDDLE EAST AND SOUTH ASIA

### 26 States

 16 Ratified

 5 Signed But Not Ratified

 5 Not Signed

State	Date of Signature	Date of Ratification
Afghanistan	24 Sep. 2003	24 Sep. 2003
Bahrain	24 Sep. 1996	12 Apr. 2004
Bangladesh	24 Oct. 1996	8 Mar. 2000
Bhutan		
India		
Iran (Islamic Republic of)	24 Sep. 1996	
Iraq	19 Aug. 2008	26 Sep. 2013
Israel	25 Sep. 1996	
Jordan	26 Sep. 1996	25 Aug. 1998
Kazakhstan	30 Sep. 1996	14 May 2002
Kuwait	24 Sep. 1996	6 May 2003
Kyrgyzstan	8 Oct. 1996	2 Oct. 2003
Lebanon	16 Sep. 2005	21 Nov. 2008
Maldives	1 Oct. 1997	7 Sep. 2000
Nepal	8 Oct. 1996	
Oman	23 Sep. 1999	13 Jun. 2003
Pakistan		
Qatar	24 Sep. 1996	3 Mar. 1997
Saudi Arabia		
Sri Lanka	24 Oct. 1996	
Syrian Arab Republic		
Tajikistan	7 Oct. 1996	10 Jun. 1998
Turkmenistan	24 Sep. 1996	20 Feb. 1998
United Arab Emirates	25 Sep. 1996	18 Sep. 2000
Uzbekistan	3 Oct. 1996	29 May 1997
Yemen	30 Sep. 1996	

## NORTH AMERICA AND WESTERN EUROPE

### 28 States

 27 Ratified

 1 Signed But Not Ratified

State	Date of Signature	Date of Ratification
Andorra	24 Sep. 1996	12 Jul. 2006
Austria	24 Sep. 1996	13 Mar. 1998
Belgium	24 Sep. 1996	29 Jun. 1999
Canada	24 Sep. 1996	18 Dec. 1998
Cyprus	24 Sep. 1996	18 Jul. 2003
Denmark	24 Sep. 1996	21 Dec. 1998
Finland	24 Sep. 1996	15 Jan. 1999
France	24 Sep. 1996	6 Apr. 1998
Germany	24 Sep. 1996	20 Aug. 1998
Greece	24 Sep. 1996	21 Apr. 1999
Holy See	24 Sep. 1996	18 Jul. 2001
Iceland	24 Sep. 1996	26 Jun. 2000
Ireland	24 Sep. 1996	15 Jul. 1999
Italy	24 Sep. 1996	1 Feb. 1999
Liechtenstein	27 Sep. 1996	21 Sep. 2004
Luxembourg	24 Sep. 1996	26 May 1999
Malta	24 Sep. 1996	23 Jul. 2001
Monaco	1 Oct. 1996	18 Dec. 1998
Netherlands	24 Sep. 1996	23 Mar. 1999
Norway	24 Sep. 1996	15 Jul. 1999
Portugal	24 Sep. 1996	26 Jun. 2000
San Marino	7 Oct. 1996	12 Mar. 2002
Spain	24 Sep. 1996	31 Jul. 1998
Sweden	24 Sep. 1996	2 Dec. 1998
Switzerland	24 Sep. 1996	1 Oct. 1999
Türkiye	24 Sep. 1996	16 Feb. 2000
United Kingdom	24 Sep. 1996	6 Apr. 1998
United States of America	24 Sep. 1996	

## SOUTH EAST ASIA, THE PACIFIC AND THE FAR EAST

### 32 States

■ 27 Ratified

■ 3 Signed But Not Ratified

■ 2 Not Signed

State	Date of Signature	Date of Ratification
Australia	24 Sep. 1996	9 Jul. 1998
Brunei Darussalam	22 Jan. 1997	10 Jan. 2013
Cambodia	26 Sep. 1996	10 Nov. 2000
China	24 Sep. 1996	
Cook Islands	5 Dec. 1997	6 Sep. 2005
Democratic People's Republic of Korea		
Fiji	24 Sep. 1996	10 Oct. 1996
Indonesia	24 Sep. 1996	6 Feb. 2012
Japan	24 Sep. 1996	8 Jul. 1997
Kiribati	7 Sep. 2000	7 Sep. 2000
Lao People's Democratic Republic	30 Jul. 1997	5 Oct. 2000
Malaysia	23 Jul. 1998	17 Jan. 2008
Marshall Islands	24 Sep. 1996	28 Oct. 2009
Micronesia (Federated States of)	24 Sep. 1996	25 Jul. 1997
Mongolia	1 Oct. 1996	8 Aug. 1997
Myanmar	25 Nov. 1996	21 Sep. 2016
Nauru	8 Sep. 2000	12 Nov. 2001
New Zealand	27 Sep. 1996	19 Mar. 1999
Niue	9 Apr. 2012	4 Mar. 2014
Palau	12 Aug. 2003	1 Aug. 2007
Papua New Guinea	25 Sep. 1996	
Philippines	24 Sep. 1996	23 Feb. 2001
Republic of Korea	24 Sep. 1996	24 Sep. 1999
Samoa	9 Oct. 1996	27 Sep. 2002
Singapore	14 Jan. 1999	10 Nov. 2001
Solomon Islands	3 Oct. 1996	
Thailand	12 Nov. 1996	25 Sep. 2018
Timor-Leste	26 Sep. 2008	1 Aug. 2022
Tonga		
Tuvalu	25 Sep. 2018	1 Apr. 2022
Vanuatu	24 Sep. 1996	16 Sep. 2005
Viet Nam	24 Sep. 1996	10 Mar. 2006





**CTBTO**  
PREPARATORY COMMISSION

PUTTING AN  
END TO NUCLEAR  
EXPLOSIONS