

2023 Annual Report

Resilience and Resolve



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PREPARATORY COMMISSION

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NUCLEAR-TEST-BAN
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This report by the Executive Secretary to the Sixty-Second Session of the Preparatory Commission gives an account of the major activities of the Commission and the Provisional Technical Secretariat in 2023. Unlike other, more detailed reports to the Commission and its Working Groups, this report is primarily intended for a non-expert audience.

Message from the Executive Secretary

I am pleased to present to you the 2023 Annual Report of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO).

The Comprehensive Nuclear-Test-Ban Treaty and our Organization remain at the centre of the global effort to achieve a world free of nuclear testing and are key elements of the broader nuclear disarmament and non-proliferation regime. Despite a challenging international environment, our community continued to advance our common objectives in 2023. Support for the Treaty was evident not only in the growing numbers of States which have deposited their instruments of ratification, but also in the way we came together, States Signatories and staff of the Secretariat alike, to take the work of the Commission forward.

Universalization of the Treaty and its entry into force continue to be at the top of my priorities. The urgency of the Treaty's entry into force is perhaps clearer now than at any time in recent memory, demonstrated by amplified calls for action from States Signatories in 2023. Those calls were heard. In 2022 and 2023, the Treaty was ratified by eight additional States, and signed by two. This progress is a critical indicator of the international community's continued confidence in the Treaty. By the end of 2023, 187 States had signed the Treaty, and 177 had ratified it. I thank all those whose tireless work stands behind each of those numbers, and those yet to come.

Regrettably, one State Signatory withdrew its instrument of ratification in 2023. This development was deeply disappointing, but it did not dampen our community's commitment to our common goals.

The essential role of the Treaty was recognized and underlined at numerous multilateral fora during the year, including at the Conference on Disarmament, in the United Nations General Assembly, and at the first session of the Preparatory Committee for the 2026 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons. The 13th Conference on Facilitating the Entry into Force of the CTBT (or Article XIV conference), which took place in New York in September, was the focal point for supporters championing entry into force. I thank once again the Foreign Ministers of Norway and Panama for their central role in the success of that conference and its important declaration.

2023 also saw the Commission host the biennial CTBT: Science and Technology conference at the Hofburg Palace in Vienna. Held in a fully hybrid format for the first time, the conference welcomed more than 2000 participants from around 150 countries across five days. There were 16 panel discussions and more than 100 presentations. The conference focused not only on the scientific advances that underpin confidence in the CTBTO's International Monitoring System (IMS), but also the broad and ever-growing civil and scientific benefits from the data our global system generates. 'The Power of Together' emerged as a defining theme of the Conference, testament to the tremendous spirit of cooperation and collaboration which was on display throughout.

We continued our work throughout 2023 to ensure that the benefits of the Treaty are understood and accessible to each and every State Signatory that wishes to make use of them. The National Data Centres for All (NDCs4All) initiative – one of my highest priorities – took further steps

towards this goal. Several new States Signatories received capacity building systems and signed up for Secure Signatory Accounts, both crucial steps in ensuring that IMS data can flow. NDCs around the world are increasingly taking advantage of data for national priorities and two more tsunami warning agreements were signed in 2023.

Capacity building programmes also continued to be rolled out. Our training courses for NDCs and other stakeholders continued in 2023 to build expertise across our States Signatories on the IMS, the International Data Centre (IDC), and on-site inspection – in order to support our operations and to prepare for the entry into force of the Treaty. Participation in IDC activities grew considerably in 2023, and I am proud to report that the participation of women grew by more than 30% as compared to 2022. The Organization continued to build out its multilingual training options, with 2023 marking the first regional training course for Spanish-speaking NDCs, to go alongside our existing offerings in English, Russian and French.

The IMS was further bolstered in 2023 with the completion of segments in Argentina and the Russian Federation. These were major achievements in our progress towards completing the global network that ensures no nuclear test goes undetected. By the end of 2023, 306 IMS facilities had been established and certified. We are getting ever closer to our goal of a complete and fully certified IMS. This progress came about as we continued to focus on ensuring that the IMS remains fit for purpose now and in the future. The Secretariat engaged closely during 2023 with States Signatories on an approach to address IMS sustainment and looks forward to continuing that process.

The IDC continued to develop its capabilities and those of our States Signatories, with a focus on ensuring we are moving with technological advancements and meeting our mandated performance targets. The increased use of artificial intelligence and machine learning in the processing of IDC data is emblematic of our progress, as is the further development of NDC in a box, which received major upgrades in 2023. The 2023 IDC experiment, the first to be conducted since the first cycle of experiments ended in 2019, was a key milestone in the progressive commissioning of the IDC.

In the second half of 2023, our on-site inspection readiness took a major step forward with the successful holding of three directed exercises. These were the Organization's first field exercises since 2014 and served to help build the Organization's capability towards the Integrated Field Exercise in 2025 in Sri Lanka. At the same time, our next generation training programme for surrogate inspectors helped to deliver the expertise we need to deliver on our on-site inspection mandate in the coming years.

One of my key priorities is ensuring an efficient, effective and agile PTS that continues to deliver value for our States Signatories. There were continued macroeconomic challenges throughout 2023 and the Secretariat focused on risk management, financial resilience and cross-cutting efficiencies to support programmatic delivery. We have also continued to focus on ensuring a diverse and talented Secretariat workforce. 2023 saw continued progress towards gender parity at the Organization, and further initiatives were launched to ensure that the best candidates from around the world can and will apply for positions in our Organization. The new CTBTO Jobs Bulletin for States Signatories was one such initiative. Another was the second cycle of the CTBTO mentoring programme for early career women in science, technology, engineering and mathematics, which served to build the skills of 13 mentees from all CTBTO geographical regions.

2023 was a year of big challenges and one of big successes for our Organization. I thank all those who played a role in our achievements through the year, and look forward to continuing our work together in the years ahead.

Robert Floyd
Executive Secretary
CTBTO Preparatory Commission
Vienna, April 2024

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Abbreviations

3-C	three component	OSI	on-site inspection
ATG	alpha testers group	PCA	post-certification activity
BGAN	broadband global area network	PKI	public key infrastructure
BIPM	International Bureau of Weights and Measures	PSR	possible source region
BOO	base of operations	PTE	proficiency test exercise
BUE	build-up exercise	PTS	Provisional Technical Secretariat
CBS	capacity building system	QA/QC	quality assurance and quality control
CENESS	Center for Energy and Security Studies	QMS	Quality Management System
COPC	CTBTO Operations Centre	QMPPM	Quality Management and Performance Monitoring (Section)
CTBT	Comprehensive Nuclear-Test-Ban Treaty	RASA	radionuclide aerosol sampler and analyser
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization	REB	Reviewed Event Bulletin
CYG	CTBTO Youth Group	RIC	Regional Introductory Course
ECMWF	European Centre for Medium-Range Weather Forecasts	SAUNA	Swedish Automatic Unit for Noble Gas Acquisition
ECS	Experts Communication System	SEL	Standard Event List
EIMO	Equipment and Instrumentation Management System for OSI	SHI	seismic, hydroacoustic and infrasound
ESS	Employee Self-Service	SnT	CTBT: Science and Technology conference
ETA	expert technical analysis	SPALAX	Système de prélèvement automatique en ligne avec l'analyse des radio xénon
EU	European Union	SOH	state of health
FDSN	International Federation of Digital Seismograph Networks	SRMR	State Requested Methods Report
HRS	Human Resources Services	SSA	Secure Signatory Account
GCI	Global Communications Infrastructure	SSI	standard station interface
GIMO	Geospatial Information Management for OSI system	STEM	science, technology, engineering and mathematics
GMS	Geophysical Monitoring System	TeST	Technology Support and Training (Centre)
IBS	Internet Based Service	UNGA	United Nations General Assembly
IDANT	International Day against Nuclear Tests	UNIS	United Nations Information Service
IDC	International Data Centre	UNODA	United Nations Office for Disarmament Affairs
IFE	Integrated Field Exercise	VATP	validation and acceptance test plan
IMS	International Monitoring System	VBO	VIC based international organization
IPSAS	United Nations International Public Sector Accounting Standards	VIC	Vienna International Centre
LMS	learning management system	VPN	virtual private network
LTP	linear training programme	VSAT	very small aperture terminal
MMPSR	Multiple Model Possible Source Region	WGA	Working Group A
NDC	National Data Centre	WGB	Working Group B
NDCs4All	National Data Centres for All		
O&M	operation and maintenance		

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 preparing for the first session of the Conference of the States Parties to the Treaty.

The Commission is made up of a plenary body responsible for directing policy and comprising all States Signatories, and has a Provisional Technical Secretariat which assists the Commission in its duties, both technically and substantively, and which carries 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.

1. THE INTERNATIONAL MONITORING SYSTEM

Highlights in 2023

- Certification of monitoring facilities RN2 and AS92, completing the International Monitoring System segments in Argentina and the Russian Federation
- Revalidation of RN40 and RN79 following their relocation to new facilities
- Surveillance assessments of the IMS radionuclide laboratories RL1, RL2, RL7, RL11, RL12 and RL14 completed

Introduction

- 1.1. 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.
- 1.2. 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.
- 1.3. 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

- 1.4. 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.
- 1.5. Seismic technology is very efficient at detecting a suspected nuclear explosion, as seismic waves travel fast and can be registered within a short period of time after the occurrence 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).

- 1.6. 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.
- 1.7. 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.
- 1.8. 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).

Infrasound Stations

- 1.9. 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.
- 1.10. Infrasound waves cause minute variations in atmospheric pressure that are measured by microbarometers. Infrasound can 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.
- 1.11. IMS infrasound stations are located 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.
- 1.12. 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.

Hydroacoustic Stations

- 1.13. 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.

- 1.14. 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.
- 1.15. 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.
- 1.16. 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.

Radionuclide Particulate Stations

- 1.17. 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.
- 1.18. 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.

Noble Gas Detection Systems

- 1.19. 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.
- 1.20. 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.

- 1.21. 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

- 1.22. 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.
- 1.23. 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 annual proficiency test exercises (PTEs) organized by the Commission, which are key elements of quality assurance and quality control (QA/QC) of IMS laboratories. This includes both particulate and noble gas PTEs.

Completing the International Monitoring System

- 1.24. 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.
- 1.25. In 2023, the certification of RN2 in Argentina and the establishment and certification of AS92 in the Russian Federation completed the IMS segments in both countries. With these certifications, as of 2023 110 auxiliary seismic stations and 73 radionuclide stations have been installed and certified in total throughout the IMS network.
- 1.26. The monitoring of radionuclide noble gases plays an essential role in the verification system of the Treaty. In line with its priorities, the Commission continued to focus on the noble gas monitoring programme in 2023 through close cooperation with the developers of next generation noble gas systems. Since the acceptance process for the Xenon

International noble gas system was successfully concluded in 2022, three next generation systems have been accepted for use in the IMS.

- 1.27. As of the end of 2023, 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 stringent technical requirements.

Table 1. Status of the Installation and Certification Programme for International Monitoring System Stations as of 31 December 2023

IMS Station Type	Installation Complete		Under Construction	Contract Under Negotiation	Not Started
	Certified	Not Certified			
Primary seismic	45	1	-	1	3
Auxiliary seismic	110	7	-	-	3
Hydroacoustic	11	-	-	-	-
Infrasound	53	1	1	-	5
Radionuclide	73	-	-	2	5
Total	292	9	1	3	16

Table 2. Installations and Certifications of Noble Gas Systems at Radionuclide Stations as of 31 December 2023

Total Number of Noble Gas Systems	Installed	Certified
40	32	26

Table 3. Certifications of Radionuclide Laboratories as of 31 December 2023

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

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

Agreements for Monitoring Facilities

- 1.29. The provisional operation of the IMS is underpinned by agreements and arrangements with the States that host IMS facilities, to regulate activities including maintenance and upgrade. Each facility agreement or arrangement provides for or recognizes, in the host State concerned, the Commission's privileges and immunities including exemption from taxes and customs duties: these are necessary for the functioning of the Commission, particularly the efficient and effective establishment and sustainment of the IMS.

- 1.30. 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. In 2023, negotiations with some of the remaining host States were reinvigorated with a view to concluding new facility agreements and arrangements in 2024.

Post-Certification Activities

- 1.31. 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.
- 1.32. Post-certification activity (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 2023 was approximately US \$22 million. This amount covers the costs related to PCAs for 184 IMS facilities, including noble gas systems and radionuclide laboratories.
- 1.33. Each station operator submits a monthly report on PCA performance, which the Provisional Technical Secretariat (PTS) reviews for compliance with operation and maintenance (O&M) plans. The Commission has developed standardized criteria for the review and evaluation of the performance of station operators.
- 1.34. 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 2023, 139 out of 168 stations and noble gas systems under PCA contracts had submitted O&M plans in the standard format.

Sustaining Performance

- 1.35. The life cycle of 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 actions, repairs, replacement, upgrades and continuous improvements to ensure monitoring capabilities are technologically up to date. 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.
- 1.36. The Commission continues to focus 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.
- 1.37. 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.

- 1.38. Preserving the substantial investments made by States Signatories in establishing the IMS network is essential for the continued delivery of the PTS's mandate. The life of major equipment has been successfully extended, thereby deferring recapitalization. However, it is not viable to keep ageing equipment that has exceeded its useful life in operation. In 2023, the PTS proposed a two-pronged approach to address IMS sustainment. The first stage focuses on actions and requirements for the current 2024-2025 biennium. The second stage looks at the longer term and the need for a rebasing of the budget for the 2026-2027 biennium and onwards.

Logistics

- 1.39. The central logistics support function continued to provide PTS-wide logistics support, including the operation and management of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) Technology Support and Training (TeST) Centre in Seibersdorf, Austria. The PTS uses the Vienna International Centre (VIC) and the CTBTO TeST Centre as platforms for logistics support for the PTS in shipping, warehouse management, goods/asset management and for the build-up and sustainment of verification activities. In 2023, the PTS finalized the standard operating procedure for the central logistics support function focusing on shipping, warehousing and goods management aspects as well as the operation and management of the CTBTO TeST Centre.
- 1.40. 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 2023, 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. Contributing to sustainability, the CTBTO TeST Centre commissioned a photovoltaic system which will provide energy savings.
- 1.41. The PTS maintained its capability for supportability analysis which underpins 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.
- 1.42. Swift customs clearance processes are crucial for minimizing disruptions to supply chains, ensuring the timely delivery of CTBTO equipment, and ultimately contributing to the functioning of IMS facilities, thus contributing to high data availability. The Commission continued to work with States Signatories and station operators to ensure smooth and timely tax- and cost-free customs clearance processes and to encourage States Signatories to establish and implement facility agreements, which contribute to efficient import and customs processes.
- 1.43. Enhanced capacity and capability in the field of health and safety are paramount when implementing activities related to the sustainment of the IMS network. Within this effort, the IMS Division implemented training for its staff in areas such as first aid training, general health and safety awareness, fire safety, working at heights and driver training. This increased capacity enables staff to make informed decisions, adhere to safety

protocols, and act decisively in challenging situations, reducing the likelihood of accidents or health related issues.

Maintenance

- 1.44. The PTS provides maintenance support and technical assistance at IMS facilities around the globe.
- 1.45. In 2023, numerous maintenance issues were addressed on-site or remotely, including long running data availability problems at several IMS facilities. Remote assistance is the preferred way of supporting the station when possible. Visits by contractors and/or PTS staff are organized when issues require specific support.
- 1.46. 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 2023, the Commission continued to advance the technical capabilities of station operators, systematically including hands-on training for local station operators during all station visits by PTS staff. A technical training programme for station operators of SHI stations in the Russian Federation was also held in Dubna in the Russian Federation in 2023.
- 1.47. 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.
- 1.48. IMS staff conducted station visits and resumed preventative maintenance visits to stations with the Swedish Automatic Unit for Noble Gas Acquisition (SAUNA), radionuclide aerosol sampler and analyser (RASA) and SPALAX systems. Preventive maintenance/troubleshooting and recovery visits were conducted to RN19, RN20, RN21, RN24, RN61, RN64, IS7, IS13, IS20, IS43, PS2, PS42, AS18, AS30, AS56, AS76 and AS97.

Recapitalization

- 1.49. Recapitalization is required when there are major failures during the life cycle of IMS facilities that affect data availability and when equipment reaches the final phase in its life cycle. In 2023, the Commission continued to recapitalize IMS facility components as they reached the planned end of their operational life cycle.
- 1.50. When managing recapitalization, the Commission and station operators consider 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.

- 1.51. Several recapitalization projects were in progress (AS56, AS57, AS118, PS17, PS26, PS44, IS2, IS4, IS5, IS11, IS18, IS19, IS25, IS40, IS49, IS51, IS52, IS53, IS55, HA9, RN1, RN7, RN34, RN49, RN53, RN56, RN57, RN63, RN77, RN80, NG11, NG38, NG49, NG77) or were completed (RN40, RN79, NG79) at certified IMS facilities in 2023. These projects, which require revalidation to ensure that the stations continue to meet technical requirements, involve substantial investments of human and financial resources.

Engineering Activities

- 1.52. 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.
- 1.53. The Commission continued its work to optimize the performance of IMS facilities and 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.
- 1.54. In 2023, the Commission concentrated its engineering efforts on the following:
 - Metrology. In 2023, the Commission continued activities with the International Bureau of Weights and Measures (BIPM) based on 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. The Commission gave an invited presentation to the Consultative Committee for Acoustic, Vibration and Ultrasound of the BIPM, highlighting the progress made over the past few years under this collaboration aiming at achieving metrological traceability of IMS SHI measurements. The results of the first intercomparison exercise for infrasound sensors were presented to a broader audience during the Infrasound Technology Workshop 2022 and the CTBT: Science and Technology conference 2023 (SnT2023). The third pilot study focusing on the evaluation of infrasound sensor performance under environmental parameter variations was ongoing at the end of 2023.
 - Sustainment and enhancement of the standard station interface (SSI) software. In order to better support station operators and public key infrastructure (PKI) operators using the SSI software, the Commission conducted a survey in 2021-2022 among station operators to collect information and configuration files from all workstations running the SSI software at IMS SHI stations. The 2021-2022 survey revealed that 92% of the IMS stations based on wave technologies are using the SSI

software. The PTS continued its efforts in 2023 to enhance the SSI software's reliability and robustness through the development of new integration tests, including the use of the next operating system (Rocky Linux 8.7), expected to progressively replace the CentOS Linux distribution upon expiration of its support services in 2024.

- 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.
- Enhancement of the CalxPy software to support the calibration of IMS seismoacoustic stations against a reference system. This included the support of multivariate analysis and publication of CalxPy in the National Data Centre (NDC) in a box alpha repository.
- Re-engineering and testing of the radionuclide SSI software continued. The first installation of the new software was performed in conjunction with the upgrade to Cinderella G2 at RN49. The new version of radionuclide SSI will be phased into operations at manual radionuclide stations from 2024.
 - The first Cinderella G2 automated particulate radionuclide sampler was installed at RN49 and its revalidation process started.
- 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. Specialized laboratory testing incorporating a bending strain relief device is planned for the first quarter of 2024.
- Nearshore and onshore sustainment actions for hydrophone stations were undertaken, including the upgrade of specialized hydrophone station onshore central recording facility equipment (Digital Data Formatter Interface and accessory components), to replace ageing spares at the central recording facilities of HA1, HA3, HA4 and to improve the resilience of these stations through remote diagnostics capability, enhanced backfilling and supplementary SOH parameters.
- A proposal addressing the technical and financial aspects of the repair of the hydroacoustic station HA8 North was received. The PTS has completed evaluation of the technical volume and initiated the evaluation of the financial volume of the proposal.

Auxiliary Seismic Network

- 1.55. The Commission continued to monitor the operation and sustainment of auxiliary seismic stations in 2023.
- 1.56. 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.

- 1.57. 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.
- 1.58. To address this, the European Union (EU), Germany, Italy and Kazakhstan 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. In 2023, AS118 in Venezuela resumed operations and underwent revalidation testing. Preliminary actions were taken at AS30, AS97 and AS76, with additional work planned in 2024. New equipment was procured for AS56 and AS74, with AS56 brought back into service and AS74 set to resume operation in the first quarter of 2024. The Commission continued its discussions with other States whose parent networks include several auxiliary seismic stations in order to make similar arrangements.

Quality Assurance

- 1.59. 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 2023 continued to focus on measures for data surety and calibration.
- 1.60. QA/QC activities for seismoacoustic capability continued. Cooperation with experts in the fields of infrasound technology, infrasound sensor development, infrasound sensor testing and calibration, laboratory and field metrology, QA, and international standardization was advanced at international venues; special sessions were dedicated to these issues during the Infrasound Technology Workshop 2022 (held in January 2023 in the Azores, Portugal) and at SnT2023.
- 1.61. 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. In this framework the PTS continued to progress the installation of calibration capabilities at infrasound facilities.
- 1.62. 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.
- 1.63. 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.

- 1.64. Under the QA/QC programme for radionuclide laboratories, the Commission organized the 2023 particulate PTE, assessed the 2022 noble gas PTE, and concluded six laboratory surveillance assessments at RL1, RL2, RL7, RL11, RL12 and RL14.

2. THE GLOBAL COMMUNICATIONS INFRASTRUCTURE

Highlights in 2023

- An average of 36 gigabytes of data and products transmitted per day
- Three additional links installed: for the NDCs of Serbia and Montenegro and for PS44
- Technology refresh proposal accepted and approved, with a new GCI contract amendment signed

Introduction

- 2.1. 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.
- 2.2. 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 link encryption to secure the communication channel and ensure that the data in transit are not tampered with.

Technology

- 2.3. 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.
- 2.4. 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.

- 2.5. At the end of 2023, the GCI network included 271 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 46 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.

Operations

- 2.6. 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 2023, the absolute availability was 98.65%. The adjusted availability for GCI III was 99.64%.
- 2.7. The figure of 36 gigabytes data per day is calculated from GCI III monitoring systems based on 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.

3. THE INTERNATIONAL DATA CENTRE

Highlights in 2023

- Strong progress in the NDCs4All initiative
- Substantial progress in IDC progressive commissioning activities with the conduct of the 2023 Experiment
- A new open source version of WEB-GRAPE desktop developed and made available

Introduction

- 3.1. 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.
- 3.2. 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 23 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

- 3.3. 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.
- 3.4. 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.
- 3.5. IDC analysts subsequently review the waveform events recorded in SEL3 and refine 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.

- 3.6. An automatic stage of processing takes place after analyst review where additional characterization parameters are computed for REB events; screening criteria are then applied to those parameters to screen out natural events. 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.

Radionuclide Measurements and Atmospheric Modelling

- 3.7. 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.
- 3.8. 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 United States National Centers for Environmental Prediction. Images generated from calculations based on ECMWF data are appended to each Reviewed Radionuclide Report. Using the WEB-GRAPE software developed by the Commission, States Signatories can combine calculations from the ECMWF and the National Centres for Environmental Prediction with radionuclide detection scenarios and nuclide specific parameters to define regions in which sources of radionuclides may be located.
- 3.9. 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

- 3.10. 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. It does so through four different internet-based methods: 1) the Secure Web Portal; 2) on-demand requests via email and subscriptions; 3) IDC external databases; and 4) data-forwarding under special arrangements.

Further Development of the Integrated CTBTO Operations Centre

- 3.11. The integrated CTBTO Operations Centre (COPC) is 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.

- 3.12. The integrated COPC also has an important role in PTS outreach activities, by providing a high-tech graphical display of the complex technology engines employed for Treaty verification. In 2023, numerous delegations from technical, scientific and diplomatic backgrounds were briefed in the COPC operations room on CTBT verification techniques, capacity building activities and the civil and scientific uses of PTS data through virtual Data Exploitation Centre access.

Build-Up and Enhancement

International Data Centre Commissioning

- 3.13. The mandate of the IDC is to provisionally operate and test the system in preparation for operation after entry into force. The IDC Progressive Commissioning Plan provides milestones that mark progress in this endeavour as well as control mechanisms, including:
- The Progressive Commissioning Plan itself;
 - Draft Operational Manuals, which set requirements;
 - The IDC 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.
- 3.14. The 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.
- 3.15. The Commission 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). The 2023 Experiment was conducted from 6 to 17 February 2023 with in-person participation of the control team and evaluators. The 2023 Experiment selected 24 validation tests to be executed and organized into five groups as part of the Test Implementation Plan approach, based on the evaluation reports of the first cycle of four experiments. A technical report was compiled containing the results from the experiment. In addition, a technical meeting was conducted on the VATP, from 14 to 16 June 2023 in a hybrid format. The initial results of the experiment and the outcome of the evaluation were presented and the path forward for the further development of the VATP and the purpose and scope of the next experiment were discussed.
- 3.16. The IDC continued to address the recommendations made in the evaluation reports of the first four experiments compiled by the Quality Management and Performance Monitoring (QMPPM) Section.

Security Improvements

- 3.17. 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 the risks of malware attacks, were taken. New vulnerability assessment and penetration test solutions were tested. The Commission continued to make progress on security governance.
- 3.18. 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 ensures a high security posture of PTS staff and information assets. It is well received by PTS staff and metrics indicate high completion rates regularly tested with phishing exercises.
- 3.19. The Commission continued to ensure high available rates of PKI services.

Software Enhancements

- 3.20. Radionuclide software development efforts focused on moving toward comprehensive open source software that will meet the needs of the future and be used both in IDC operations and NDCs. In 2023 the main focus was on developing and doing analyst testing of iNtegrated Software Platform for Interactive Radionuclide rEview (iNSPIRE) phase 2, which extends the software's functionalities to process particulate systems and high purity germanium noble gas systems. The deployment of iNSPIRE phase 2 is anticipated in the second quarter of 2024, at which point it will also be shared with NDCs as part of radionuclide NDC in a box.
- 3.21. The implementation phase of the IDC SHI re-engineering project, which began in 2019, progressed in 2023. The aim is to achieve a modern, maintainable, open source SHI processing system. In 2023, the focus was on the integration of a new version of threshold monitoring (delivered by the Norwegian NDC), and the integration and extension of a new station SOH monitoring system (building on a Geophysical Monitoring System (GMS) delivery from the NDC in the United States of America (USA)). Additional software components from the GMS deliveries, such as the initial capabilities for the interactive analyst interface and the Oracle data bridge, were also evaluated.
- 3.22. The re-engineering alpha testers group (ATG), funded by the EU, invites States Signatories and NDCs to support, assess and validate the progress of the IDC re-engineering project in a low barrier way. The fourth and final ATG meeting took place in September 2023.
- 3.23. 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. The use of an expert analyst consultant allowed rapid testing of the system, and quick feedback between analyst and software developer. Analyst feedback led to a plan to address a specific cause of false events. After modification of the software, testing was done on 11 days of data

from September 2023, with the test environment set up to compare the automatic bulletins created by NET-VISA and the current software Global Associator. The testing results confirm that NET-VISA v2.5.14 builds *fewer* events than Global Associator, while finding *more* events which the analyst includes in the Late Event Bulletin. This means that NET-VISA is building more good events without increasing the number of events an analyst will later discard. A review of NET-VISA history and testing was presented at the Sixty-First Session of WGB, and the detailed results of the 11 days of testing will be presented to WGB in 2024.

- 3.24. The IDC continued testing 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 velocity model and the corrections are accompanied by corresponding uncertainties. Testing will continue in 2024.
- 3.25. The IDC is preparing software to assist in executing expert technical analysis (ETA), as required by the Treaty's protocol. The ETA software suite for SHI technologies aims to find similarities between newly detected events and historical events (otherwise known as master events) by using cross-correlation. The software at the core of this is the Spot Check Tool, which was extended in 2023 to allow the inclusion of additional bulletins. The Spot Check Tool graphical user interface allows the analysis of events reported in the REB, SEL and vSEL bulletins, and the integration of the Late Event Bulletin is under development and is expected to be operational in the first half of 2024.
- 3.26. The ETA for radionuclide requires software implementation of radionuclide analysis approaches for nuclear event screening and characterization based on isotopic activity ratios detected in the IMS radionuclide network. Analysis modules cover the whole procedure from a test detonation, through atmospheric transport, to sample measurements, including event definition of radionuclide detections at IMS stations, calculation of isotopic ratios using different methods, sample association based on decay curve consistency, simulation of release scenarios using Bateman equations, event discrimination and timing, as well as creation of the radionuclide part of the State Requested Methods Report (SRMR). The first version of the ETA radionuclide software was completed in November 2023, and includes basic analysis modules.
- 3.27. The redesigned station processing and interactive review software, respectively DTK-PMCC and DTK-(G)PMCC, was made compatible in 2023 with Enterprise Linux 9 (RedHat 9 and derivatives), and updated to enhance analyst ease of use.
- 3.28. In August 2023, the new version of the WEB-GRAPE Internet Based Service (IBS), 3.1.9, was released. It includes further technical and functional enhancements improving its performance and stability. For example, the Multiple Model Possible Source Region (MMPSR) functionality has been enhanced by adding the additional option of calculating averaged possible source region (PSR) by averaging an ensemble of single model PSR results. Two additional colour palettes have been added, allowing for an easier distinction between co-displayed plumes. The PSR functionality has been enhanced by adding graphs which allow one to analyse temporal and spatial changes in PSR values interactively.

- 3.29. In addition to the IBS release, a major revision of WEB-GRAPE Desktop was released, in response to user feedback requesting an open source desktop version. Desktop version 3.2.0 was released in December 2023, and is the first version that is based purely on open source software. This new desktop version shared its source code base with IBS. As a result, WEB-GRAPE IBS and desktop have a common look and feel. The current desktop version includes the following functionalities: Field of Regard, PLUME, Multiple Model Field of Regard, PSR and MMPSR. These functionalities work on the same principles as in WEB-GRAPE IBS. In addition, for user convenience, a tool allowing the downloading of source-receptor sensitivity files was added.

National Data Centre in a Box

- 3.30. Major releases of both NDC in a box SHI and NDC in a box radionuclide were prepared in 2023. All NDC in a box software was updated to run on Enterprise Linux 9; these updates were needed because the support window for the current platform, CentOS7, ends in June 2024. Version 7 of NDC in a box SHI was released in December 2023. It includes updates of all libraries, and an updated version of SeisComp, v6.1.
- 3.31. The SeedLink service, which allows GCI connected NDCs to subscribe to near real time IMS waveform data of specific station/channels of primary seismic stations as well as hydroacoustic and infrasound stations, saw increased usage by NDCs during 2023. At the end of the reporting period, the monthly data volume retrieved through the SeedLink service was approximately 500 GB.
- 3.32. International Federation of Digital Seismograph Networks (FDSN) web services, providing IMS data and IDC products in a standard compliant way, was made available to NDCs for testing in April 2023, and went into full operation in December 2023. In addition to being fully standard compliant with the 2019 edition of the FDSN web service specification, the IDC implementation will support additional formats such as INT and CM6 for waveform data as well as Dataless SEED and SeisComp XML for station information.

International Noble Gas Experiment and Atmospheric Radioxenon Background

- 3.33. 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.
- 3.34. The International Noble Gas Experiment 2024 workshop will take place in June 2024. At this event, all aspects relating to noble gas monitoring will be discussed.
- 3.35. An initiative funded by the EU to improve understanding of the global radioxenon background, which started in December 2008, continued in 2023 with EU and Japanese 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 2023, the Commission continued operating two

transportable noble gas systems in Horonobe and Mutsu, Japan. Results from this field measurement campaign are used to develop and validate enhanced methods for identifying the source of events that cause frequent radionuclide detections at radionuclide station RN38 in Takasaki, Japan. These methods and knowledge have the potential to be applied to all IMS stations in order to enhance the capabilities to identify a radionuclide signal that might indicate a nuclear test. 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

- 3.36. By the end of 2023, a total of 20 agreements had been signed for the purpose of providing continuous IMS data in near real time to recognized tsunami warning organizations, further to the Commission's decision in November 2006 to permit this use of its data. Two tsunami warning agreements – those with Honduras and Spain – entered into force in 2023.
- 3.37. It is now established that information obtained by infrasound technology is useful to the civil aviation community, as real time detection of a volcanic eruption can help reduce the air traffic hazard of ash clouds clogging jet engines. As eruptions around the world are recorded by IMS infrasound stations and reported in IDC products, the Commission supported the research and development activities of several NDCs in collaboration with the Volcanic Ash Advisory Centres designated by the International Civil Aviation Organization.
- 3.38. The range of scientific applications of IMS data is increasing, including 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.

Enhanced Hydroacoustic and Seismic Waveform Modelling

- 3.39. 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

- 3.40. Work continued in both gaining capabilities and clarifying procedures and processes for executing special studies and ETA. After several years of online meetings, SHI, atmospheric transport modelling and radionuclide experts met in October 2023 in Daejeon, Republic of Korea, 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 draft IDC Operational Manual. Together the experts advanced procedures for carrying out an ETA by updating the draft standard operating procedure for an ETA, the guidelines for requesting an ETA, the flowchart of an ETA, and the draft template for the SRMR. Progress was also made in developing the methods for an ETA.

Updating Documentation of Basic International Data Centre Analysis Procedures

- 3.41. 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 Signatories, further efforts were made to update technical documents with transparency about changes. This ensures open and convenient tracking of individual changes in the documents.
- 3.42. Revision of the Analyst Instructions for Interactive Analysis of Noble Gas Beta–Gamma Spectra using (IDC/OPS/WIN/353) was initiated. The main changes are the update of the document to reflect the use of the iNSPIRE software for the analysis of beta–gamma coincidence spectra, and the subsequent changes in the analysis method and approach. A revision of the Analyst Instructions for Interactive Analysis of Calibration Spectra using SAINT2 (IDC/OPS/WIN/356) was also initiated to better reflect the current practice of the calibration validation process, and includes, among other changes, new internal cross-validation steps. Both revisions will be concluded and made available to authorized users via the secure web portal during the next reporting period.

CTBT: Science and Technology Conferences

- 3.43. The SnT2023 conference was hosted by the Commission in the Hofburg Palace, Vienna, Austria and online from 19 to 23 June 2023. This seventh event in a series of biennial SnT conferences was the first one held fully in a hybrid format. Over 2000 participants from around 150 countries registered to participate in SnT2023, with 80% indicating in-person attendance while the others made use of online functionalities. The Executive Secretary opened the conference alongside a diverse group of high level speakers at ministerial, agency head, senior official and expert level. Key themes of the high level segment, which permeated the entire conference, were inclusion, unity, universalization and harnessing the benefits of the IMS for all. ‘The Power of Together’ emerged as an overarching motto. For the high level segment, simultaneous interpretation into the six languages of the Commission was made available to in-person participants.
- 3.44. The scientific programme of SnT2023 featured 102 oral presentations, 455 electronic posters, 16 panel discussions, including panels held in the Arabic, French and Spanish languages, all with the active participation of early career scientists and the CTBTO Youth Group (CYG). The conference covered the following five themes: The Earth as a Complex System; Events and Nuclear Test Sites; Monitoring and On-Site Inspection Technologies and Techniques; Sustainment of Networks, Performance Evaluation and Optimization; and CTBT in a Global Context. Special highlights included the response to the Hunga Tonga–Hunga Ha‘apai volcano eruption on 15 January 2022, the development of new primary measurement standards for traceable calibration of infrasound and low frequency seismic measurements, achievements and challenges of noble gas monitoring, and preparations for the Integrated Field Exercise in 2025 (IFE25) that will take place in Sri Lanka. Special emphasis was put on the benefits that all States Signatories gain from the access to data of the IMS for Treaty verification and for civil and scientific applications as well as from related capacity building and training. The session videos are available on the CTBTO YouTube Channel. All conference materials can be found on the event portal at <https://ctbto.org/SnT2023>. The call for a topical issue of Pure and Applied Geophysics with the title “Nuclear Explosion Monitoring and

Verification: Science and technology to tackle global challenges” with manuscripts building on presentations made at SnT2023 received more than 30 submissions.

- 3.45. A topical issue of Pure and Applied Geophysics containing peer-reviewed scientific papers on presentations made at SnT2021 was published in 2023 as volume 180, issue 4/2023, with the title “Nuclear Explosion Monitoring and Verification: Innovation in technology and scientific methods”. It is the second topical issue in this series that started with papers of SnT2019 as volume 178, issue 7/2021. The collection of papers on key technical accomplishments of the verification regime for the 25th anniversary of the Organization and the challenges and prospects for the future – entitled “Twenty-Five Years of Progress of the Comprehensive Nuclear-Test-Ban Treaty Organization” – was also completed in 2023. Most of the 16 papers were based on invited talks given at SnT2021. The compilation appeared in electronic format as a PTS technical document.

The National Data Centres for All Initiative

- 3.46. 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 the IDC, and 8 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).
- 3.47. 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.
- 3.48. As a result of the outreach activities undertaken by the task force created to implement the NDCs4All initiative since its launch in mid-2022, 7 States Signatories have created or re-activated their SSA, 10 States Signatories have established or re-established their NDCs and 32 States Signatories have requested a CBS.

4. ON-SITE INSPECTION

Highlights in 2023

- Coordination and implementation of three directed exercises – the first OSI field exercises since 2014 – as well as the tabletop exercise on senior management responsibilities during an OSI
- Implementation of the next generation surrogate inspector training programme (the linear training programme) and conduct of two Regional Introductory Courses, increasing the number of nominees for the linear training programme
- A revised version of the comprehensive draft list of equipment for use during OSIs published as CTBT/PTS/INF.1573/Rev.1 in July 2023

Introduction

- 4.1. 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.
- 4.2. 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.
- 4.3. 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.
- 4.4. 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 developed a new OSI programme of work for 2022-2023 and exercise programme for 2022-2025, which are being implemented.

Programme of Work for 2024-2025

- 4.5. In 2023, the PTS developed and published a programme of OSI work for 2024-2025 (CTBT/PTS/INF.1671) to provide transparency and structure regarding the expected work of the OSI Division over a two-year period. As in the preceding programme of work, it includes activities aimed at supporting the further development of OSI capabilities towards the establishment of a balanced, coherent and robust verification regime at entry into force.

- 4.6. The programme of work is closely linked 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 PTS has nevertheless largely commenced, and is continuing to execute, activities in line with the proposed schedule.

Policy Planning and Operations

- 4.7. Policy planning and operations efforts during 2023 predominately focused on implementation of activities outlined in the programme of work for 2022-2023 and on designing, publishing and subsequently executing the initial activities in the OSI exercise programme for 2022-2025.
- 4.8. The fourth and final operational test of the Geospatial Information Management System for OSI (GIMO) ahead of the September directed exercises was conducted in March 2023, focusing on full integration of the GIMO central dashboard for the OSI field laboratory with laboratory systems and the deployment of 'highly protected' and 'not yet classified' environments in the GIMO platform. With the conclusion of this phase of development and testing, a robust, operational version of GIMO was in place for use by surrogate inspectors during the exercises. The directed exercises provided an opportunity for GIMO to be used in operational conditions. This enabled the PTS to assess the performance of the GIMO platform with large volumes of data flow and peak loads of inspectors, while using the system across a greater variety of inspection techniques and field missions.
- 4.9. Upgraded OSI communications system equipment was also obtained and tested ahead of the September 2023 directed exercises. The PTS assessed the functionality of new handheld radios, ultra high and very high frequency radios, push-to-talk satellite phones, and high frequency backup radios. All systems performed well, and minor issues identified during the tests were successfully addressed or mitigated. Furthermore, considerable progress has been achieved in the area of satellite communications designed to ensure reliable connectivity between the inspection team and the Operations Support Centre in Vienna, Austria. The September directed exercises allowed the upgraded communications systems to be used in operational conditions, and valuable lessons were learned that will assist the PTS to prepare and implement upcoming OSI exercises in 2024 and 2025.

On-Site Inspection Exercise Programme

- 4.10. The OSI exercise programme for 2022-2025, including IFE25, was approved by the Preparatory Commission at its Fifty-Eighth Session in June 2022. Subsequently, the PTS concluded an assessment process of candidate host countries, which comprised a rigorous assessment from technical, operational, health and safety, security, financial and legal perspectives, including reconnaissance visits. A summary was provided to the Sixty-First Session of WGB, and in July 2023 the Commission confirmed the recommendation of the Executive Secretary for Sri Lanka to host IFE25.
- 4.11. The directed exercises were held in Bruckneudorf, Austria, from 3 to 28 September 2023. Substantial efforts were invested in the planning, preparation and implementation of the exercises. Planning and preparation activities included the development of a detailed

exercise scenario and specifications, identification of appropriate locations and selection of participants from States Signatories. In total, 78 individuals participated in the directed exercises as exercise players or managers, including 23 PTS staff members or consultants. The directed exercises were centred on simulated play of inspection team functions in accordance with specific exercise modules. Inspection team members were selected from the roster of surrogate inspectors in the third training cycle. The approach of conducting the directed exercises as the next step after the inspector training proved to be useful. The mode of exercise play with briefings, debriefings and opportunities to repeat inspection activities provided participants opportunities to further deepen their understanding of OSI methodology and to conduct activities at a bigger scale than during regular training. The PTS will build on the positive outcomes of the directed exercises and implement proven concepts as well as recommendations for improvement in preparing and conducting the next field exercises.

- 4.12. In October and December 2023, PTS management and staff conducted operational visits to Hungary in preparation for the build-up exercise in 2024 (BUE24). Meetings were held with both governmental officials and landowners on legal arrangements to facilitate hosting the exercise. PTS personnel also held discussions with local service providers that may be engaged to support the exercise. The PTS has worked with and appreciates the contributions of both the Permanent Mission of Hungary as well as the Hungarian Atomic Energy Authority for assistance in implementing technical and operational arrangements.
- 4.13. In November 2023, PTS management and staff conducted an IFE25 management visit to Sri Lanka to meet host country officials. The meetings aimed to establish and maintain contact with key government stakeholders, to agree on mechanisms for future cooperation and to make progress towards concluding appropriate legal frameworks for future activities. The PTS provided the national Committee of Experts with a comprehensive briefing on the exercise, the envisaged host country support (in organizational, logistical and technical areas) and the schedule of preparatory activities. An initial legal agreement will be finalized, followed by a PTS visit in the first quarter of 2024 for technical and operational planning for future activities such as technical equipment field tests.
- 4.14. In December 2023, IFE25 scenario task force members conducted a site reconnaissance visit to Sri Lanka to support the development of a technically realistic, temporally logical, scientifically credible and challenging scenario for the exercise. Ten technical experts nominated by States Signatories and two PTS staff members participated in this one-week activity. The visit enabled decisions to be taken on exercise and scenario parameters, as well as the high level narrative and the triggering event file, which will be subject to a peer review in the first quarter of 2024.
- 4.15. On 14 December 2023, the PTS conducted a tabletop exercise on senior management responsibilities during an OSI. Twenty-two PTS managers and staff participated as exercise players. In addition, seven PTS managers and staff participated as exercise management or coordinators, and approximately 30 PTS managers and staff attended as observers. The 2023 tabletop exercise built on the success of the 2022 tabletop exercise on the role of senior management during an OSI, which increased PTS-wide engagement in building OSI capability. The main objective of the 2023 tabletop exercise was to prepare PTS senior management for their involvement in the upcoming BUE24 and IFE25. The 2023 tabletop exercise also sustained and further advanced the engagement

of PTS senior management in relation to OSI, demonstrated specific processes and criteria for future Technical Secretariat senior management before and during an OSI, and reinforced Organization-wide efforts for future Technical Secretariat response preparedness relating to OSIs and events of potential or actual CTBT relevance. The execution of the 2023 tabletop exercise was centred on ‘directed role play’, where exercise players were immersed into four specific situations of OSI relevance and asked to arrive at decisions or develop strategies to resolve issues on the basis of their organizational role. The PTS will build on the positive outcomes of this tabletop exercise and provide additional opportunities for senior management to participate in the upcoming OSI exercises.

Equipment Procedures and Specifications

- 4.16. 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 2023 to enhance OSI capabilities in the area of equipment development and testing.
- 4.17. A field test of OSI active seismic surveys and selected geophysical techniques was conducted by the OSI Division, with support from personnel across the PTS and external experts, from 8 to 19 May 2023 in Folkestone, United Kingdom. The objective of the field test was to complement and expand on the outcomes of the field test of geophysical techniques (seismic and non-seismic) for deep applications that took place from 5 to 16 September 2022 in a mountainous area in the vicinity of Rotmoos, Austria. Due to the complementary nature, the objectives of the 2023 field test varied depending on the specific status and needs of the different geophysical techniques implemented during the field test. OSI geophysical techniques applied during the 2023 field test included active seismic surveys, resonance seismometry, gravitational field mapping and electrical conductivity measurements. The field test was conducted in farmland above the Channel Tunnel. The tunnel is located approximately 90 metres below the ground surface and was considered as a potential observable. A technical report covering technical and operational aspects of the field test was prepared.
- 4.18. A field test of the data transmission system for OSI was conducted from 23 to 27 October 2023 in the Seetaler Alpen, Austria. The purpose of the field test was to validate the functionality of the new configuration of the data transmission system in field conditions. The field test also validated data transmission capabilities over a longer distance for three OSI techniques: passive seismic monitoring for aftershocks, position finding and subsurface gas sampling. The field test confirmed the operational readiness of the OSI data transmission system for deployment during upcoming OSI exercises.
- 4.19. A field equipment demonstration of a ground based platform carrying a laser scanner payload was conducted in Morsleben, Germany, in November 2023. The activity, in an underground mine setting, allowed the relative merits of the platform and the sensor to be assessed in challenging conditions.
- 4.20. A revised version of the comprehensive draft list of equipment for use during OSIs was published as CTBT/PTS/INF.1573/Rev.1 in July 2023. The revised draft list incorporates feedback provided by the participants of OSI Workshop-25, in particular the addition of a detailed introductory narrative and the presentation of different pieces of equipment as

a non-hierarchical list. The updated technical and operational specifications reflect the current level of development and testing for all inspection activities and techniques specified in Part II, paragraph 69, of the Protocol to the CTBT, with the exception of drilling (paragraph 69(h)), as well as specifications for data and information handling equipment. The revised draft is a step forward in the development and completion of a final draft list of equipment.

Airborne Techniques

- 4.21. To further the development and testing of OSI airborne configurations, the OSI airborne simulator was enhanced through the addition of a near-real-world-view monitor system. This also improves the development of in-flight procedures and provides more realism in a greater range of training scenarios. The simulator was also deployed to SnT2023.

Position Finding Techniques

- 4.22. As a result of feedback from the 2022 geophysics field test in Austria and OSI Workshop-25, the control units for survey-grade position finding were upgraded to industry standard devices. These were tested during the 2023 geophysics field test in the United Kingdom.

Geophysical Techniques

- 4.23. The processing software for passive seismological monitoring was updated to include the ability to accommodate topographical changes in the survey area. In addition, a new project was started to update the full OSI data flow for passive seismological monitoring, including automated merging of metadata with the waveform data, as well as tools for planning the station network for OSI missions and presenting the final data products in GIMO. These updates are expected to be available for BUE24.
- 4.24. The seismometers for passive seismological monitoring were calibrated, and new batteries and larger memory cards (8 GB) were acquired for all stations to improve operability.
- 4.25. The 300 node recording system for active seismic surveys obtained in 2022 was enlarged with 500 additional nodes in 2023, increasing the total number of nodes to 800. The system is scalable for the future and represents an enhancement of capabilities in the field of seismic geophysical techniques. The system was used for the second time in field conditions during the field test of OSI active seismic surveys and selected geophysical techniques in Folkestone, United Kingdom, in May 2023.
- 4.26. Two proposed approaches to the current concept of operations for resonance seismometry, using ambient noise and earthquake recordings, were tested by processing data collected during the field test of the OSI geophysical inspection techniques for deep applications in Rotmoos, Austria, in September 2022. The results of the processing are available to experts from States Signatories in electronic reports on the Alfresco platform.
- 4.27. Two contracts with external vendors were concluded at the end of 2023 to build the OSI forward modelling capability for non-seismic geophysical techniques and for the

development of software for OSI gravitational field mapping. These new capabilities are expected to be available for IFE25.

- 4.28. A project was launched to update and complement the current Quality Management System (QMS) documentation for geophysical techniques, including new field guides. The documentation will be available for BUE24 and updated, as applicable, before IFE25.

Measurements of Radioactivity and Radionuclide Particulate Related Inspection Techniques

- 4.29. OSI field laboratory software development focused on data flow enhancement for the chain of custody within the GIMO framework, improvement of the OSI field laboratory application graphical user interface for easier field operations, and documentation integration with new manuals, checklists and field guides for OSI field laboratory activities. A field laboratory workflow was tested during the March 2023 operational test of the GIMO system and validated during the directed exercises in September 2023. Feedback and lessons learned have been documented for implementation in 2024.
- 4.30. During the last quarter of 2023 the OSI field laboratory was assessed, and actions were initiated to protect future OSI field laboratory activities against hardware, firmware and software obsolescence. These efforts aimed to enhance the robustness and sustainability of OSI field laboratory activities during BUE24 and IFE25.

Noble Gas Related Inspection Techniques

- 4.31. Data interpretation of noble gas samples in the working area at the base of operations (BOO) during an OSI will become mostly automated. After the majority of noble gas experts convened and agreed to the automation level in April 2023, terms of reference were drafted for a competitive bidding process. Services have been contracted to develop the necessary tools.
- 4.32. To ensure long term capability to process and measure samples for ^{37}Ar , procurement processes were undertaken to ensure the availability of ^{37}Ar equipment beyond 2025.
- 4.33. The upgrade of the SAUNA system continued, with the delivery of a multi-sample inlet and radio-frequency identification tags, along with the necessary software. All noble gas sampling equipment is being upgraded to operate with radio-frequency identification tags instead of bar codes for the chain of custody.

Field Operations Support

- 4.34. Components of the video surveillance and security project were delivered and assembled in functional modules at the CTBTO TeST Centre. Full set-up of the system, integrating sensors with the management platform, will be done at the conclusion of system training in 2024.
- 4.35. An almost complete BOO infrastructure was established in the field for the directed exercises in September 2023, including the first full set-up of the high pressure modularized working area. The set-up was functional and flexible, allowing for modifications of the BOO planning template. The modularization was effective with

regard to packing, transportation, establishment and reconstitution, proving the concept. Opportunities to further streamline field operations support to OSI deployments have been identified.

- 4.36. The Equipment and Instrumentation Management System for OSI (EIMO), which is used by the PTS to manage deployable OSI equipment, was subject to functionality and user interface improvements. EIMO was used during the directed exercises in September 2023, and feedback from participants was catalogued and prioritized. New functionality introduced in 2023 improves the ability of inspectors to record sealing events and perform checks of container content at the point of entry and in the joint area of the BOO. Furthermore, the application now includes an offline mode, which aims to support the dispatch of equipment during OSI deployment.

On-Site Inspection Documentation

- 4.37. Activities during 2023 involved providing support to WGB in its elaboration of the draft OSI Operational Manual, organizing the expert meeting on OSI QMS documentation, coordinating revision of OSI QMS documents, supporting OSI training and exercises, maintaining the OSI QMS document repository, and preparing for future OSI workshops.
- 4.38. The PTS continued to provide substantive, technical and administrative assistance to WGB for the elaboration of the draft OSI Operational Manual. Support was provided to the Task Leaders in issuing the updated Model Text for the draft OSI Operational Manual (CTBT/WGB/TL-18/67), which consolidated results from discussions at WGB up to its Sixty-First Session. The latest version of the Model Text will be available in all six languages of the Commission for the planned IFE25.
- 4.39. The expert meeting on OSI QMS documentation was held during 18-20 April. Twenty-one experts from States Signatories, the International Atomic Energy Agency and the Organisation for the Prohibition of Chemical Weapons took part. The aims were to review the status of OSI QMS documentation, to contribute to the preparation of relevant documents in the lead-up to IFE25 and to discuss the development and integrated use of OSI QMS documents beyond IFE25. The meeting generated substantive suggestions and recommendations on the further development of OSI QMS documentation, as well as on the preparation of OSI QMS documents for IFE25.
- 4.40. The existing OSI QMS documents were continuously revised and enhanced based on the lessons learned from the implementation of previous OSI action plan projects and exercises. Based on the feedback from the expert meeting on OSI QMS documentation, the documents that establish the foundation for the drafting, review and issuance of all OSI QMS documentation have been revised.
- 4.41. To follow up on recommendations of the expert meeting and improve the user friendliness of OSI QMS documentation, field guides on inspection team functionality and the GIMO field application were created and tested during the directed exercises in September. These documents will be further improved on the basis of feedback on the exercises. More field guides on key OSI techniques and procedures will be created for use in upcoming training and exercises.

- 4.42. The hard copy archives of OSI QMS documents at the VIC and in the documentation room at the CTBTO TeST Centre are continually maintained and updated to ensure that the latest versions are available on demand. Full sets of printed OSI QMS documents were prepared for in-person activities, and a new version of the field library was tested during the directed exercises as part of efforts to enhance user friendliness and accessibility. In addition, customized documentation kits comprising electronic versions of specific OSI QMS documents were prepared for OSI training and exercises. The use of e-readers as a means to ensure that all OSI QMS documents are accessible in the field under any circumstances was tested during training and exercises. E-readers will also be provided for IFE25.
- 4.43. The maintenance and enhancement of the OSI e-Library continued in 2023. The underlying software of the OSI e-Library was updated. Synergies with the PTS QMS site were improved. Subsidiary documents are now organized by topic code, rather than document type, and new functionality has been added to filter out obsolete versions of documents, enhancing user friendliness, particularly in the field. The metadata of documents in the OSI e-Library are being reviewed and revised to ensure consistency and improve the document search function.
- 4.44. Preparations were made for OSI Workshop-26, which is scheduled to take place in Chile in October 2024. The workshop will focus on reviewing lessons learned from the directed exercise in 2023 and BUE24 ahead of IFE25.

On-Site Inspection Training Courses

- 4.45. The new surrogate inspector training programme (linear training programme (LTP)) was in full operation, with the delivery of refresher courses to the existing roster as well as two key courses of the introductory block. The LTP aims to add an additional 50 fully trained surrogate inspectors to the roster. As of 31 December 2023, the PTS had received 85 nominations (of which 34% were women) from 39 States Signatories from all geographical regions of the Treaty.
- 4.46. A key driver of the increased number of nominations was the conduct of two RICs, in January and April, hosted by Thailand and Slovakia respectively. The courses resulted in an increase in the number of nominees from the Eastern Europe and the Southeast Asia, Pacific and Far East regions and highlighted the importance of RICs as a point of entry for national experts to become acquainted with the OSI regime. Such courses also improve the geographical balance of the pool of participants in OSI training. In addition, preparations were launched for the next RIC, which will focus on the Africa region and be hosted by Egypt in February 2024.
- 4.47. Two key courses of the introductory block of the LTP were successfully conducted from 30 October to 4 November 2023 (introductory course) and from 6 to 11 November 2023 (health, safety and security course). Activities took place at the CTBTO TeST Centre and the Austrian Armed Forces International Centre in Götzendorf, Austria. Further detailed information on these courses is provided in CTBT/PTS/INF.1683 (introductory course) and CTBT/PTS/INF.1691 (health, safety and security course).

- 4.48. Ninety-two participants (trainees, external facilitators, observers and PTS staff) attended the two courses, making it the largest training course conducted at the CTBTO TeST Centre by far. The success of the courses with regard to classroom availability and configurations, as well as audio, video and livestreaming capabilities, highlighted the adaptability of the CTBTO TeST Centre to provide training to up to 100 participants and successfully stress-tested the design and infrastructure of the facility.
- 4.49. To prepare the existing roster of surrogate inspectors for the directed exercises in September 2023, the PTS conducted two directed exercise training courses, comprising two-week blocks, in June and July 2023. A total of 85 surrogate inspectors and PTS staff attended the training, which was held at the CTBTO TeST Centre and focused on field operations support, environmental field sampling and the field laboratory, and data flow management.
- 4.50. In the area of remote and computer based training, the new learning management system (LMS) was successfully fully launched in December 2023. It now serves as the online hub for OSI training courses and materials. The LMS is integrated with the Services and Training Management System and the OSI Inspectorate Database and allows surrogate inspectors and surrogate inspector trainees to visualize their inspection team roles and the learning pathways for those roles. The features of the LMS have improved the refresher training programme by adding annual refresher assessments and self study resources to help surrogate inspectors maintain their active status on the roster.
- 4.51. A cloud based remote software training infrastructure was deployed, providing surrogate inspectors with their own personal virtual machine from which they can access training versions of GIMO and EIMO as well as desktop based software such as the passive seismological monitoring software suite and complete self paced online training activities.
- 4.52. A new virtual reality training tool was introduced at the SnT2023 exhibition. The tool allows users to experience OSI activities, including a visual observation field mission at a former mining site and an interactive tour of the BOO constructed during the directed exercise training course.

5. IMPROVING PERFORMANCE AND EFFICIENCY

Highlights in 2023

- Further development and consolidation of the PTS QMS
- Consolidation and enhancement of a performance monitoring platform and deployment of a flexible and more user friendly graphical interface for the Performance Reporting Tool (PRTool)
- Technical evaluation of IDC progressive commissioning and preparing for the evaluation of the OSI BUE24 and IFE25

Introduction

- 5.1. 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.
- 5.2. 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

- 5.3. The evaluation of the 2023 Experiment as part of IDC progressive commissioning was completed. This evaluation, the first after the completion of the first cycle of experiments performed from 2016 to 2019, successfully tested the methodology developed during the first cycle. The evaluation was performed with the assistance of an external evaluation team, comprising nine experts from nine States Signatories. The report on the evaluation of the 2023 Experiment was issued, with six recommendations and 19 proposals for improvement.
- 5.4. To ensure the continual improvement of the QMS applied to the verification system, the follow-up on the status of implementation of the recommendations and improvements resulting from the evaluation of the first cycle of experiments continued in close cooperation with the IDC.
- 5.5. A new experiment in 2024 is being prepared. This experiment will be the second after the introduction of the test implementation plan and will focus on timelines and the quality of IDC products.
- 5.6. As part of preparations for the evaluation of BUE24 and IFE25, the PTS continued to maintain the Evaluation Information Management System so that it can be used by the evaluation team during the exercises and to prepare the evaluation report.

Performance Monitoring

- 5.7. The PTS continues to enhance performance monitoring. A new performance monitoring platform became operational in 2023, including a modern dashboard based and more user friendly graphical interface. This was introduced with version four of the PRTool accessible to experts from States Signatories, focusing on the quality of processes, data and products related to the development and provisional operation of the verification system. Together with the completed technology refreshment, the PRTool aims to provide evidence of the long term sustainability of the verification system beyond the life cycle of its various components.
- 5.8. A QA process established for validation of metrics and performance indicators was formalized as part of the configuration management of the new performance monitoring framework made operational in 2023, ensuring the reliability and sustainability of the performance monitoring tools of the PTS.
- 5.9. Specific metrics and performance indicators are being developed within the new performance monitoring platform in preparation for the 2024 Experiment within the IDC Progressive Commissioning Plan, in line with the applicable performance monitoring metrics associated with the validation tests to be tested in the experiment.

Quality Management

- 5.10. 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 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.
- 5.11. 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.
- 5.12. The use of the QMS document management system continues to increase. More than 3000 documents are currently filed, with an increase of more than 12% in 2023 in the number of formalized procedures.
- 5.13. To continue consolidating the reliability of data and products of the verification system, the QMPM Section 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.
- 5.14. The CTBTO Quality Policy emphasizes client satisfaction. The Commission therefore 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. Since 2023, NDC recommendations are being tracked by the PTS in an integrated system together with the recommendations resulting from experiments within the IDC Progressive Commissioning Plan, thus enhancing the use of recommendations from experiments to support closing and reporting on the status of implementation of NDC recommendations.

6. INTEGRATED CAPACITY DEVELOPMENT

Highlights in 2023

- Continued capacity development activities
- Ensuring integration of NDC capacity building into policy initiatives and educational engagement efforts
- Further development of online events and e-learning

Introduction

- 6.1. 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 address the political, legal, technical and scientific challenges facing the Treaty and its verification regime.
- 6.2. 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 benefit from the civil and scientific applications of its verification regime.
- 6.3. 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 PTS's Learning Management System and other technical and scientific outreach to the broader scientific community and civil society.

Activities

- 6.4. 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.
- 6.5. In 2023, in addition to in-person activities, the Commission was able to provide and conduct online training courses and hybrid expert meetings and workshops through videoconferencing. 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.

International Data Centre and National Data Centre Training Courses and Workshops

- 6.6. In 2023, the PTS observed a remarkable increase in participation in IDC training courses and workshops. Out of 1549 applicants, 800 NDC technical staff, station operators and experts participated in 29 capacity building events, including SnT. Furthermore, 2028 people attended SnT2023. Female participation in IDC activities rose to 31.8% (899 participants), from 24.2% (223 participants) in 2022.
- 6.7. Nine training courses on NDC capacity building took place during the reporting period. The objectives were to familiarize participants with the role and functions of NDCs in the verification regime, to develop and/or enhance NDC capabilities, to provide participants with the knowledge and skills required to access and use IMS and IDC data for Treaty verification and for civil and scientific applications. These courses also included the use of NDC in a box and SeisComp3 software. The NDC capacity building courses and events included:
 - NDC training courses on access and analysis of waveform IMS data and IDC products took place in Vienna, Austria from 13 to 24 February and from 5 to 16 June 2023. In total, 27 participants from 27 countries attended these courses.
 - An NDC training course for French-speaking NDCs took place in Niamey, Niger from 27 February to 3 March 2023. Thirty-three experts from 15 French-speaking African countries attended this training course.
 - An introductory training course on radionuclide IMS data and IDC products (particulates and noble gas) took place at the VIC from 6 to 17 March 2023. Fourteen participants from 14 countries attended this training course.
 - An online training course for advanced WEB-GRAPe users took place on 28 and 29 March 2023. Thirty-seven participants from 22 countries attended.
 - NDC capacity building waveform training courses using SeisComp3 took place in Vienna, Austria from 8 to 12 May 2023 and from 16 to 20 October 2023. Twenty-seven participants from 26 countries attended these courses.
 - An NDC training course on access and analysis of waveform IMS data and IDC products took place at the VIC from 5 to 16 June 2023. Fourteen participants from 14 countries attended this training course.
 - An NDC training course for Spanish-speaking NDCs took place from 20 to 24 November 2023, in San José, Costa Rica. Twenty-nine participants from 15 countries attended this training course.
- 6.8. Seven 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.

- Experiment 2023 took place from 6 to 17 February 2023. Five participants took part.
 - A hybrid technical meeting on the IDC VATP took place from 14 to 16 June 2023. Twenty-seven participants from 11 countries and the PTS took part in the technical meeting in person, and 10 participants from seven countries attended online. The objectives of the meeting were to discuss further work on the draft VATP and to review the plans for the next experiment.
 - A hybrid technical meeting on SHI software engineering at the IDC took place from 26 to 27 June 2023. Twenty-three participants from 10 countries and the PTS attended the meeting. The technical meeting was focused on reviewing the current status of work, including progress updates, discussion of the project plan, projected milestones and updating deliverables.
 - A hybrid technical meeting of the IDC SHI re-engineering ATG took place from 4 to 5 September 2023. Twenty-nine participants from 23 countries and the PTS took part in 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.
 - A hybrid technical meeting on legacy data from nuclear tests took place from 27 to 29 September 2023. Forty-one participants from 18 countries and the PTS attended the technical meeting. Finding methods to recover and digitize recordings from historical nuclear tests conducted between the 1950s and 1980s is critical for preserving these valuable records. Making these recordings accessible in digital format offers opportunities for a new generation of researchers to study what signatures are encoded in the data.
 - An expert meeting on advances in waveform processing and special studies and ETA with radionuclide and atmospheric transport modelling methods took place from 16 to 20 October 2023. Eighty-four experts from 28 countries and the PTS attended the meeting. The objective of this technical expert meeting was twofold: to explore advances in waveform processing that may improve IDC waveform pipeline processing, including tools and methodologies for testing and validation, and to discuss waveform special studies and ETA and review methods that may be suited for special studies and ETA, explore the potential use of various non-IMS data for the SRMR and advance common understandings of procedures and methods to be developed.
- 6.9. Eight 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 operation and maintenance 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 technical training session for PKI operators for IMS radionuclide and waveform stations took place at the VIC from 6 to 10 March 2023. Twenty participants from 12 countries and the PTS attended this training session.

- A technical training session for radionuclide station operators using RASA systems took place from 20 to 24 March 2023 in Virginia, USA. Seven participants from four countries and the PTS attended this training session.
 - A technical training course for radionuclide station operators with SAUNA equipment took place from 8 to 12 May 2023, in Uppsala, Sweden. Six participants from three countries and the PTS attended this training course.
 - A technical training course for Russian-speaking station operators of IMS waveform stations took place from 22 to 26 May 2023, in Dubna, Russian Federation. Twenty participants attended this training course.
 - A technical training session for station operators from Tristan da Cunha, UK took place from 7 to 9 August 2023, in Vienna, Austria. Two participants attended this training session.
 - A technical training course for radionuclide station operators with Mirion (Canberra) equipment took place from 17 to 20 October 2023, in Olen, Belgium. Nine participants from seven countries attended this training course.
 - A technical training session for radionuclide station operators with ORTEC equipment took place from 15 to 17 November 2023, in Oak Ridge, USA. Eight participants from six countries attended this training session.
 - A technical training session for waveform station operators of Joint IMS and International Deployment of Accelerometers equipment took place from 4 to 8 December 2023, at the CTBTO TeST Centre in Seibersdorf. Fifteen participants from 11 countries attended this training session.
- 6.10. One regional workshop – the East Asia Regional National Data Centre Workshop – took place in Bali, Indonesia from 18 to 22 September, 2023. Twenty-one participants from 11 countries and the PTS attended this workshop. The objectives were to strengthen knowledge of the CTBT and the work of the Preparatory Commission; to further build the capacity of States Signatories to participate in the implementation of the verification regime and assess how participants are making use of IMS data and IDC products; to encourage NDCs within the region to undertake a joint exercise for the analysis of waveform and radionuclide data and compare their results; and to promote the exchange of experience and expertise among the NDCs.
- 6.11. One technology workshop took place during the reporting period: the International Infrasond Workshop 2023, in the Azores, Portugal from 30 January to 3 February. A radionuclide laboratories workshop took place at the VIC from 3 to 6 April 2023. Ninety participants from 38 countries and the PTS attended this workshop. The objective of the workshop was to create an international forum for presenting and discussing recent advancements in infrasond research and operational capabilities of global and regional networks.
- 6.12. A radionuclide laboratories workshop took place in Vienna, Austria from 3 to 6 April 2023. Fifty-five experts from 18 countries and the PTS attended this workshop. The objectives of the workshop were to: discuss and address developments and issues pertaining to laboratory operations; review and plan PTEs for particulate and noble gas samples; discuss certification and surveillance assessments; share operational experiences

and lessons learned towards quality improvement; and discuss advances in gamma spectrometry and noble gas measurements.

- 6.13. A high performance computing workshop for nuclear explosion monitoring took place in Vienna, Austria in a hybrid format from 15 to 17 May 2023. Seventy-eight participants from 27 countries and the PTS took part in this workshop in person and approximately 100 participants from 71 countries attended online. The objective of the workshop was to discuss the use of high performance computing to support monitoring the world for any nuclear explosions on the ground, in the ocean and in the atmosphere.
- 6.14. The PTS continued to support NDCs through the donation and installation of CBS equipment. During 2023, CBSs were installed and commissioned in Ukraine, Belarus, Bosnia and Herzegovina and Mauritania.
- 6.15. Hardware items for thirteen additional new systems procured using EU funds were fully delivered to the CTBTO TeST Centre in November 2023. These systems will be further distributed to NDCs of States Signatories in accordance with the requests received by the PTS and prioritized for the NDCs4ALL initiative.

Other Capacity Building Activities

- 6.16. On 30 March 2023, the PTS hosted a delegation from France as part of a non-proliferation training course conducted by the Permanent Mission of France in Vienna, Austria. The visit included presentations from each Division of the PTS and included a tour of the PTS facilities. The event was conducted almost entirely in French.
- 6.17. The PTS supported the Vienna Center for Disarmament and Non-Proliferation's introductory course on nuclear non-proliferation and disarmament by hosting junior to mid-career diplomats at the PTS in March 2023. Expert briefings on CTBT monitoring technologies and a tour of the CTBTO Operations Centre were provided.
- 6.18. In 2023, the PTS reinvigorated its CTBTO introductory seminars for diplomats, which are designed to deepen understanding of the Treaty and the work of the Commission. On 30 August 2023 the first seminar was held, in New York, for Ambassadors and delegates participating in the United Nations General Assembly's (UNGA) First Committee on Disarmament and International Security. It was co-organized by the United Nations Institute for Training and Research and attended by more than 70 participants from a broad range of States. On 24 October 2023 the seminar for diplomats reached Vienna, Austria and was attended by 88 delegates from Permanent Missions. Simultaneous interpretation in all languages of the Commission was provided at both sessions.
- 6.19. The annual visit of the United Nations Disarmament Fellows to the CTBTO took place on 7, 8 and 11 September 2023. Among the highlights was an afternoon visit to the OSI directed exercises in Bruckneudorf, Austria on 8 September 2023 and a briefing by the Executive Secretary.
- 6.20. The third cycle of the CTBTO Research Fellowship included 26 fellows from 23 countries. The Center for Energy and Security Studies (CENESS) in coordination with the CYG Task Force developed an online course on critical topics concerning the role of

the Treaty in the global non-proliferation regime, potential ways of facilitating the Treaty's entry into force, and CTBT related regional issues. At both the opening and closing sessions of the online course the Fellows had a unique opportunity to have an in-depth discussion with the Executive Secretary. The culmination of the CTBTO Research Fellowship was the production of analytical research papers by the fellows, addressing a wide range of CTBT related topics.

Technical Experts Support Programme

- 6.21. The Technical Experts Support Programme, formerly known as 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 programme for another three years.
- 6.22. In 2023 the programme facilitated the participation in WGB of 12 experts, including 6 women, from the following 12 States: Algeria, Chile, Cuba, Iran (Islamic Republic of), Kenya, Malaysia, Nicaragua, Niger, South Africa, Sudan, Tanzania and Thailand.
- 6.23. During 2023, experts supported under the project participated in the Sixtieth and Sixty-First Sessions of WGB. Participation in the programme 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 programme 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.

7. OUTREACH

Highlights in 2023

- Two new ratifications and one new State Signatory
- Sustained high level engagement with States and further youth outreach activities
- Focus on support to ensure all States Signatories derive full benefit from Treaty membership

Introduction

- 7.1. The outreach activities of the Commission aim to encourage the signature and ratification of the Treaty, enhance understanding of its objectives, principles and verification regime and of the functions of the Commission, and 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.
- 7.2. The Executive Secretary continued 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. In 2023, he visited Thailand, Japan, Portugal, Qatar, South Sudan, Ethiopia, Somalia, Sri Lanka, Nepal, Chile, Bolivia, Republic of Korea, United States of America, Kyrgyzstan, China and the United Kingdom.

CTBTO Youth Group

- 7.3. The CYG, the Organization's flagship next generation outreach programme, has continued its active engagement in support of the Treaty. Having passed the 1000-member milestone, the group reached 1415 members from 129 countries by December 2023. Its activities in 2023 focused on advocacy for the CTBT and its universalization and entry into force and occurred during several events including SnT2023, the CTBTO Research Fellowship in collaboration with CENESS, and the mentoring programme for early career women in science, technology, engineering and mathematics (STEM).

Interacting with States

- 7.4. 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.
- 7.5. The Executive Secretary participated in a range of bilateral meetings and other high level events at which he met heads of State and Government. These included the Prime Minister of Japan, the First Vice President of South Sudan, the President of Ethiopia, the Prime Minister of Somalia, the Prime Minister of the Republic of Korea, the President of Sri Lanka and the Prime Minister of Nepal.

- 7.6. During his missions and in Vienna, the Executive Secretary met with foreign ministers, vice-foreign ministers, other ministers of States Signatories and observers, and senior officials, including the: Vice-Minister of Foreign Affairs of Thailand, Foreign Minister of Japan, Foreign Minister of South Sudan, Foreign Minister of The Gambia, Deputy Prime Minister and Foreign Minister of Ethiopia, Foreign Minister of Somalia, Assistant Minister for Foreign Affairs of Australia, Vice Foreign Minister of the Republic of Korea, First Deputy Foreign Minister of Kazakhstan, Foreign Minister of the Republic of the Congo, Minister for Foreign Affairs and Worship of Costa Rica, Minister of Justice and Correctional Services of South Africa, Minister of Foreign Affairs of Sri Lanka, Minister of Environment of Sri Lanka, Minister of Law, Justice and Parliamentary Affairs of Nepal, Foreign Secretary of Nepal, Acting Foreign Minister of Chile, Vice Minister of Defence of Chile, Vice Minister at the Foreign Ministry of Bolivia for Institutional and Consular Management, Minister of Foreign Affairs of Kyrgyzstan, Deputy Minister of Foreign Affairs of the Russian Federation, Minister of Foreign Affairs of Burkina Faso, Minister of Foreign Affairs of Yemen, Minister of Foreign Affairs of Pakistan, Minister of State for Middle East, North Africa, South Asia and the United Nations of the United Kingdom, Minister of Foreign Affairs of Australia, Vice Minister of Political Multilateral Affairs of Brazil, Under Secretary for Multilateral Affairs of Mexico, Minister of Higher Education and Scientific Research of Iraq, Executive Vice Minister of Foreign Affairs of China, Minister for Europe and Foreign Affairs of Albania, and Secretary-General of the Ministry of Foreign Affairs of Austria.
- 7.7. With a view to promoting parliamentary engagement, the Executive Secretary interacted with a number of parliamentarians from States Signatories both in Vienna and during overseas missions.

Outreach Through the United Nations System, Regional Organizations, Other Conferences and Seminars

- 7.8. 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.
- 7.9. During 2023 the Executive Secretary met with a range of United Nations officials, including the: United Nations Secretary General, Director General of the United Nations Office in Geneva, the Director of the United Nations Institute of Disarmament Research, the United Nations Under-Secretary-General and High Representative for Disarmament Affairs and the Director General of the International Atomic Energy Agency. He also met with the President of the 77th UNGA. All of these meetings highlighted progress towards the Treaty's universalization, its importance and value to international peace and security, and the value of strong linkages with the United Nations system.
- 7.10. The Executive Secretary travelled to Addis Ababa, Ethiopia from 16 to 19 February 2023 at the invitation of the African Union Commission, to participate in the 36th Ordinary Session of the African Union Summit. In the margins of the Summit, he delivered an address at a side event jointly hosted by CTBTO, the African Commission on Nuclear Energy and the African Union Commission.

- 7.11. On 2 May 2023, the Executive Secretary delivered remarks at the opening ceremony of this year's United Nations Chinese Language Day in the VIC reaffirming the importance of promoting and sustaining multilingualism at the CTBTO.
- 7.12. The Executive Secretary opened the biennial SnT2023 alongside a diverse group of high level speakers, experts, and academics. The event was a powerful example of multilateralism and multilingualism in action. A highlight was the commitment of Somalia to sign the Treaty – which was completed on 8 September 2023.
- 7.13. On 31 July, the Executive Secretary addressed the Preparatory Committee for the 2026 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons to promote the role and importance the CTBT plays within the global nuclear non-proliferation and disarmament architecture.
- 7.14. On 29 August 2023, the Executive Secretary delivered a statement to the high level segment of the UNGA to mark the International Day Against Nuclear Tests (IDANT) and participated in the UNODA “#StepUp4Disarmament” symbolic walk in New York. During that visit he also met with the Secretary-General of the Inter-Parliamentary Union and exchanged views on promoting parliamentary engagement with a view to achieving the CTBT's universalization.
- 7.15. The Executive Secretary delivered opening remarks at CTBTO introductory seminars for diplomats in Vienna, Austria (24 October) and New York, USA (30 August). The events were well attended and very positively received – providing insight into the deeper workings of the Organization for the CTBTO diplomatic community. The Vienna event was offered with full simultaneous interpretation. The Executive Secretary also spoke at the high level opening session of the 2023 CTBTO Research Fellowship.
- 7.16. From 7 to 8 September 2023, the Executive Secretary attended and addressed the regional workshop in Bishkek, Kyrgyzstan on strengthening the nuclear non-proliferation regime. The workshop was co-organized by CENESS, the Evgeniy Primakov Centre for International Cooperation, and Kyrgyzstan. The Executive Secretary underlined the importance of central Asia's leadership and advocacy in the field.

Public Information

- 7.17. The reporting period saw strong engagement with diverse audiences to promote the work of the PTS and highlight the urgent need for the Treaty's entry into force. Key events throughout the year offered opportunities to showcase the CTBT's contributions to global peace and security, including: SnT2023; Treaty ratifications by the Solomon Islands and Sri Lanka and signature by Somalia; observance of IDANT; the 13th Conference on Facilitating Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty (Article XIV conference) during the 78th UNGA; the Lower Austria Research Festival; IDC training sessions; OSI exercises; IMS station installations and upgrades; employment vacancies; and numerous Executive Secretary missions. These events all enjoyed extensive coverage on PTS social media accounts (X formerly Twitter, Facebook, LinkedIn, YouTube and Flickr) as well as the public website.

- 7.18. For SnT2023, the PTS designed and implemented a digital strategy to promote the conference and increase in-person and online attendance as well as abstract submissions, with particular emphasis on outreach to underrepresented communities. The PTS provided extensive social media coverage before, during and after the conference that had more than 233 000 impressions and 17 000 engagements across X, Facebook, and LinkedIn between January and July 2023, created and executed a briefing programme for sponsored journalists, and facilitated media interviews with the Executive Secretary which resulted in significant coverage in 15 media outlets in seven countries, including two Annex 2 States (India and Pakistan).
- 7.19. 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. This resulted in over 17 000 impressions and 430 engagements on X (formerly Twitter) for the social media video, 500 visits to the IDANT web page, and 350 views of the Executive Secretary video message on YouTube and 8000 impressions for the video message on X.
- 7.20. Coverage of the Executive Secretary's missions was a consistent driver of audience engagement, with a mission to Hiroshima and Nagasaki, Japan followed by several days in the Republic of Korea being notable examples of the widespread interest in his outreach efforts. The Executive Secretary's attendance at the peace memorial for victims of the Hiroshima atomic bombing was featured in several media outlets including *Jiji Press*, *Asahi Shimbun*, *Chukogu Shimbun* and a press read-out from the Japanese Ministry of Foreign Affairs. The Executive Secretary's first trip to Seoul received extensive media coverage in the Republic of Korea where he was interviewed by the *Korea Times*, *Dong-a Ilbo*, *Seoul Shinmun*, Channel A, Arirang TV and the Yonhap News Agency, whose interview was picked up by numerous other publications.
- 7.21. The 13th Article XIV conference received extensive social media coverage to highlight the high level political backing enjoyed by the Treaty and the global momentum and support that exists for its universalization and entry into force. A media briefing in New York with the Executive Secretary, the incoming and outgoing co-presidents of the Article XIV conference, and the Foreign Minister of Sri Lanka (as the most recent ratifying State) provided an additional opportunity for media coverage of the conference.
- 7.22. Following the complete redesign of the CTBTO public website in 2022, the PTS used the 2023 reporting period to refine the site to offer richer, search-engine-optimized content, build out functionalities for various stakeholders including States Signatories, job seekers and vendors, and beta test a multilingualism solution using generative artificial intelligence and machine learning for a cost-effective approach to language inclusion. The site's information architecture was completely changed, and despite deprecating outdated content that accounted for 25-30% of the website's traffic, average yearly website views decreased marginally to 692 954 (compared to 749 782 for 2022). The decrease is also attributable to the introduction of Google Analytics 4 for tracking web analytics, which uses a different methodology to count website traffic and accounts for some revisions of the way data is reported. Even accounting for these major changes, website traffic remained relatively steady. There was also a shift in the most accessed pages of the site. Prior to the redesign, the top performing pages were all related to

historical information such as a timeline of nuclear testing and information on specific nuclear tests. Now the top pages relate to the Treaty, the Organization's mission, employment and procurement opportunities, and resources for delegates. Rather than being a repository for historical data, the website now showcases the dynamism of the PTS and the tangible contributions the Treaty is making to global peace and security.

- 7.23. The number of X (formerly Twitter) followers rose 4% to 26 838 by early December 2023, an increase of 1138 since the end of 2022. Total impressions for 2023 were 1 519 264, with 52 996 engagements. Of note, posts for SnT2023 received more than 109 000 impressions and over 5085 engagements between January and June. IDANT proved to be of particular interest to our X audience with 214 782 impressions and 5935 engagements in August. September also saw high levels of interest due to the OSI directed exercises and the Article XIV conference, whose coverage received a combined 255 805 impressions and 8706 engagements. Given the volatility the platform has experienced under new ownership, navigating the changing dynamics to maintain or grow audience engagement has proven challenging.
- 7.24. The CTBTO Facebook page had over 16 000 likes by late 2023, an increase of 700 followers from the previous year. This audience was particularly interested in content related to the CTBTO mentoring programme, key dates and events such as IDANT and international days, CTBTO workshops and trainings held worldwide, and IMS sustainment visits. Throughout the year, CTBTO posts on Facebook reached 1 079 644 impressions and 29 937 engagements.
- 7.25. The CTBTO YouTube channel was populated with 93 videos, 87 of them related to SnT2023 and two video statements from the Executive Secretary (International Women's Day and IDANT). There were 105 551 views of the channel's content and 387 new subscribers, bringing total channel subscription to 3215.
- 7.26. The CTBTO LinkedIn account saw growth of 40% in the second half of the reporting period, increasing from fewer than 10 000 followers to nearly 14 000. The yearly impressions on the account reached 594 136, with 50 992 engagements. This is the result of a new approach of tailoring campaigns by platform and audience behaviour and providing a broader range of content – beyond employment vacancies – that showcase the dynamic work of the PTS and position the Organization as an employer of choice for job seekers. Content that performed notably well included a post on the film *Oppenheimer*, with more than 19 000 impressions and more than 900 engagements, as well as posts on the OSI directed exercises, which received more than 2000 engagements and reached more than 17 000 viewers. In addition, the strategy for promoting open vacancies has been refined to include bundling vacancies so that people can see the range of employment opportunities available and adjusting publishing times to reach audiences when they are most active on the platform. This has led to an increase of more than 250% in impressions (from 890 impressions to 3380) and a more than 200% increase in engagements (from 47 engagements to 155) per post. An effort has also been made to amplify our work using LinkedIn influencers whose large audiences become aware of our messaging when they share or comment on our content. This approach has yielded promising results in expanding our reach to a larger, more diverse pool of job candidates.

- 7.27. Efforts to engage in-person audiences included participation in several host country initiatives to raise awareness about the work of VIC based international organizations (VBOs), including the Vienna+30 Human Rights Fair from 5 to 6 June 2023 and the Lower Austria Research Festival on 22 September. The two-day Open Air Human Rights Fair at the MuseumsQuartier in the heart of Vienna gave visitors the opportunity to interact with CTBTO staff members who explained the work of the Organization in English and German. The Lower Austria Research Festival featured over 70 exhibits, as well as a colourful array of games, interactive quizzes and performances to showcase the science shaping our present and future. At the CTBTO exhibition booth staff explained how the verification regime detects nuclear tests round the clock and spoke 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. CTBTO also took part in several initiatives organized by the United Nations Information Service (UNIS) Vienna including a panel discussion following the screening of the documentary *The Loneliest Whale* to mark International Mother Earth Day, and an exhibit booth at the Westfield Shopping City Süd in Vienna to mark United Nations Day on 24 October.
- 7.28. The PTS also conducted public outreach through briefing programmes requested through UNIS Vienna. In 2023, CTBTO staff conducted twelve briefings on the work of the Organization, reaching more than 275 participants ranging from students to delegates and military personnel. This was in addition to various tours of facilities and briefings provided to institutions upon request. The PTS also supported the United Nations Vienna Virtual Shadowing Programme 2023 which took place from 24 October to 24 November by having staff volunteers virtually mentor eight of the programme's student participants who were interested in the work of the PTS.
- 7.29. In the last quarter of the reporting period a new CTBTO permanent exhibit was installed in the Kofi Annan Building of the VIC. The immersive, interactive exhibit was designed to convey the importance of the Treaty and its contributions to nuclear non-proliferation and disarmament to a broad range of stakeholders, including the more than 50 000 visitors who take UNIS Vienna guided tours each year. The exhibit highlights the science and technology used by the IMS, how information from the IMS is analysed by staff in the IDC, and how on-site inspections can be conducted once the Treaty enters into force. The exhibit also invites visitors to learn more about the civil and scientific applications of IMS data and how they can contribute to the work of CTBTO. The exhibit includes QR codes to direct people to the website where they can learn more about the Organization and features a photo activation that encourages visitors to share their pictures of the exhibit on social media.
- 7.30. The importance of gender empowerment, equity and inclusion in advancing nuclear non-proliferation and disarmament remained a focus of communications efforts in 2023. The PTS observed several international days including the International Day of Women and Girls in Science and International Women's Day by highlighting the contributions of women in STEM to the mandate of the Organization. The PTS participated in Daughters' Day on 27 April at the VIC, a city-wide event organized by the City of Vienna each year to introduce girls to careers in STEM. Over 150 girls between the ages of 11 and 16 had the opportunity to learn about careers at the CTBTO and the work of the Organization as well as participate in hands-on exhibits and activities. In addition, the PTS designed and

implemented a social media campaign to promote the CTBTO mentorship programme for early career women in STEM and share insights from both mentors and mentees about the importance of gender inclusion in achieving a world free of nuclear testing. Targeted outreach to encourage women's participation in SnT2023 was undertaken and the Organization promoted virtual career fairs for women candidates for CTBTO employment vacancies. The activities of the International Gender Champions network in Vienna, of which the Executive Secretary is a prominent member, were highlighted on social media, and gender equity and inclusion were mainstreamed, including in the communications strategy, in the selection of images for informational materials, social media posts and web pages, and in the composition of panel speakers for discussions.

Global Media Coverage

- 7.31. Extensive media coverage of the CTBTO and the Executive Secretary's engagements was achieved by liaising proactively with media outlets and targeted outreach to local press, as well as promoting CTBTO activities, signatures and ratifications, and the Executive Secretary's missions and media interviews on social media. The Organization, the Treaty and its verification regime featured in a wide range of articles, blogs and broadcast pieces around the world.
- 7.32. Statements issued by the Executive Secretary on the Russian Federation's revocation of its ratification of the Treaty were quoted extensively by media outlets, with nearly daily mentions in October 2023 and direct quotes for the statements used in more than 90 publications. Between 6 and 30 October 2023, there were more than 2800 mentions for search terms related to CTBTO and the Treaty, representing articles published on the sites of over 1200 publishers. The regional distribution of publishers was concentrated in North America and Western Europe with 593 publishers, South-East Asia, the Pacific and the Far East with 243 publishers from countries in the region, followed by the Middle East and South Asia with 163 publishers; Eastern Europe with 171 publishers; 27 publishers from Africa; and 32 publishers from Latin America and the Caribbean. Social media posts from the Executive Secretary's account had extensive engagement, with the statement issued on 6 October receiving 17 000 impressions, the statement on 9 October garnering 15 400 impressions, and the statement of 18 October reaching 72 000 impressions.

National Implementation Measures

- 7.33. The Commission published an updated note for States Signatories on the national measures taken by each State Signatory to implement its obligations under the Treaty. It continued to provide advice and assistance on the legal measures required for ratification and implementation of the Treaty, both by presenting at workshops, training courses and academic lectures, and by publishing an updated Signature and Ratification Guide in English, French and Spanish and updated Background Information for Parliamentarians in all six languages of the Commission (available on the public website).

8. PROMOTING THE ENTRY INTO FORCE OF THE TREATY

Highlights in 2023

- 187 States had signed the Treaty and 177 had ratified it as of 31 December 2023
- Two States ratified the Treaty (the Solomon Islands and Sri Lanka) and one State signed it (Somalia)
- The thirteenth Article XIV conference was held on 24 September 2023 in New York

Introduction

- 8.1. 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 reference to the article of the Treaty concerning its entry into force). The first Article XIV conference took place in Vienna in 1999. Subsequent conferences have been held every two years, with the latest taking place in New York in September 2023. Article XIV conferences, convened by the Secretary-General of the United Nations at the request of a majority of States that have ratified the Treaty, discuss and decide on what measures, consistent with international law, may be undertaken to accelerate the ratification process in order to facilitate the entry into force of the Treaty. Article XIV conferences adopt a final declaration by consensus.
- 8.2. 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 Universality of the Treaty

- 8.3. 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.
- 8.4. As of 31 December 2023, 187 States had signed and 177 States had ratified the Treaty. Of those, 35 Annex 2 States had ratified the Treaty, with nine yet to ratify the Treaty and three yet to sign it. In 2023, the Treaty was signed by Somalia (8 September) and ratified by the Solomon Islands (20 January) and Sri Lanka (25 July). 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. Regrettably, the Russian Federation – an Annex 2 State – revoked its ratification of the CTBT in 2023.
- 8.5. The Executive Secretary reaffirmed his determination to progress towards entry into force, complete the establishment of the IMS and ensure all States have full access to the full benefits of the Treaty.

- 8.6. In 2023 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.

Thirteenth Article XIV Conference

- 8.7. The 13th Article XIV conference was held on 22 September 2023 during the high level week of the UNGA and was presided over by the Foreign Minister of Norway and the Foreign Minister of Panama. During the conference, ministers and senior officials from nearly 60 countries delivered statements of strong support for the Treaty, joining the United Nations Secretary-General (represented by the United Nations Under-Secretary-General and High Representative for UNODA) and the Executive Secretary in making calls for its urgent entry into force and universalization.
- 8.8. The speakers underlined the significance of the Treaty for nuclear disarmament and non-proliferation and the established norm against nuclear testing. They called on non-ratifying States, in particular the remaining Annex 2 States, to ratify the Treaty as soon as possible. They also expressed appreciation for the activities of the Commission and the effective performance of the verification regime of the Treaty.
- 8.9. The Executive Secretary noted the steady progress towards universal recognition of the CTBT, with eight further ratifications – by Dominica, Equatorial Guinea, The Gambia, São Tomé and Príncipe, the Solomon Islands, Sri Lanka, Timor-Leste and Tuvalu – and one signature – Somalia – since the previous Article XIV conference in 2021, and he noted that further signatures and ratifications were likely in the near future. The Executive Secretary urged States to make the case for the Treaty in all appropriate settings and noted the urgency of reaffirming the importance of the CTBT.
- 8.10. The conference unanimously adopted a Final Declaration that urged the remaining Annex 2 States to "sign and ratify the CTBT without further delay." The Final Declaration characterized the Treaty as a "vital multilateral instrument for nuclear disarmament and non-proliferation" and called upon "all States to reaffirm and maintain all existing moratoria on nuclear weapon test explosions." However, it underlined that these steps "do not have the same permanent and legally binding effect to end nuclear weapon testing and all other nuclear explosions, which can only be achieved with the entry into force of the Treaty."
- 8.11. The Declaration also outlined a series of concrete measures to be taken, including supporting outreach initiatives, and encouraging the remaining Annex 2 States to provide information on practical steps towards signing and/or ratifying the CTBT.

9. POLICY MAKING

Highlights in 2023

- Election of the Chairperson and Vice-Chairpersons of the Preparatory Commission for 2024
- Appointment of the Chairperson and a Vice-Chairperson of Working Group A
- Appointment of the Chairperson and a Vice-Chairperson of WGB

Introduction

9.1. 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 verification 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 2023

9.2. The Commission and its subsidiary bodies each met in two regular sessions in 2023. The Commission also held resumed sessions.

Table 4. Meetings of the Commission and Its Subsidiary Bodies in 2023

Body	Session	Dates	Chairperson
Preparatory Commission	Sixtieth	12-14 June, 21 July	Ambassador Benno Laggner (Switzerland)
	Sixty-First	13-15 and 17 November, 4 December	
Working Group A	Sixty-Third	24-25 May	Ambassador Nguyen Trung Kien (Viet Nam)
	Sixty-Fourth	16-18 October	
Working Group B	Sixtieth	13-24 March	Mr Erlan Batyrbekov (Kazakhstan)
	Sixty-First	21 August- 1 September	
Advisory Group	Sixtieth	8-12 May	Ms Rashmi Rajyaguru (United Kingdom)
	Sixty-First	26-29 September	

- 9.3. Among the major issues addressed by the Commission during 2023 were the promotion of the entry into force of the Treaty; adherence to the moratorium on nuclear testing; progress made on the completion of the IMS network; capacity building activities of the Commission; business continuity; proposals and related decisions on the 2024-2025 Programme and Budget; appointment of the Chairperson and a Vice-Chairperson of WGA; and appointment of the Chairperson and a Vice-Chairperson of WGB.

Supporting the Commission and its Subsidiary Bodies

- 9.4. 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.
- 9.5. 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 supporting the work of the Commission and its subsidiary bodies.

Virtual Working Environment

- 9.6. Sessions of the Commission and of its subsidiary bodies were live streamed on the ECS and the recordings were made available on the platform after each session. The Interprefy platform was used for all sessions of WGB, and the Webex platform for some informal and technical briefings.
- 9.7. 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.
- 9.8. 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

- 9.9. 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.

Election of the Chairperson and Vice-Chairpersons of the Commission

9.10. The Commission elected Ambassador Kaifu Atsushi (Japan) as its Chairperson for 2024. The Commission also elected the Permanent Representatives of Lithuania (Eastern Europe), Chile (Latin America and the Caribbean), Finland (North America and Western Europe) and Australia (South East Asia, the Pacific and the Far East) as its Vice-Chairpersons for 2024.

Appointment of the Chairperson and a Vice-Chairperson of Working Group A

9.11. The Commission appointed Ambassador Evangelina Lourdes A. Bernas (Philippines) as the Chairperson and Ambassador Elena María Freije Murillo (Honduras) as a Vice-Chairperson of WGA, 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 starting on 1 January 2024 and expiring on 31 December 2026.

Appointment of the Chairperson and a Vice-Chairperson of Working Group B

9.12. The Commission appointed Mr Erlan Batyrbekov (Kazakhstan) as the Chairperson of WGB, 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 starting on 1 January 2024 and expiring on 31 December 2026; and Ms Tebogo Gladness Matlou (South Africa) as a Vice-Chairperson of WGB for a term starting on 21 August 2023.

10. MANAGEMENT

Highlights in 2023

- Effective administrative support to ensure business continuity
- Navigating volatility and ensuring financial resilience
- A further substantial decrease in recruitment throughput time

Introduction

- 10.1. 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.
- 10.2. 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.
- 10.3. 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.
- 10.4. In addition to the services provided to all programmes, during the reporting period, the Division of Administration provided support to enable a seamless and successful SnT2023. The support encompassed a variety of areas, including logistical arrangements; procurement of goods and services; insurance; vendor payments; and travel related services, including visas, arranging for travel tickets, and reimbursement of expenses. The administration of contributions in kind from event sponsors was also a focus area. SnT2023 provided an opportunity to optimize collaboration with internal and external stakeholders facilitating the efficient and timely delivery of services for the event.

Oversight

- 10.5. Internal Audit is an independent and objective internal oversight function. Through the provision of assurance, advisory and investigation services, it contributes to the improvement of the PTS governance, risk management and control processes.
- 10.6. 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.
- 10.7. The internal audit assignments performed in 2023 were conducted in accordance with the Financial Regulations and Rules and in conformity with the International Standards for the Professional Practice of Internal Auditing. These assignments were based on an

approved risk based work plan addressing areas of strategic importance with a focus on identifying opportunities to mitigate risks and strengthen the overall control environment of the PTS. As a result, Internal Audit provided several recommendations to management.

- 10.8. In addition, Internal Audit undertook periodic follow-up exercises on the status of implementation of its recommendations and corresponding actions taken by management. Following these exercises, Internal Audit submitted relevant progress reports to the Executive Secretary which included specific analyses regarding the prioritization and chronology of the recommendations.
- 10.9. 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. The main aim of such activities was to support management in its ongoing efforts to achieve operational efficiency and effectiveness.
- 10.10. Likewise, to augment organizational accountability and integrity, Internal Audit took steps to increase its investigation capacity in 2023. Throughout the year, the Chief of Internal Audit continued to monitor the whistleblowing line and took relevant action, as appropriate.
- 10.11. Additionally, Internal Audit played a key role in fostering a cooperative and constructive professional working relationship between the External Auditor and the PTS.
- 10.12. In 2023, Internal Audit finalized the procurement process for the acquisition of specialized audit software. The installation and full implementation of the software, planned for completion in the first part of 2024, will advance the automation of Internal Audit processes towards enhanced efficiency within audit workflows.
- 10.13. Internal Audit continued to improve the quality of its services through its QA and improvement programme, in line with the International Standards for the Professional Practice of Internal Auditing. For this purpose, in order to streamline its methodologies and align its activities with evolving leading practices in the profession, Internal Audit reviewed and updated its Charter in 2023.
- 10.14. In continuous pursuit of professional excellence, Internal Audit participated in knowledge sharing and exchanges on methodologies, practices and innovations in oversight, 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.

Legal Services

- 10.15. Legal Services continued to provide legal advice and support to the PTS, the Preparatory Commission and its subsidiary bodies, and States Signatories on request – ranging from advice on the interpretation of the Treaty, to the negotiation of agreements between the Commission and States Signatories, through the review of procurement contracts and other financial and administrative processes, to advice on human resources issues.

Finance

2022-2023 Programme and Budget

- 10.16. 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%.
- 10.17. 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.
- 10.18. During 2023, close interaction with State Signatories, the Commission and subsidiary bodies including the Advisory Group and WGA was maintained as part of the budget setting, reviews and approvals process. A new budget brochure concept was implemented to highlight for State Signatories key budget areas as part of the deliberations on the 2023 Budget final draft.
- 10.19. 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

- 10.20. Ensuring financial sustainability and resilience of the Organization remained a key priority. The year 2023 was again marked by inflation, rising interest rates, tight labour markets and geopolitical factors contributing to supply chain disruptions. Close monitoring of budget appropriations against forecasted and actual expenditure took place through the year to ensure funds availability for planned activities.
- 10.21. Given ongoing global macro-economic challenges and financial constraints faced by States Signatories, the 2020-2021 cash surplus provided a unique opportunity to support unfunded initiatives while avoiding the need for supplemental appropriations. From a total cash surplus of \$23.8 million, an amount of \$21.7 million (91%) was provided to finance unfunded initiatives pertaining to the verification related major programmes.

Table 5. Distribution of the 2022-2023 Budget by Area of Activity

Area of Activity	2022 Budget (US\$ millions) ^a	2023 Budget (US\$ millions) ^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
Total	125.9	129.2

^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

10.22. As of 31 December 2023, the collection rates of the assessed contributions from States Signatories for 2023 were 96.2% (92.9% in 2022) of the US dollar portion and 96.9% (93% in 2022) of the euro portion. The number of States that had paid their 2023 assessed contributions in full as of 31 December 2023 was 108.

Expenditure

10.23. The expenditure for the Programme and Budget in 2023 amounted to \$138 854 983, of which \$20 109 112 was from the Capital Investment Fund, \$11 206 352 was from the multiyear funds, and the remainder from the General Fund. For the General Fund, the unused budget was \$13 211 175, as reported in the financial statements for 2023.

Automation

10.24. The PTS continued to build upon automation projects in vendor payment processing. For instance, improvements in reporting have enabled the PTS to obtain data per division and expedite payment processing. In 2023, 3528 invoices were processed through the e-invoicing system.

10.25. Automation of the reconciliation process for air travel tickets was completed successfully in the year, with the resulting benefits of streamlined and more efficient accounts payable processes. In 2023, the air travel volume handled by the PTS increased steadily to exceed volumes experienced before the COVID-19 pandemic. For example, the PTS processed 1554 travel claims in 2023, representing a 15% increase for external participants compared to the pre COVID-19 years. Automation has proven vital for the ability of administrative support to handle these increased volumes.

10.26. A new Assessed Contributions Information System was designed, implemented and fully integrated into the PTS' SAP Enterprise Resource Planning system.

- 10.27. The automation of various reporting tools remains a priority for the PTS, allowing for streamlined financial operations and support, enhanced financial analysis and decision making.

United Nations International Public Sector Accounting Standards Task Force Conference

- 10.28. The CTBTO, together with other VBOs, co-hosted the United Nations International Public Sector Accounting Standards (IPSAS) Task Force Conference in 2023. This annual event provides a forum for the exchange of policies and best practices in finance and accounting among United Nations system organizations from around the world. The topics covered at the conference were varied and included, amongst others, areas such as annual financial reporting, external audit and consultations and guidance on the application of new IPSAS accounting standards, particularly those in the areas of revenue, leases, and financial instruments. The conference was held in a hybrid format with over 80 participants attending in person and many others online, representing approximately 40 United Nations system organizations. Keynote speakers included representatives from the IPSAS Board, United Nations Board of Auditors, United Nations system organizations and individual experts. Excellent feedback was received from attendees, as the event provided a valuable platform, promoting collaboration, the sharing of experiences and lessons learned, identifying common challenges faced by finance professionals in the United Nations system along with opportunities for enhanced financial reporting efficiencies and process improvements. Of particular note was the engagement by the Task Force with a member of the IPSAS Board and the member's participation in the focus groups session, where implementation challenges from across the United Nations system were discussed in the context of current and forthcoming IPSAS Standards.

Statutory Compliance

- 10.29. In 2023, the PTS successfully underwent an external audit of the 2022 financial statements, receiving an unqualified (unmodified) audit opinion attesting to compliance with IPSAS and the true and fair presentation of the financial situation of the Organization. The Division of Administration and Internal Audit both served as key interlocutors with the External Auditor in support of the external audit process.
- 10.30. The PTS also completed a successful verification of the EU-financed project CFSP/2018/298/CTBTO VII which required direct involvement in particular of both the Budget and Finance and Procurement Sections within the Division of Administration.

General Services

- 10.31. During the reporting period, inter-agency cooperation with the other VBOs continued, with the PTS actively participating in all inter-VBO committees, both decision making and advisory. Furthermore, 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 where possible.

- 10.32. The development of PTS-wide procedures for the management of documents, including their electronic handling and signature and the automation of document management processes was an area of continued work. In addition, the PTS pursued further optimization of available office space, using cross-Divisional arrangements and accommodating archiving needs to ensure safe storage of the Commission's records and documentation.
- 10.33. During the reporting period, the PTS continued to provide the necessary support related to travel and booking arrangements during a period of increased volume.
- 10.34. The PTS 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.
- 10.35. All customs declarations for the release of CTBTO equipment were processed and submitted to the customs clearing agents in a timely manner.

Procurement

- 10.36. As of 31 December 2023, the PTS completed major milestones in the project implementation of streamlining Enterprise Resource Planning system processes in the addition of several new functionalities. These included the completion of a new procure-to-pay cycle report, procurement dashboard implementation, procurement implementation reports, and enhancements to 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.
- 10.37. The Commission obligated \$75 157 920 through 909 procurement transactions and \$1 083 590 through 631 low-value purchases for an overall aggregated total of \$76 241 510 in procurement implementation as of 31 December 2023.
- 10.38. As of 31 December 2023, 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

- 10.39. 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.
- 10.40. In 2023, the Commission received voluntary contributions from notable country donors (Austria, China, France, Italy, Japan, Republic of Korea, Spain, the United Kingdom and the United States of America). Additionally, the Commission signed a new agreement with the European Union on support for the activities to strengthen the CTBTO's monitoring and verification capabilities. 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.

Human Resources

- 10.41. Throughout 2023, 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 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.
- 10.42. The PTS advanced its human resources objectives and improved the efficiency of its human resources operations as both are crucial for continuous operations and organizational effectiveness. This includes activities such as: the continuous review of the Commission's regulatory framework to ensure an efficient and fair internal justice system, modernizing human resources operations to support the needs of staff members, implementation of measures to further improve the efficiency of recruitment operations, and the launch of an online and digital Learning Hub to support the learning and development needs of staff. These initiatives collectively fostered a diverse and skilled workforce to advance the CTBTO's mission. These measures also underscore the Organization's commitment to equal opportunity and leadership development as part of an effort to ensure an agile, resilient and efficient Secretariat. Efficiencies in recruitment were notably improved, reducing throughput times and leveraging strategic staffing plans and talent pools, alongside a focus on diversity through targeted outreach and the second cycle of the CTBTO mentoring programmes for early career women in STEM especially from underrepresented geographical regions.
- 10.43. The PTS continued its efforts to improve human resources policies, procedures and processes. Administrative Directives were reviewed and updated to align with evolving organizational needs and to ensure further harmonization with the United Nations Common System of international organizations. The process of updating Administrative Directives is continuous and methodical, guided by a strategy of prioritization. This approach ensures regular and systematic revisions to these directives, aligning with organizational needs and procedures.
- 10.44. Progress was made in enhancing the efficiency of administrative support and ensuring the continuity of business operations through the further adoption of digital tools like the JIRA ticketing system and the pilot Employee Self-Service (ESS) portal. Staff members actively used the JIRA system and the ESS portal for efficiently managing their personal information and individual requests regarding certain entitlements and benefits. While operating within budgetary constraints, HRS collaborated with colleagues responsible for corporate IT to further plan and initiate IT modernization projects. These efforts included adding more services to the ESS portal and evaluating the migration to more advanced systems like SharePoint and SAP high-performance analytic appliance (HANA). This proactive approach and cooperation were instrumental in maintaining operational efficiency and business continuity for the PTS.

- 10.45. Achieving a diverse and talented Secretariat remained a core goal of recruitment operations. Talent acquisition activities were guided by an outreach strategy that included numerous events, joint webinars with other international organizations, and a new social media outreach branding strategy. These efforts specifically targeted difficult-to-fill positions, women in STEM and candidates from underrepresented regions. The CTBTO mentoring programme culminated with a recruitment bootcamp session to support mentees when competing for job opportunities at international organizations. In support of the joint responsibility for identifying qualified candidates, the PTS continued to partner with States Signatories through conducting a series of recruitment outreach events and the launch of the new Jobs Bulletin sent via the ECS. Recruitment staff participated in a series of human resources network events and in the Career Development Roundtable to keep abreast of best practices and developments in the field. In recruitment, 2023 saw further efficiency measures, particularly in a further substantial decrease in recruitment throughput time to achieve HRS' key performance indicator for the 2022–2023 biennium, a major milestone achievement for HRS.
- 10.46. As of 31 December 2023, there were 293 regular fixed term staff members of the PTS from 91 countries, compared with 296 staff members from 92 countries on 31 December 2022. In 2023, there were 196 staff members in the Professional and higher categories, which was the same number as in 2022. By the end of 2023, 39.8% of staff at the professional or higher level were women compared to 39.3% at the end of 2022. Meaningful and measurable progress has been made in implementing the Commission's decision on Equal Opportunity Employment – Women in the PTS. For instance, as of 31 December 2023, women occupied 45.2% of P5 posts and 57.1% of P2 posts. In this way, the PTS is contributing to a pipeline of talent for both middle- and executive-management posts.

Table 6. Fixed Term Staff Members by Field of Work as of 31 December 2023

Field of Work	Professional	General Services	Total
QMPM Section	3	1	4
IMS Division	36	26	62
IDC Division	81	14	95
OSI Division	23	6	29
<i>Subtotal, verification related</i>	<i>143</i>	<i>47</i>	<i>190</i>
<i>Share, verification related</i>	<i>73%</i>	<i>48.5%</i>	<i>64.8%</i>
Office of the Executive Secretary	6	3	9
Internal Audit	3	1	4
Human Resources Services	6	8	14
Division of Administration	21	21	42
Legal and External Relations Division	17	17	34
<i>Subtotal, non-verification-related</i>	<i>53</i>	<i>50</i>	<i>103</i>
<i>Share, non-verification-related</i>	<i>27%</i>	<i>51.5%</i>	<i>35.2%</i>
Total for 2023	196	97	293

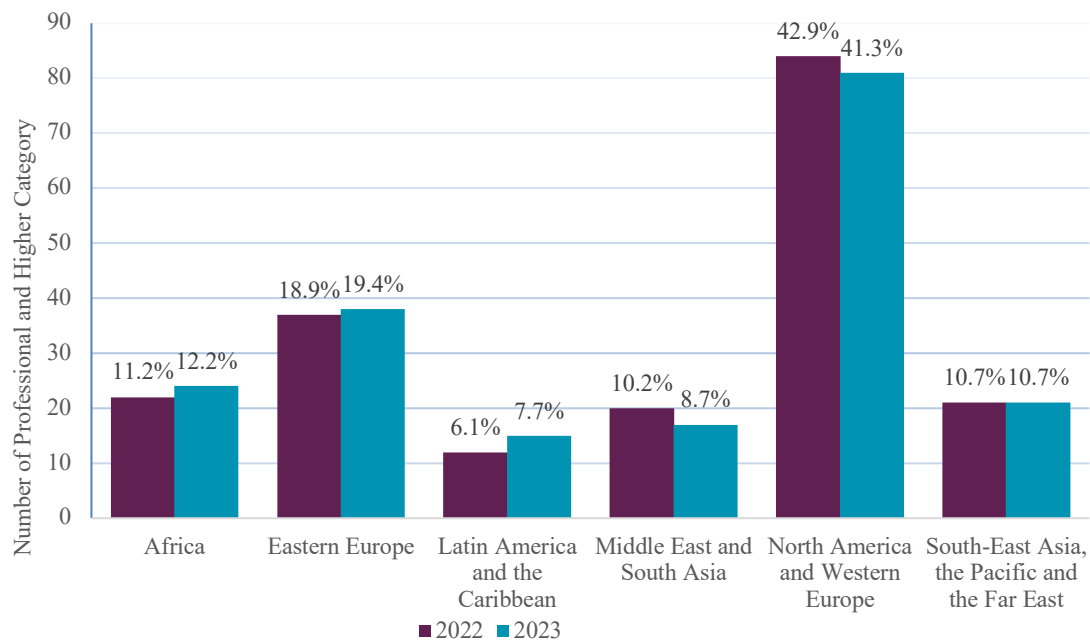


Figure 1. Fixed term Professional staff and higher category by geographical region as of 31 December 2022 compared to 31 December 2023.

Table 7. Fixed Term Staff Members by Grade, 2022 and 2023

Grade	2022		2023	
D1	5*	(1.7%)	6	(1.7%)
P5	33	(11.1%)	31	(10.6%)
P4	58	(19.6%)	64	(21.8%)
P3	70	(23.6%)	67	(22.9%)
P2	30	(10.1%)	28	(9.6%)
P1	-	-	-	-
<i>Subtotal</i>	<i>196</i>	<i>(66.2%)</i>	<i>196</i>	<i>(66.9%)</i>
G7	1	(0.3%)	1	(0.3%)
G6 [†]	6	(2.0%)	5	(1.7%)
G6	28	(9.5%)	27	(9.2%)
G5	44	(14.9%)	42	(14.3%)
G4	21	(7.1%)	22	(7.5%)
<i>Subtotal</i>	<i>100</i>	<i>(33.8%)</i>	<i>97</i>	<i>(33.1%)</i>
Total	296	(100%)[‡]	293	(100%)

* 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.

Table 8. Fixed Term Staff Members by Grade and Gender, 2022 and 2023

Grade	Male				Female			
	2022		2023		2022		2023	
D1	3	(1.9%)	3	(1.9%)	2*	(1.5%)	3	(2.3%)
P5	18	(11.1%)	17	(10.6%)	15	(11.2%)	14	(10.5%)
P4	37	(22.8%)	39	(24.4%)	21	(15.7%)	25	(18.8%)
P3	48	(29.6%)	47	(29.4%)	22	(16.4%)	20	(15.0%)
P2	13	(8.0%)	12	(7.5%)	17	(12.7%)	16	(12.0%)
P1	-	-	-	-	-	-	-	-
<i>Subtotal</i>	<i>119</i>	<i>(73.5%)</i>	<i>118</i>	<i>(73.8%)</i>	<i>77</i>	<i>(57.5%)</i>	<i>78</i>	<i>(58.6%)</i>
G7	-	-	-	-	1	(0.7%)	1	(0.8%)
G6 [†]	6	(3.7%)	5	(3.1%)	-	-	-	-
G6	18	(11.1%)	17	(10.6%)	10	(7.5%)	10	(7.5%)
G5	14	(8.6%)	13	(8.1%)	30	(22.4%)	29	(21.8%)
G4	5	(3.1%)	7	(4.4%)	16	(11.9%)	15	(11.3%)
<i>Subtotal</i>	<i>43</i>	<i>(26.5%)</i>	<i>42</i>	<i>(26.3%)</i>	<i>57</i>	<i>(42.5%)</i>	<i>55</i>	<i>(41.4%)</i>
Total	162	(100%)[‡]	160	(100%)	134	(100%)	133	(100%)

* 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.