CTBTO
PREPARATORY COMMISSION

BUSINESS CONTINUITY

ANNUAL REPORT 2020

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The maps on pages 22-25 show the approximate locations of International Monitoring System facilities based on information in Annex 1 to the Protocol to the Treaty adjusted, as appropriate, in accordance with proposed alternative locations that have been approved by the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization for reporting to the initial session of the Conference of the States Parties following entry into force of the Treaty.

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Message from the Executive Secretary

In 2020, our activities continued to be guided by the strategic goals of the Medium Term Strategy: 2018-2021. These include acceptance of the verification system, global commitment to the Comprehensive Nuclear-Test-Ban Treaty (CTBT) and an efficient and sustainable Secretariat.

To meet our strategic goals, our activities were geared towards fostering political support for the Treaty and advancing its entry into force and universalization. We also continued to further our high level engagement with States and promoted the roles of youth and women in the outreach activities of the Organization.

As for the verification regime of the Treaty, the priorities were centred around sustainment as well as further development of the International Monitoring System (IMS), the International Data Centre (IDC), and on-site inspection (OSI) capabilities.

The COVID-19 pandemic was a major stress test for the organization and its verification regime. To stem the pandemic, many States introduced strong restrictive measures which presented notable challenges for the functioning of the Commission and its verification activities.

In response, the Commission quickly adapted to the new circumstances. Arrangements were made for staff to work from home. Seeking the cooperation of host countries, efforts were made to secure the daily operation of the IMS facilities. Continuous and close interactions with operators were maintained at all times.

We continued to maintain the uninterrupted and timely flow of data and products to States Signatories through the release of Reviewed Event Bulletins and Reviewed Radionuclide Reports. States Signatories have been receiving a weekly summary regarding the state of health of the IMS, data availability and IDC products.

Travel restrictions have caused some delays in the sustainment and station establishment activities where on-site presence of our experts is essential. To lessen the effects of the situation, some mitigation initiatives were adopted. These included enhanced technical guidance and support to station operators, increased use of local and regional support services and purchasing, ensuring the availability of critical spare parts, development of a shipping tool to monitor, track and re-route shipments, and increased frequency of replenishment of consumables.

The COVID-19 containment measures prompted a revision of the schedule and modalities of outreach activities planned by the Commission, including

workshops, seminars and training courses. In some cases, events were held virtually, thus offering the opportunity to expand the number of participants. The organization continued to support the Chairperson of the Commission and its subsidiary bodies in their interactions with States Signatories and in preparing for the meetings of the policy making organs. A range of virtual meeting platforms were tested and used to help the timely and efficient holding of meetings with provision of simultaneous interpretation when required.

In short, the demanding mission of the operation and maintenance of our global verification regime in the face of movement restrictions implemented by many countries has been successfully accomplished. This showcases the resilience of the organization and its preparedness to withstand unforeseen situations and to ensure business continuity.

I would like to take this opportunity to express my deep appreciation to States Signatories for their unwavering support during these challenging times and in particular their assistance in facilitating the continued operation of IMS stations.

Drawing on lessons learned, the business continuity plan of the Commission was thoroughly reviewed and updated in order to ensure its robustness. The updated plan defines risk areas as well as prerequisites for business continuity such as agile leadership; an operationally minded and results based culture; as well as sound risk analysis and management. The CTBTO elements that are operational or serve operational needs of States Signatories are given priority over other elements.

Throughout the year, the support for the CTBT, as one of the main pillars of the international nuclear non-proliferation and disarmament regime, remained high. This was well reflected in the remarks and statements made by world leaders, State officials and civil society representatives. The significance of the CTBT for international peace and security as well as the call for its entry into force were reinforced on many occasions. The occasions involved, inter alia, my bilateral meetings with senior officials of States Signatories, a ministerial webinar on 13 May and the statements during the virtual high level week of the United Nations General Assembly, a ministerial video message from the Friends of the CTBT and a webinar discussion hosted by the CTBTO on "The CTBT and the 10th NPT Review Conference" on 6 October 2020.

Words were further complemented by actions. States Signatories spared no efforts in demonstrating their commitment to the Treaty by offering full assistance to facilitate the smooth and uninterrupted functioning of our global monitoring facilities during the COVID-19 lockdowns.

A variety of initiatives, including the outreach efforts of the Group of Eminent Persons and the CTBTO Youth Group, provided opportunities to engage with government officials, technical experts, academics and the media. We also furthered an intergenerational network through interactions between the Group of Eminent Persons and the CTBTO Youth Group, which has now grown to nearly 1000 members.

To review the functioning of our verification regime and relevant technological evolution, we commenced the preparation for the next international CTBT: Science and Technology conference. The Scientific Programme Committee of the conference was established, and its objectives and main themes were defined. The conference will be held from 28 June to 2 July 2021. For the first time, most of the conference is planned to be virtual, with presentations and participation being online, making it possible for more participants to join remotely. The opening session on the first day will be hybrid, with limited presence at the Hofburg palace in Vienna.

The scope and coverage of the integrated capacity development programme of the Commission continued to grow. Many experts, mostly from developing countries, attended our educational programmes, workshops and training courses and gained expertise in using the data and products of the verification system. They also benefited from discussions on political and legal aspects of the Treaty.

The establishment and sustainment of the 321 monitoring stations and 16 radionuclide laboratories of the IMS is essential to meeting the verification requirements of the Treaty. In 2020, additional IMS facilities were certified, thus improving both the coverage and resilience of the network. At present 302 IMS facilities have been certified. The figure represents almost 90% of the network foreseen by the Treaty.

In the meantime, advances in station design and sensor capabilities in all four monitoring technologies of the Treaty continued. This enhances the detection capability and reliability of newly installed stations.

With the completion of the cycle of four experiments, substantial progress was made in IDC progressive commissioning activities. In addition, the COVID-19 crisis allowed the IDC to fully test its ability to work remotely. In particular, it was demonstrated that the analyst team can operate effectively in a remote setting.

The highlights of the OSI activities during 2020 included evaluation and reporting on the outcomes of the OSI action plan for 2016-2019; training courses for the third training cycle of future inspectors; and development of the first comprehensive draft list of OSI equipment. These activities will contribute considerably to our OSI capabilities.

The year also witnessed continued efforts aimed at increased synergies, streamlining of activities, efficiency gains and smart planning and resource allocation.

In closing, I wish to express my gratitude to States Signatories and the staff of the organization for their strong support that has made these achievements possible.

Lassina Zerbo
Executive Secretary
CTBTO Preparatory Commission
Vienna, April 2021

I would like to take this opportunity to express my deep appreciation to States Signatories for their unwavering support during these challenging times.

Lassina Zerbo, Executive Secretary

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Abbreviations

3-C	three component
ATM	atmospheric transport modelling
BUE	build-up exercise
COPC	CTBTO Operations Centre
CTBT	Comprehensive Nuclear-Test-Ban Treaty
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
ECS	Experts Communication System
EU	European Union
GCI	Global Communications Infrastructure
GIMO	Geospatial Information Management for OSI
IDC	International Data Centre
IMS	International Monitoring System
NDC	National Data Centre
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
O&M	operation and maintenance
OSI	on-site inspection
PCA	post-certification activity
PRTool	performance reporting tool
PTE	proficiency test exercise
PTS	Provisional Technical Secretariat
QA/QC	quality assurance and quality control
QMPM	Quality Management and Performance Monitoring (Section)
QMS	Quality Management System
REB	Reviewed Event Bulletin
SAUNA	Swedish Automatic Unit for Noble Gas Acquisition
SEL	Standard Event List
SHI	seismic, hydroacoustic and infrasound
SPALAX	Système de prélèvement automatique en ligne avec l'analyse des radio xénons
SOP	standard operating procedure
SSI	standard station interface
VIC	Vienna International Centre
VPN	virtual private network
VSAT	very small aperture terminal
WGA	Working Group A
WGB	Working Group B
WMO	World Meteorological Organization

▶ The Treaty

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

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

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

▶ The Commission

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

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

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

I

THE INTERNATIONAL MONITORING SYSTEM

HIGHLIGHTS

- **Bringing the total number of certified facilities to 302**
- **Ensuring a high level of data availability, despite COVID-19 related restrictions**
- **Progress was achieved in the development of the next generation of all noble gas systems**

INTRODUCTION

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

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

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

Completing the International Monitoring System

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 International Data Centre (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.

In 2020, following outreach to host States, the Commission made further progress with the installation and establishment of facilities in a number of States. Two IMS facilities were certified: radionuclide station RN55 (Russian Federation), and infrasound station IS25 (France), bringing the total number of certified IMS facilities to 302 (89.6% of the network foreseen by the Treaty), thus improving both the coverage and resilience of the network.

Installation of Infrasound Station IS25, Guadeloupe, France.

Monitoring of radionuclide noble gases plays an essential role in the verification system of the Treaty, as was demonstrated following the announced nuclear tests by the Democratic People's Republic of Korea in 2006 and 2013. It also proved to be invaluable following the nuclear accident at Fukushima, Japan, in 2011. In line with its priorities, the Commission continued to focus on the noble gas monitoring programme in 2020 through close cooperation with the developers of next-generation noble gas systems.

As of the end of the year, 31 noble gas systems were installed (78% of the planned total of 40) at IMS radionuclide stations. Of these, 25 systems were certified as meeting the stringent technical requirements.

Proficiency test exercises (PTEs) are key elements of quality assurance and quality control (QA/QC) of IMS laboratories. For the noble gas PTE, the proficiency test framework has reached enough maturity and will become official in 2021.

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

Status of the Installation and Certification Programme for International Monitoring System Stations as of 31 December 2020

IMS Station Type	Installation Complete		Under Construction	Contract Under Negotiation	Not Started
	Certified	Not Certified			
Primary seismic	44	1	1	1	3
Auxiliary seismic	108	7	2	-	3
Hydroacoustic	11	-	-	-	-
Infrasound	53	1	1	0	5
Radionuclide	72	0	1	2	5
Total	**288**	**9**	**5**	**3**	**16**

Installations and Certifications of Noble Gas Systems at Radionuclide Stations as of 31 December 2020

Total Number of Noble Gas Systems	Installed	Certified
40	31	25

Certifications of Radionuclide Laboratories as of 31 December 2020

Total Number of Laboratories	Certified for Particulate Capability	Certified for Noble Gas Capability
16	14	4

Agreements for Monitoring Facilities

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

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

In 2020, the Commission continued to address the importance of concluding facility agreements and arrangements and their subsequent national implementation. The absence of such legal mechanisms in some cases results in substantial costs (including in human resources) and major delays in sustaining certified IMS facilities. These costs and delays adversely affect the availability of data from the verification system.

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

Post-Certification Activities

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

PCA contracts are fixed cost contracts between the Commission and some station operators. These contracts cover station operations and various preventive maintenance activities. The total expenditure of the Commission related to PCAs in 2020 was US$19 020 000. This amount covers the costs related to PCAs for 183 IMS facilities, including noble gas systems and radionuclide laboratories.

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

The Commission continued to standardize the services provided under PCA contracts. It requested all new budget proposals to follow a standard O&M plan template. By the end of 2020, 135 out of 167 stations and noble gas systems under PCA contracts had submitted O&M plans in the standard format.

Sustaining Performance

In order to meet the verification requirements of the Treaty while protecting the existing investment of the Commission, a holistic approach is needed to establish and sustain the complex global network of the IMS, which comprises 321 monitoring stations supported by 16 radionuclide laboratories. This is achieved through testing, evaluating and sustaining what is in place and then further improving on this.

The life cycle of the IMS network proceeds from conceptual design and installation to operation, sustainment, disposal of parts and rebuilding. Sustainment covers maintenance through necessary preventive maintenance, repairs, replacement, upgrades and continuous improvements to ensure the technological relevance of the monitoring capabilities. This process also involves management, coordination 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 cycle, there is the need to plan, manage and optimize the recapitalization (i.e. replacement) of all components of each facility in order to minimize downtime and optimize resources.

Support activities for IMS facilities continued to focus on preventing interruptions to the flow of data. They also aimed at preventive and corrective maintenance and recapitalization of stations and station components as they reach the end of their life cycle. The Commission continued its efforts to develop and implement engineering, maintenance and sustainment solutions to improve the robustness and resilience of IMS facilities.

The Commission made progress in identifying the root causes of failure at IMS stations. Some activities, which led to the improvement of data availability, included upgrades to power, grounding and station infrastructure, equipment standardization, optimizing sparing levels at IMS stations and enhanced and targeted station operator technical training courses. The Commission will continue to advance preventive maintenance practices where possible.

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 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.

Logistics

The Central Logistics Support function was established in 2019 and is designated as a centre of expertise and experience, providing cross-Divisional integrated logistical support. The Central Logistics Support manages and operates the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) Technology Support and Training (TeST) Centre in Seibersdorf, Austria. It utilizes the TeST Centre as a logistics platform to play a central role for the PTS in shipping, warehouse management, goods/asset management, and for the build-up and sustainment of verification activities. In line with the TeST Centre's increasing level of functionality, the Commission continued to cooperate closely with the Austrian authorities to ensure its full operability, effectiveness, and efficiency.

The TeST Centre serves in addition as a PTS wide multipurpose facility hosting the Equipment Maintenance and Storage Facility, providing the capability for technology development, testing and maintenance as well as for seminars, workshops, exercises and training courses. The TeST Centre continued its successful operations to store, inter alia, on-site inspection (OSI) equipment and to undertake regular operational activities in support of its programme to develop, test, maintain and rapidly deploy inspection techniques and auxiliary equipment.

The PTS installed a Snow White radionuclide air sampling system at the TeST Centre and successfully used the radionuclide aerosol sampler/analyser system installed in 2020 for testing, validation, and training purposes. These activities significantly strengthen the TeST Centre's operational functions in capacity building to train station operators and staff as well as test and validate equipment.

Snow White air sampler at the CTBTO TeST Centre in Seibersdorf, Austria.

In 2020, as the PTS navigated the COVID-19 crisis and ensured business continuity across its operations, the TeST Centre contributed to the CTBTO's preparedness as a technology-driven organization and played a key role in adapting core operations including capacity building and training, the Equipment Maintenance and Storage Facility and an efficient Integrated Logistics Function with regard to a COVID-19 crisis management context.

The PTS developed and maintained its capability for supportability analysis which underpins the planning and oversight of the recapitalization and sustainment decision making processes, while ensuring overall operational availability of stations. This activity involved the development of business intelligence based reports and the integration of additional data from various sources, such as the IMS Reporting System and the Database of the Technical Secretariat, which could enable the development of a systematic approach to recapitalization decisions in the future.

IMS configuration management was administered ensuring that proposed changes at IMS stations are assessed to determine their effect on cost, effort, and performance including data availability. Configuration management also strengthens confidence that IMS monitoring facilities continue to meet IMS technical specifications and other requirements for certification.

Supply and support contracts related to equipment and services for IMS facilities continued to be maintained as an important component of the sustainment strategy.

A project on establishing and maintaining quality station specific documentation based on a simplified, standardized set of defined documents and quality criteria and using automation and reusable content practices, was completed. The project also included the development of internal processes and assignment of responsibilities. The viability of the approach was demonstrated and will continue to be used going forward.

The Commission continued to work with States and station operators to enhance shipment procedures for IMS equipment and consumables and ensure their timely tax- and cost-free customs clearance. Nonetheless, shipping and customs clearance processes continued to be very time consuming and resource intensive. This increases the time needed to repair an IMS station and reduces the data availability of that station. The Commission therefore continued to seek measures to enhance the supply, distribution and storage of equipment and consumables to IMS stations.

▼ *Maintenance*

The PTS provides maintenance support and technical assistance at IMS facilities around the globe. During 2020, numerous maintenance requests were addressed, including long running data availability problems at several IMS facilities. In lieu of undertaking preventive and corrective maintenance visits due to COVID-19 related travel restrictions, the PTS provided enhanced remote assistance to station operators and relied on them as well as contractors and other sources of support to perform such tasks.

A programme to standardize equipment at radionuclide stations has largely been completed. The programme aims to overcome obsolescence and address equipment becoming non-standard as newer equipment is rolled out to newly certified stations, resulting in improved data availability and simplified sustainability.

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 2020, the Commission continued to advance the technical capabilities of station operators. In addition to providing technical training for operators, station visits by PTS staff included hands on training for local staff, with the aim of minimizing the need for PTS staff to travel from Vienna to resolve problems.

Complete and updated station specific technical documentation contributes to the efficient sustainment of IMS stations. Further progress was made in 2020 in the creation and maintenance of this documentation.

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

Recapitalization

The final phase in the life cycle of equipment for IMS facilities involves its replacement (known as recapitalization) and disposal. In 2020, the Commission continued to recapitalize IMS facility components as they reached the planned end of their operational life cycle.

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

Revalidation of infrasound station IS60, Wake Island, United States of America.

Many recapitalization projects were in progress or completed at certified IMS facilities in 2020, involving a substantial investment in human and financial resources. In nine cases, namely IS31 (Kazakhstan), IS36 (New Zealand), IS48 (Tunisia), AS14 (Canada), IS53, IS55, IS57, IS59 and IS60 (United States of America) recapitalization was followed by revalidation to ensure that the stations continued to meet technical requirements.

Engineering Solutions

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

In 2020, the Commission carried out several complex repairs requiring substantial engineering work in order to return stations to operation. Improvements to infrastructure and equipment were implemented at several certified IMS facilities to improve their performance and resilience. Engineering solutions were also deployed to minimize station downtime during upgrades.

The Commission continued its work to optimize the performance of the IMS facilities and the monitoring technologies. Analysis of station incident reports and failures helped identify the main causes of data loss and assisted the subsequent analysis of the subsystem failures responsible for downtime. In particular, in 2020 the Commission carried out trend analyses of the downtime of each subsystem for all waveform technologies. It also continued systematic analysis based on the incident reports for radionuclide particulate stations and noble gas systems. The outcome of these activities provided valuable input to prioritize the design, validation and implementation of improvements for IMS stations and technologies.

In 2020, the Commission concentrated its engineering efforts on the following:

- Collaboration with the International Bureau of Weights and Measures on measurement science for IMS seismoacoustic monitoring technologies.
- Enhancements to the standard station interface (SSI) software. A new release was delivered which included a new interface for simplifying the management of software configurations, the migration to CentOS 8, a new input module to interface with Science Horizon equipment, improvement to the digital data formatting interface input module as well as integration with new equipment for the calibration module.
- Consolidation of guidelines for standardized IMS power systems with the objective of improving IMS station power availability and quality.
- Development of procedures for assessing and testing current IMS station power systems with the objective of assessing station power supplies, identifying station vulnerabilities, and initiating maintenance or upgrade actions when necessary.
- Validation of elliptic curve digital signature algorithm digital signing capability for several digitizers.
- Enhancements to the internal Multi-Technology Integration Portal including the visualization of data quality metrics and station parameters with the objective of supporting station troubleshooting and configuration activities.
- Development of the CalxPy software to support the calibration of IMS seismoacoustic stations against a reference system. This included performance optimization and packaging for both IDC and NDC in a box environments.
- Progressing the hybrid modular design for hydroacoustic hydrophone stations as the optimal approach to enable reparability of individual nodes and underwater system subcomponents, while at the same time maintaining the advantages of the proven and safe linear deployment of the present systems. In 2020, the latch mechanism that makes it possible to readily disconnect a node from the trunk or internode cable any time after deployment, so that a failed cable near a node, or a failed node, can be repaired without disturbing the other elements of the underwater triplet, was completed.
- Development of the new central recording facility digital data formatting interface enhanced backfilling and diagnostic capability to enhance the resilience, remote monitoring and troubleshooting. This was completed in 2020 and is ready for roll-out across the network.

- Investigating nearshore underwater cable sustainment solutions through conducting studies into: cable replacement options, underwater jointing options, system cathode options, and the conduct and feasibility of horizontal directional drilling to protect cables from damage in the nearshore energetic surf zone.
- Development of the next generation of noble gas systems. SAUNA III passed the acceptance testing process for use in the IMS and is getting ready for deployment; SPALAX NG acceptance testing neared completion; MIKS and Xenon International are at a late stage of development. The PTS will continue planning for the possible deployment of all the new systems.
- Commenced evaluation of automated particulate radionuclide sampler Cinderella G2 and its integration into IMS station software and hardware environment.

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

▼ *Auxiliary Seismic Network*

The Commission continued to monitor the operation and sustainment of auxiliary seismic stations in 2020. The data availability of auxiliary seismic stations was sustained during the year.

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

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

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

▼ *Quality Assurance*

In addition to improving performance at individual stations, the Commission accords great importance to ensuring the reliability of the IMS network as a whole. Hence, its engineering and development activities in 2020 continued to focus on measures for data surety and calibration.

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

The PTS also deployed and configured the SSI calibration module at 11 seismic stations. This allowed yearly scheduled calibration activities to be performed at these stations including full frequency calibration results sent in IMS 2.0 format to the PTS.

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

Under the QA/QC programme for radionuclide laboratories, the Commission assessed the 2019 PTE and accepted four laboratory surveillance reports at RL9 (Israel), RL10 (Italy), RL11 (Japan) and RL16 (United States of America).

QA/QC activities for noble gas capability continued with the execution of two intercomparison exercises for the noble gas capability of radionuclide laboratories.

In an ever growing but also ageing IMS network, ensuring data availability is a daunting task. However, through close cooperation, all stakeholders – station operators, host States, contractors, States Signatories and the Commission – worked hard to ensure the solid and effective performance of the network.

PROFILES OF THE MONITORING TECHNOLOGIES

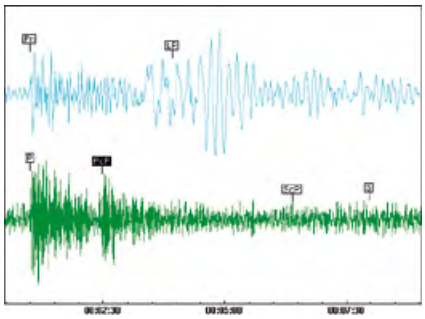
170 SEISMIC STATIONS

120 AUXILIARY | 50 PRIMARY | 76 COUNTRIES

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 wave are looked at during analysis to collect specific information on a particular event.

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

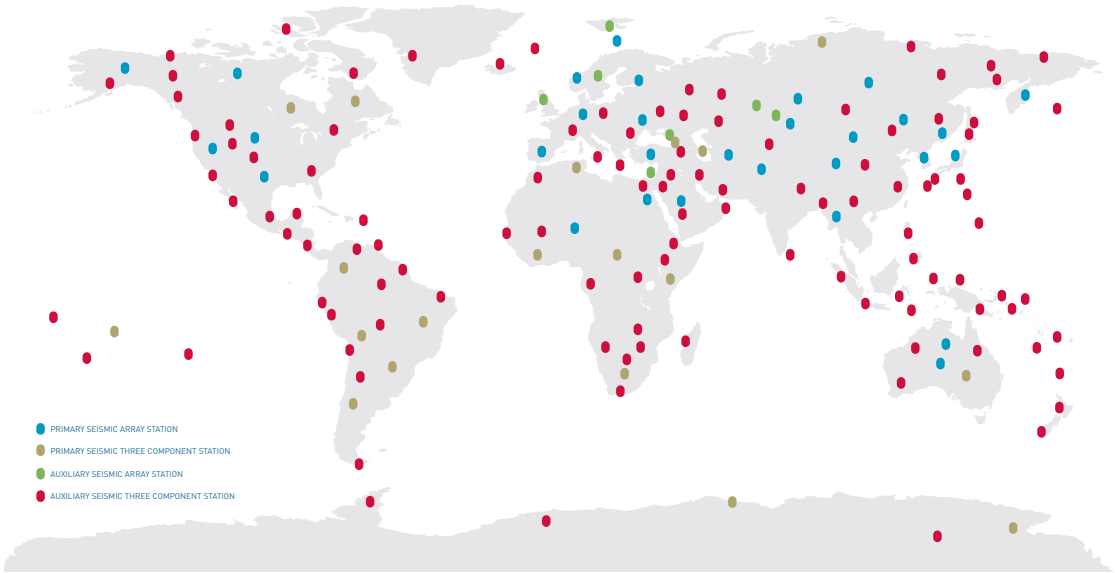
The IMS has primary and auxiliary seismic stations. Primary seismic stations send continuous data in near real time to the IDC. Auxiliary seismic stations provide data on request from the IDC.



▶ ***Example of seismic waveform.***

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.

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. The primary ailiary seismic network is mostly composed of 3 C stations (112 of 120 stations).

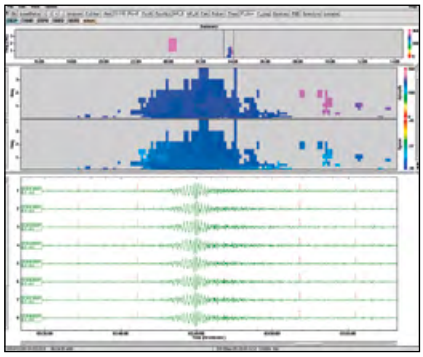


60 INFRASOUND STATIONS

34 COUNTRIES

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

Infrasound waves cause minute changes in the atmospheric pressure that are measured by microbarometers. Infrasound has the ability to cover long distances with little dissipation, which is why 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.



Example of infrasound waveform.

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

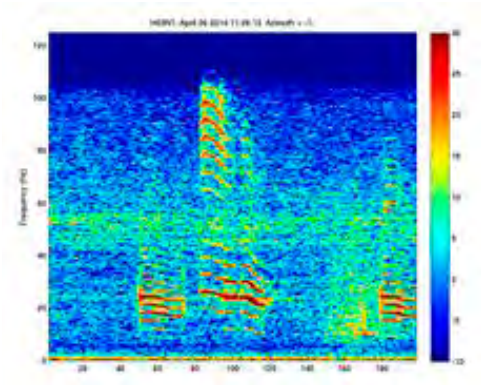
An IMS infrasound station (also known as an array) typically employs several infrasound array elements arranged in different geometrical patterns, a meteorological station, a system for reducing wind noise, a central processing facility and a communication system for the transmission of data.

11 HYDRO-ACOUSTIC STATIONS

8 COUNTRIES

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

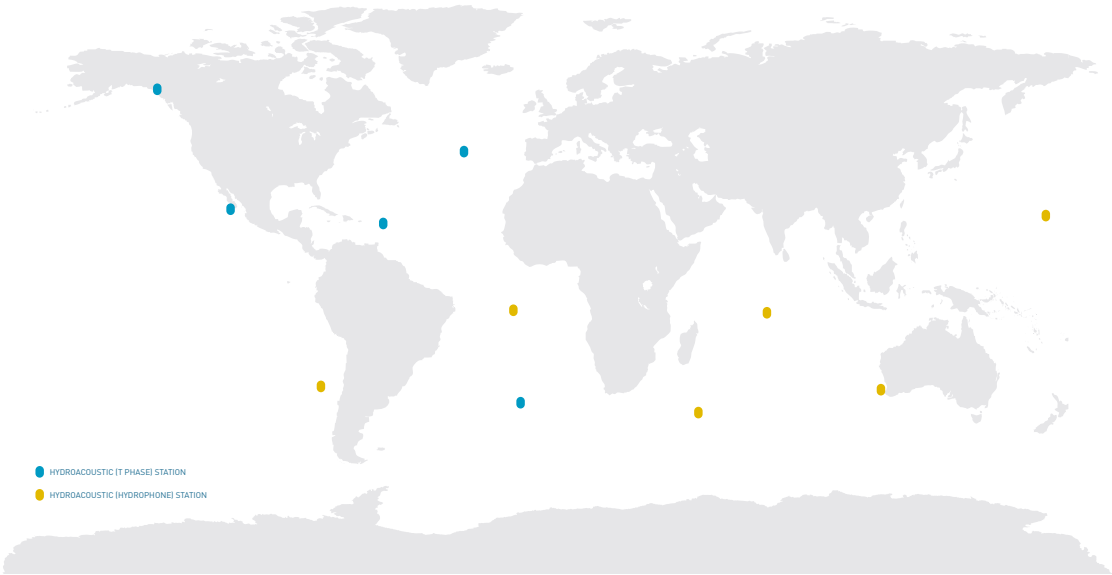
Hydroacoustic monitoring involves recording signals that show changes in water pressure generated by sound waves in the water. Owing to the efficient transmission of sound through water, even comparatively small signals are readily detectable at large distances. Thus 11 stations are sufficient to monitor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



▶ ***Example of hydroacoustic waveform, Pacific whale vocalization spectrogram.***

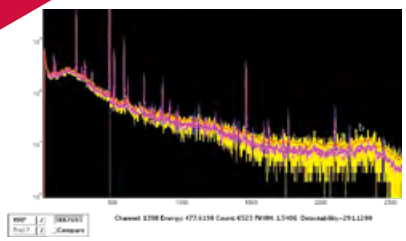
There are two types of hydroacoustic station: underwater hydrophone stations and T phase seismometer stations on islands or on the coast. Underwater hydrophone stations that are more effective than T phase stations and are among the most challenging and costly monitoring stations to manufacture and install.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

The deployment of the underwater components of a hydrophone station (i.e. accurately placing the hydrophones and laying the cables) is a complex ocean engineering undertaking. It involves the chartering of specialized ships, extensive underwater work, and the use of materials and equipment engineered to withstand the challenging underwater environment.



80 RADIONUCLIDE PARTICULATE STATIONS

96 FACILITIES 16 LABORATORIES 41 COUNTRIES



▶ *Example of gamma spectra.*

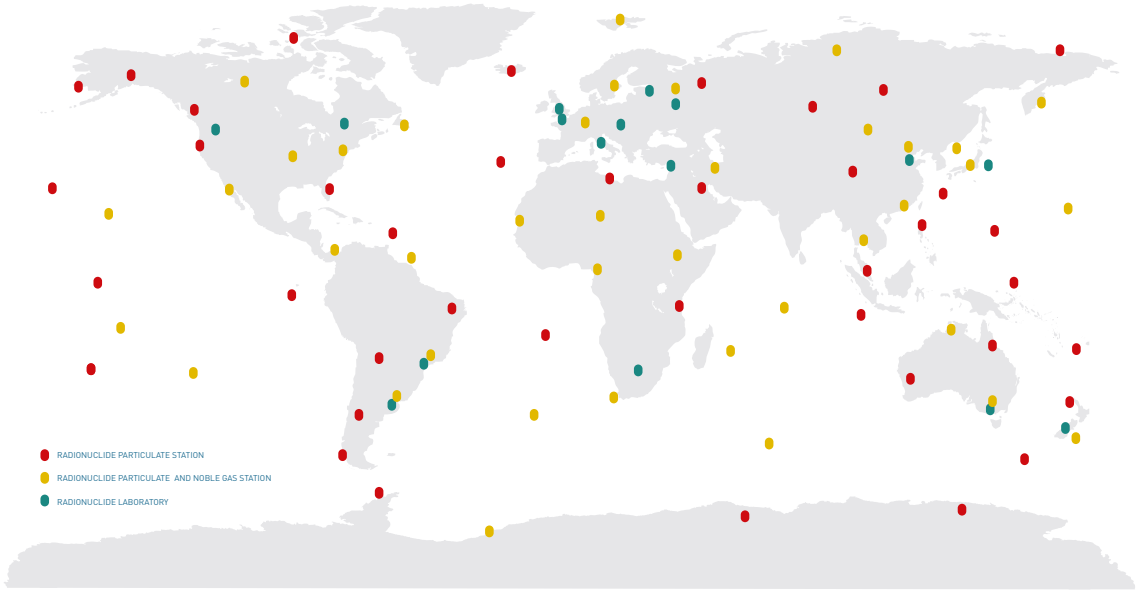
Radionuclide monitoring technology complements the three waveform technologies employed in the Treaty verification regime. It is the only technology that is able to confirm whether an explosion detected and located by the waveform methods is indicative of a nuclear test. It provides the means to identify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

Radionuclide stations detect radionuclide particles in the air. 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 to the IDC in Vienna for analysis.

▼ *Noble Gas Detection Systems*

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

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



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

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

Radionuclide Laboratories

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

The radionuclide laboratories are certified under rigid requirements for analysis of gamma spectra. The certification process provides assurance that the results provided by a laboratory are accurate and valid. These laboratories also participate in the annual PTEs organized by the Commission. Certification of IMS radionuclide laboratories for noble gas analysis capability started in 2014.

We are nearing completion of the most far reaching monitoring system ever designed.

Lassina Zerbo, Executive Secretary

II
THE GLOBAL COMMUNICATIONS INFRASTRUCTURE

HIGHLIGHTS

- **High GCI availability maintained during migration to new infrastructure**
- **An average of 25 gigabytes of data and products transmitted per day**
- **Third generation of the GCI for 2018-2028 is operational**

INTRODUCTION

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

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

Technology

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.

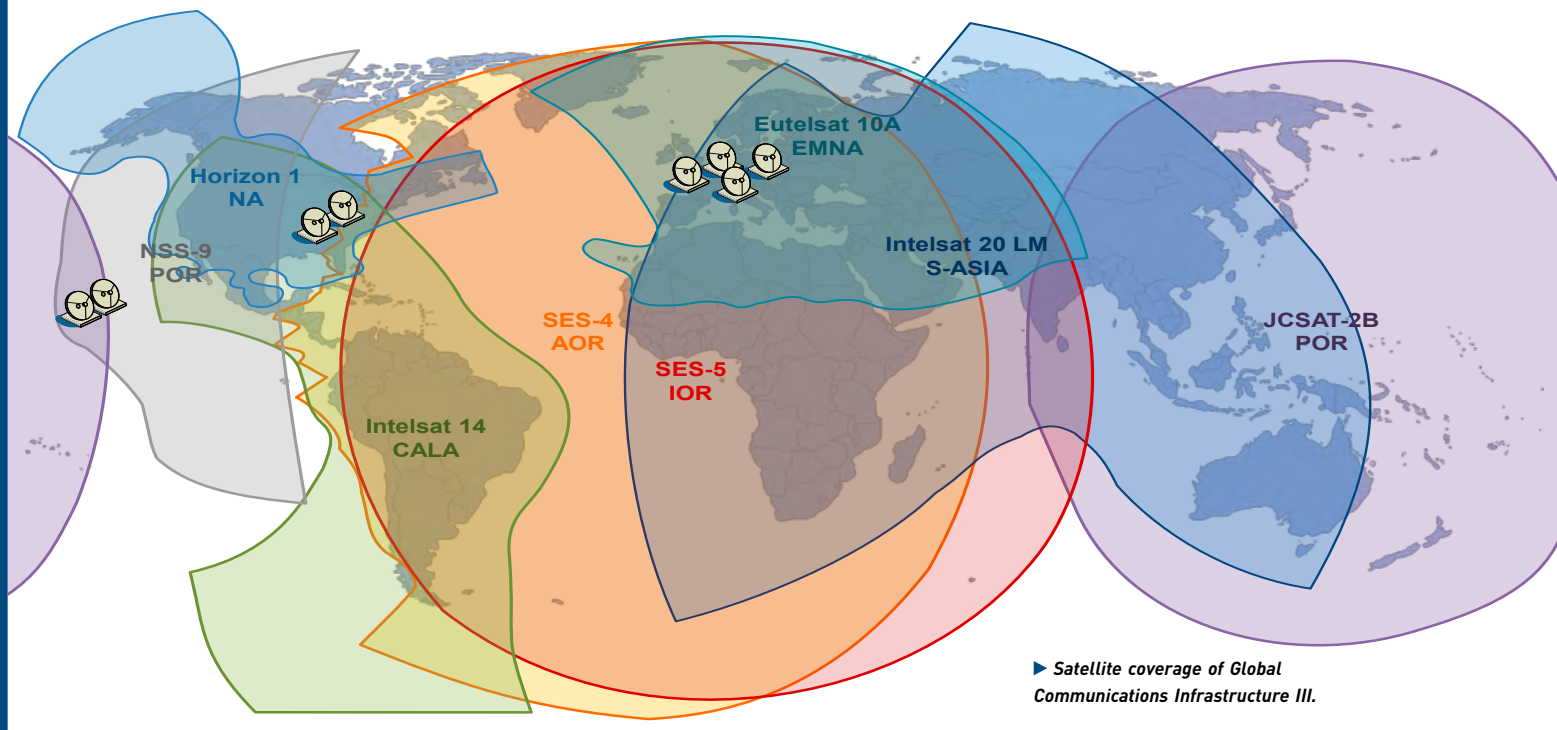
In situations where VSATs are not in use or are not operational, other technologies such as broadband global area networks (BGANs), 3G/4G or virtual private networks (VPNs) can provide alternative means of communication. A VPN uses existing telecommunications networks to transmit data privately. Most 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 National Data Centres (NDCs) with a viable Internet infrastructure, a VPN is the recommended medium for receiving data and products from the IDC.

At the end of 2020, the GCI network included 264 redundant links. Of these, 206 are primary VSAT links backed up by 3G (117 links), BGAN (77 links), VPN (6 links) or VSAT (6 links). There are also 41 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

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 2020, the absolute availability was 96.42%. The adjusted availability for GCI III was 99.93%.

The figure of 25 gigabytes data per day is calculated from GCI III monitoring systems on the basis of filtering all traffic to the receivers in the IDC by port and protocol used for the transmission of GCI data and products. It specifically excludes network management overhead and use of GCI links to transfer data directly between stations and NDCs.



Satellite coverage of Global Communications Infrastructure III.

“Seeking multilateral solutions to twenty-first century challenges remains the only viable approach.”

Lassina Zerbo, Executive Secretary

III
THE INTERNATIONAL DATA CENTRE

HIGHLIGHTS

- **The ability of the IDC to work remotely in face of COVID-19 restrictions**
- **Substantial progress in IDC progressive commissioning activities**
- **Development of the CTBTO Operations Centre (COPC) into a central monitoring and control hub**

INTRODUCTION

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

The Commission has created full computer network redundancy at the IDC to ensure a high level of availability of its resources. A mass storage system provides archiving capacity for all verification data, which now cover approximately 20 years. Most of the software used in operating the IDC has been developed specifically for the Treaty verification regime.

Operations: From Raw Data to Final Products

Seismic, Hydroacoustic and Infrasound Events

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

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

The new detections analysis software RN Toolkit was ported from desktop to a web based application and made available to NDCs along with relevant documentation.

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

Radionuclide Measurements and Atmospheric Modelling

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

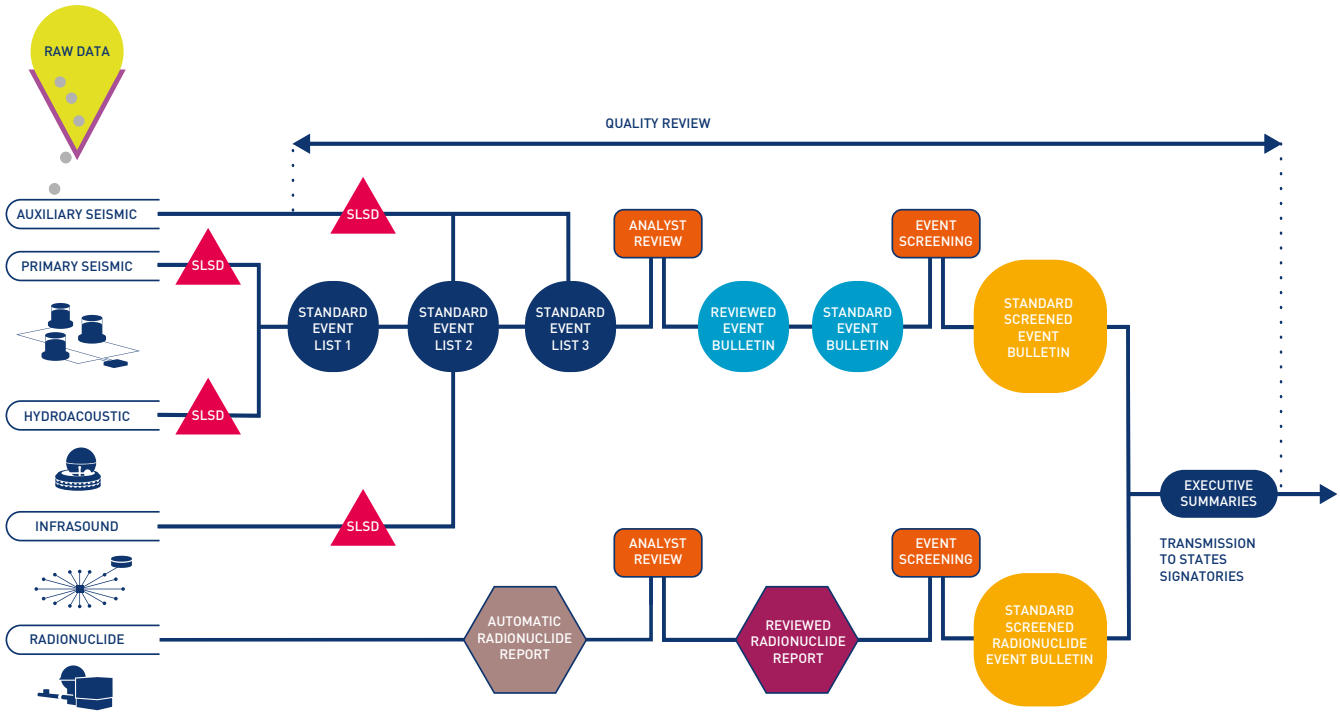
The Commission performs daily atmospheric backtracking calculations for each of the IMS radionuclide stations with near real time meteorological data obtained from the European Centre for Medium-Range Weather Forecasts (ECMWF) and from the National Centres for Environmental Prediction (NCEP). Images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

To corroborate the backtracking calculations, the Commission collaborates with the World Meteorological Organization (WMO) 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 WMO located around the world. In response, the centres aim to submit their computations to the Commission within 24 hours.

Distribution to States Signatories

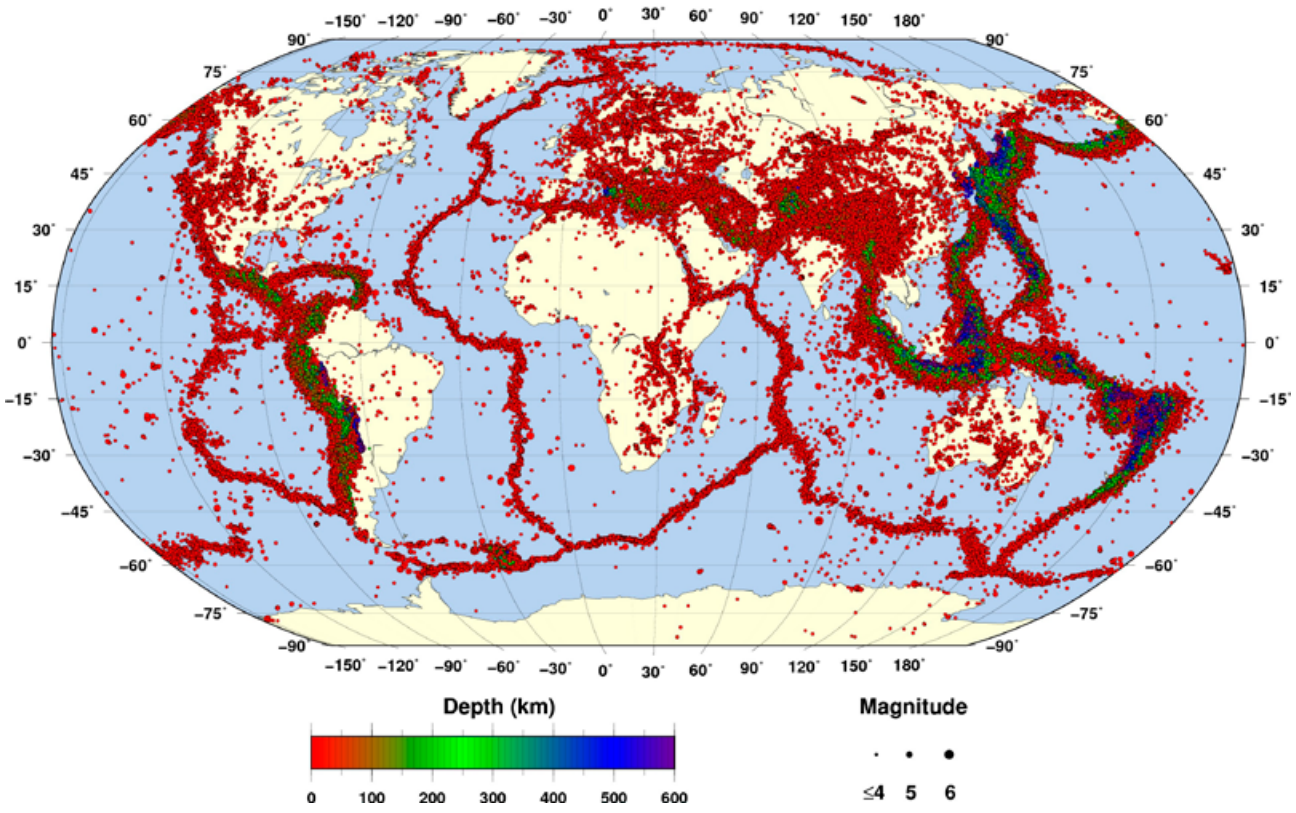
After these data products have been generated, they must be distributed in a timely way to States Signatories. The IDC provides subscription and Internet based access to a variety of products, ranging from near real time data streams to event bulletins and from gamma ray spectra to atmospheric dispersion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

International Data Centre Standard Products



SLSD: STANDARD LIST OF SIGNAL DETECTIONS

2020 Reviewed Event Bulletin (666 465 Events)



Further development of the Integrated CTBTO Operations Centre

Since the establishment of the integrated COPC, the facility has gradually become the central IMS performance monitoring and control hub, where preventive, condition based, planned and corrective maintenance is coordinated. As part of the PTS strategy regarding COVID-19 the COPC business continuity has allowed for mission-critical O&M functions to be carried out.

Services

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

Build-Up and Enhancement

International Data Centre Commissioning

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

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

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

The cycle of four experiments from 2016 to 2019 concluded with the release of the technical and evaluation reports for Experiment 4 in 2020. The IDC continued to address the recommendations that were made in the evaluation reports compiled by the Quality Management and Performance Monitoring (QMPM) Section on the experiments.

The Commission also continued drafting the validation and acceptance test plan that will be used in phase 6 of IDC progressive commissioning. The activities in this area continue to involve technical meetings, interaction on the Experts Communication System (ECS) and discussions during sessions of Working Group B (WGB). Specifically, during 2020, the PTS conducted a technical meeting on the next revision of the validation and acceptance test plan, the assessment of the cycle of four experiments and the plans for the 2021 experiment.

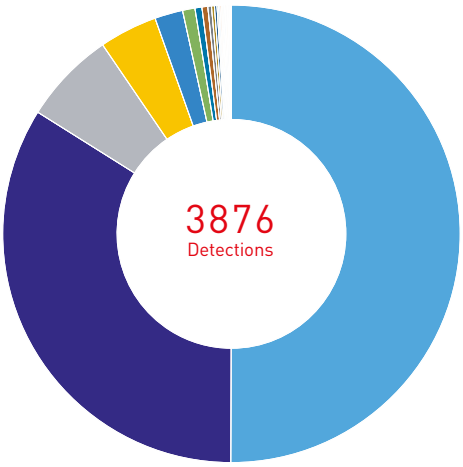
Security Improvements

The Commission continued to identify and address risks to its operational environment and to strengthen security controls on information technology. Measures to safeguard information technology assets included mitigating risks of malware attacks and phased implementation of network access control to prevent unauthorized access to the resources of the Commission. Specialized tools were deployed in order to support the PTS incident response process including but not limited to vulnerability assessment, threat analysis and cyber forensics capabilities. In addition, The Commission's Information Security Services initiated several corporate wide security infrastructure projects including but not limited to: deployment of Microsoft Advanced Threat Protection agents on all Windows 10 hosts, DocuSign eSignature infrastructure, and Security Operations Centre managed services (through the United Nations International Computing Centre).

To ensure an effective information security programme, the Commission completed the roll-out of its awareness programme to educate PTS staff on best

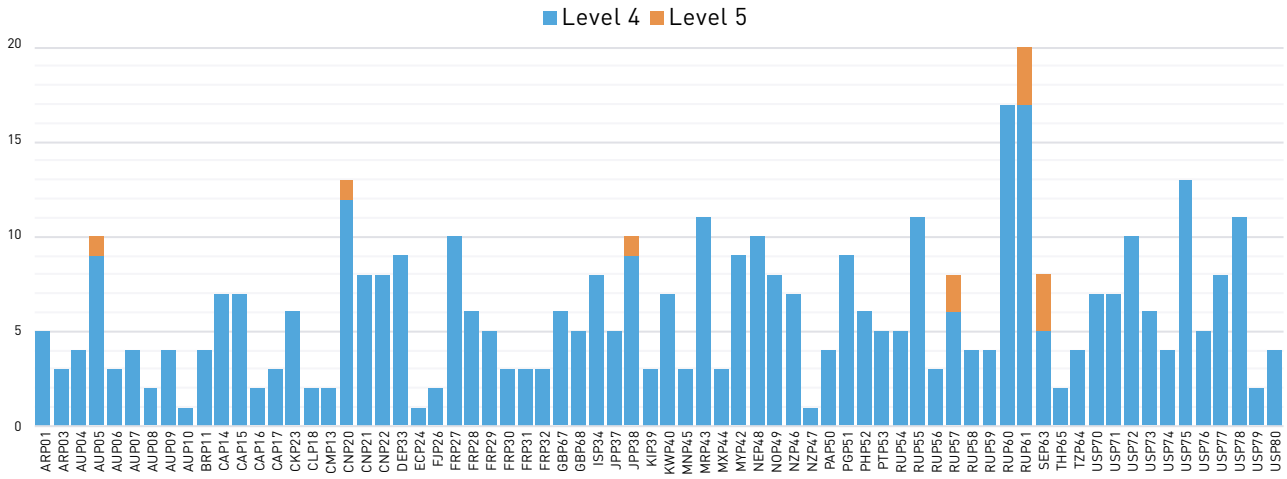
practices in security. The programme focuses on the key tenets of information security: protection of confidentiality, integrity and availability of information assets. The programme successfully ensures a high security posture of PTS staff and information assets.

Treaty Relevant Radionuclides Detected in 2020

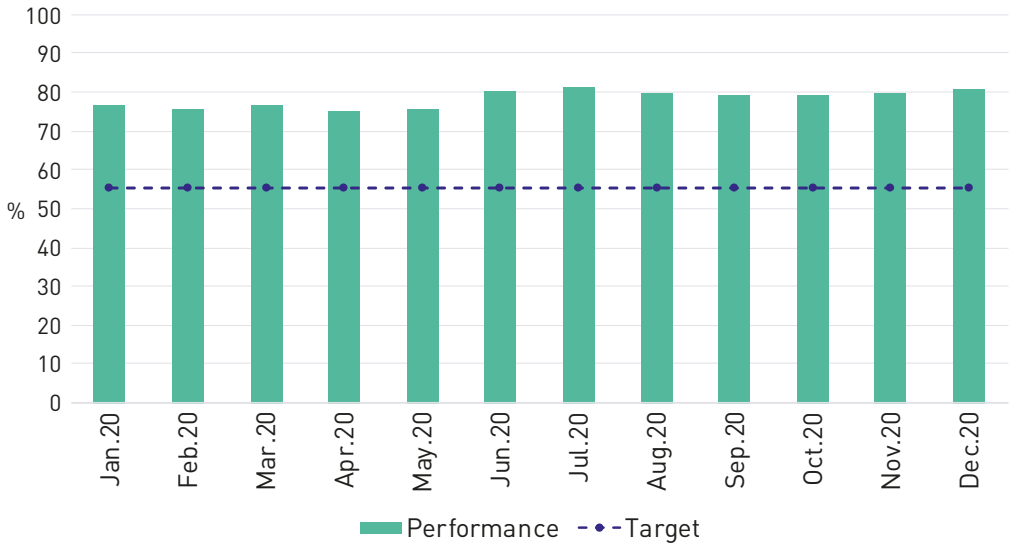


NA-24	(1940)	MN-54	(7)	Y-88	(2)
CS-137	(1313)	ZR-89	(4)	CO-58	(2)
I-131	(254)	K-42	(4)	ZN-65	(2)
CO-60	(159)	RU-106	(4)	CE-143	(1)
CS-134	(77)	ZN-69M	(3)	TE-131M	(1)
TC-99M	(34)	ND-147	(3)	LA-140	(1)
SB-122	(19)	RU-103	(2)	PM-151	(1)
NB-95	(16)	CR-51	(2)	BA-140	(1)
I-133	(10)	I-130	(2)	SC-46	(1)
CE-144	(8)	ZR-97	(2)	RB-84	(1)

Radionuclide Events Recorded by IMS Stations in IDC Operations in 2020

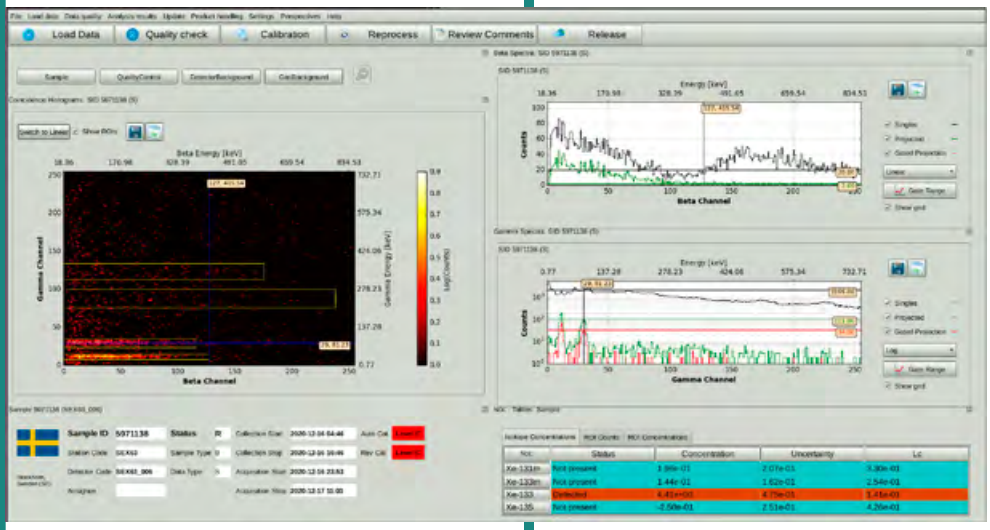


Correctly Categorized Automatically Processed Radionuclide Spectra



▼ Software Enhancements

In radionuclide software development efforts focused on moving toward open source, comprehensive software that will meet the needs of the future and be used both in IDC operations and at NDCs. Software efforts are underway to improve capacities at several processing stages. Starting with station data handling, the new automatic Software Tool for Radionuclide Data Analysis (autoSTRADA) is intended for the automatic processing of data from both IMS particulates stations and noble gas systems. AutoSTRADA is a python language based license-free application using shared libraries with iNtegrated Software Platform for the Interactive Review (iNSPIRE). A first release of autoSTRADA which handles data from beta–gamma coincidence based noble gas systems, including high resolution detectors (next-generation SPALAX), is installed in the IDC test bed for pre-release testing before deployment into IDC operations.



▶ *The integrated set of iNSPIRE functionalities will further boost the quality of the IDC reviewed products.*

With the aim of replacing the current license based code Virtual Gamma Spectroscopy Laboratory, the IDC initiated the development of a new, open source, Monte Carlo (Geant4) based simulation tool for detector systems. The new tool will cover high purity germanium and beta–gamma coincidence based detection systems in use at IMS stations, including upcoming noble gas technologies making use of high resolution detectors. The software design includes a wide range of new features for more automated use in IDC operations. A first release of GRANDSim with particulates functionality is installed in the IDC test bed environment. Moreover, GRANDSim was built in a virtual machine and made available to NDCs along with relevant documentation for alpha testing. A webinar on GRANDSim was delivered to NDCs in October 2020. This included a live demonstration on GRANDSim functionalities and main features. This new tool will be integrated in future releases of the radionuclide NDC in a box software package.

The new interactive review tool iNSPIRE was deployed in IDC operations in December 2020 after extensive testing by analysts. iNSPIRE is intended to replace the Saint2 and Norfy software applications. This first release covers the functionalities for beta–gamma noble gas data analysis; particulate capabilities are expected to be forthcoming. In addition to handling currently operated noble gas systems, iNSPIRE will also process next-generation noble gas technologies. The integrated set of iNSPIRE functionalities will further boost the quality of the IDC reviewed products. A webinar on iNSPIRE was delivered to NDCs in October 2020. It was also delivered to NDCs as part of NDC in a box release 4.0, released in late November 2020.

The new detections analysis software RN Toolkit was ported from desktop to a web based application and made available to NDCs along with relevant documentation. A webinar on RN Toolkit was delivered to NDCs in September 2020. This included a live demonstration on the key functionalities and main features for both particulates and noble gas.

Phase 3 of IDC re-engineering began in the fourth quarter of 2018. In phase 3 the IDC will implement the software and architecture designed in phase 2, which concluded in the second quarter of 2017. Based on the second release of a component delivered by the US NDC, which was received in December 2019, the IDC has developed a prototype integration of DTK-PMCC as well as mock ups of user interface integration of threshold monitoring. The US NDC announced that upcoming deliveries will include state of health monitoring and

interactive analyst review software. An Alpha Testers Group is being formed to enable NDCs to assist with testing and gain familiarity with development efforts, with project meetings planned for March and October 2021.

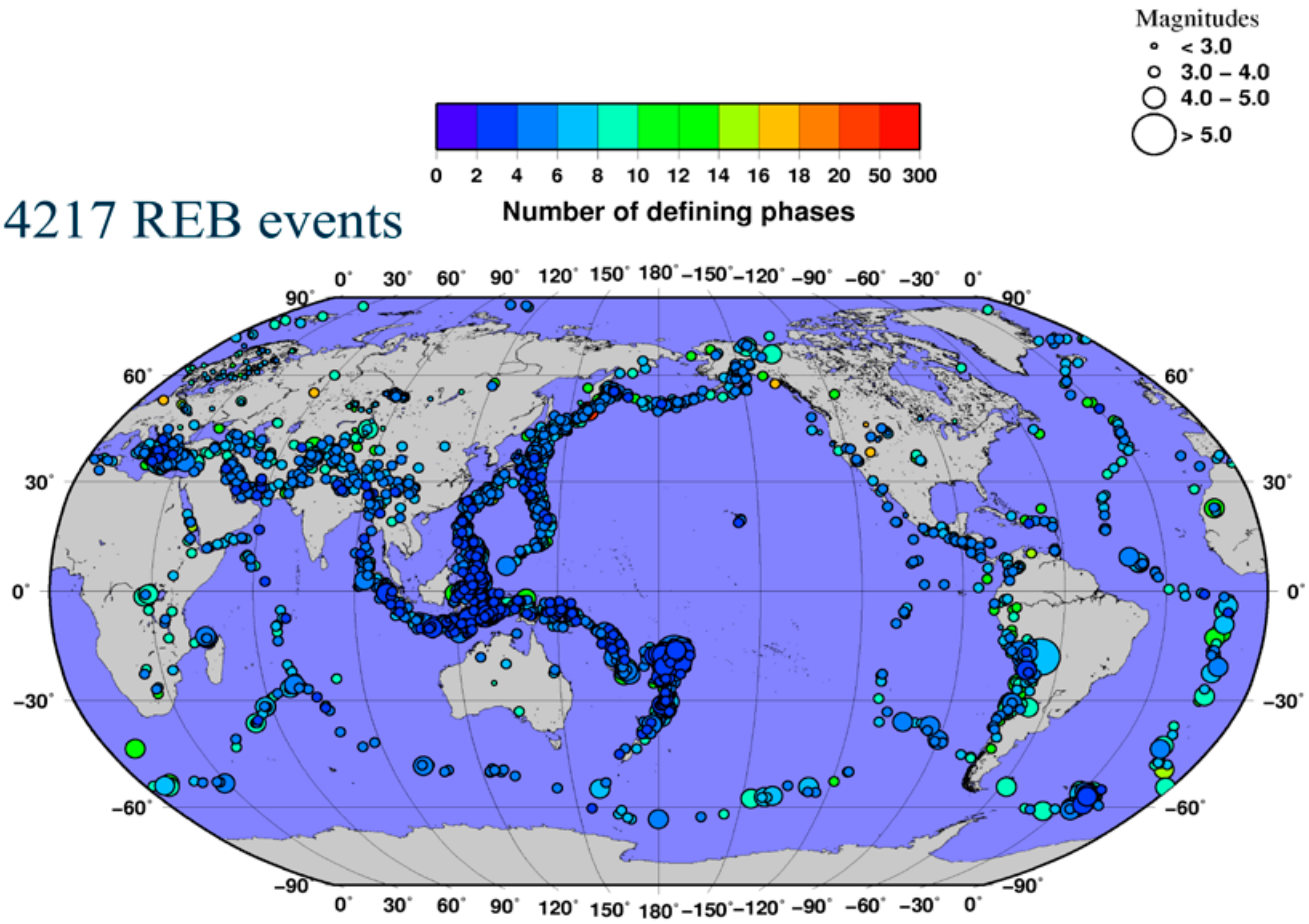
▶ ***RN Toolkit, the new detections analysis software.***

The PTS continued to develop advanced automatic and interactive software that uses state of the art machine learning and artificial intelligence techniques. An interactive module has been developed and provides analysts with NET-VISA events upon demand in addition to the SEL3 automatic bulletin. This functionality has been available to all analysts since 1 January 2018. Analysis of the provenance of the REB events shows that about 10% originate from NET-VISA, as expected from previous tests. A test is being performed in a three pipeline environment on a virtual machine to generate a three month historical data set to be distributed to the authorized users for evaluation. The testing involves the auxiliary seismic station data request mechanism, reproducing the operational configuration very closely.

The PTS promoted a version of the regional seismic travel time velocity model based travel time corrections to provisional operations in August 2020. The regional seismic travel time based source specific station corrections were thoroughly tested. These corrections are expected to improve the products of automatic processing (SEL1, SEL2 and SEL3) by associating additional regional phases to events and to improve both the accuracy and precision of event spatiotemporal location of the IDC event bulletins.

The IDC performed a study regarding the impact of the modification of the retiming maximum interval for analysts, which occurred in December 2018 and changed the retiming limit from 4 seconds to 10 seconds. Results from studying one year of data showed that this modification has resulted in a decrease of 5-8% in the missed detections rate and increase of up to 4% in the detection precision rate in the most prolific primary seismological stations of the IMS. These improvements enable analysts to simply re-time arrivals they used to need to remove and add, leading to improved efficiency.

Continuing its focus on reducing analyst workload, the IDC has tested three algorithms to expedite processing of aftershock sequences. Aftershock sequences present a challenge for automatic and interactive processing as seismic activity in an area may increase tenfold following a strong mainshock.



▶ ***Examples of events that occurred on a NET-VISA map.***

The performance of these algorithms was presented in an expert technical meeting in May 2020, during which the experts provided useful comments and directions for further testing.

The prototype XSEL and Spot Check software, based on waveform cross correlation using historical REB events as master events, is run offline in parallel to the operational SEL3 and REB processing, testing what improvement could be achieved reducing the missed events rate. The interactive version of Spot Check software is used for quality control by evaluating the consistency of a given SEL or REB event hypotheses with the whole REB. This prototype waveform cross correlation software was also used for relative location and characterization of the Democratic People's Republic of Korea events and their aftershocks, and provides the starting point for expert technical analysis methods development.

The development and introduction into the IDC system of the redesigned detector and interactive review tools based on progressive multichannel correlation DTK-PMCC and DTK-(G)PMCC continued throughout 2020. The main efforts focused on the full compliance of the software package with the IDC processing system and for NDC in a box. The software package processed infrasound data in real time for all IMS infrasound arrays in IDC development and IDC test environments since the end of 2020 and receives regular updates as functionalities are rolled in. The implementation in IDC Operations started and was postponed to the first half of 2021 once IDC analyst training was completed. The real time processing of data from hydrophone triplets was set up on the IDC development pipeline in preparation for the homogenization of software components.

The IDC work on increasing the temporal resolution of operational atmospheric transport modelling (ATM) simulations from three hours to one hour was finalized in August 2020. The source–receptor sensitivity fields are now

produced at a spatial resolution of 0.5 degree and a temporal resolution of one hour. Technical documentation related to the ATM pipeline is available in the directory: "Software Documentation/ATMDOCS" placed on the IDC Documentation page of the secure web portal: https://swp.ctbto.org/web/swp/manuals.

The IDC, with funding from EU Council Decision VII, conducted three ATM projects to quantify the uncertainties and the confidence level in ATM guidance, to evaluate the benefits of increasing resolution and to develop a launching interface to quickly produce forward and backward ATM simulations. All three projects were completed by December 2020. The scientific results will be presented at the CTBT: Science and Technology 2021 conference (SnT2021).

Work on enhancements of WEB-GRAPE (desktop version) continued. In November 2020, the new WEB-GRAPE version 1.8.6 and related documentation were disseminated on the secure web portal. The new version 1.8.6 is compiled with interactive data language version 8.7.3. It includes several enhancements, e.g. the additional option to calculate the possible source region using Spearman's rank correlation coefficient. Functionality such as network coverage and continuously emitting sources calculations are enhanced to work with mixed spatial and/or temporal resolutions source–receptor sensitivity files.

The work to enhance WEB-GRAPE Internet based service is progressing according to schedule. A first version of WEB-GRAPE Internet based service allowed users to calculate and visualize field of regard products against the backdrop of a base map in 2-D and 3-D mode. The current upgraded version of WEB-GRAPE available in production includes the new functionality called the network coverage. The network coverage is the product displaying a colour coded percentage indicating which parts of a given area are monitored by the selected network with sufficient sensitivity to trigger detection. The network coverage layers are created in a separate tool called network coverage web application (this application is accessible from WEB-GRAPE Internet based service). In this application, users can create their own network and group stations that are of interest to them. They can also schedule automatic network coverage layer calculations on a regular basis.

▼ *NDC in a box*

NDC in a box distribution methods have been updated for both radionuclide and SHI versions, in response to NDC requests. Distributions are now done using Red Hat package management system Yellowdog Updater, Modified (YUM). This simplifies installation on physical and virtual machines based on Red Hat Enterprise Linux operating systems (RHEL, CentOS) and allows seamless future updates.

A major upgrade of the radionuclide NDC in a box software package, version 4, was released on the IDC secure web portal in November 2020. This new version includes the iNSPIRE software, which has several useful features, including the ability to download radionuclide data from within the graphical user interface to facilitate automatic data processing. The functionality covers both particulates and noble gas pulse height data (sample, quality control, detector background, gas background, calibration, blank) from all IMS certified stations. Moreover, iNSPIRE also enables automatic processing of downloaded data.

In addition, the software for beta–gamma noble gas data processing was updated with the new net count calculation configuration of not using any binary decisions. This software change has been proven to significantly reduce the rate of false detections of radioxenon isotopes.

The Automatic Radionuclide Report and Reviewed Radionuclide Report templates for noble gas samples were enhanced with time series and frequency

distribution plots of xenon categorization parameters and isotopic ratios. This empowers NDC users in the radionuclide event screening process.

To ensure all users can easily access the new version, two options are available to end users for installing the new radionuclide software package. These include NDC in a box virtual machine and installation from the IDC repository using the new YUM package management tool.

Upgrades of the SHI components of the NDC in a box software package were released throughout 2020, as new updates became available. These releases integrated major updates of SeiscomP3, Geotool, and DTK-(G)PMCC. Upcoming enhancements include replacing Geotool with a new version, GeotoolQt. Upon completion of documentation and testing tasks, GeotoolQt will replace the old, Motif, version of Geotool. The old Motif version will remain part of NDC in a box until all NDCs have migrated to the new application.

A survey of authorized users of IMS data and IDC products was conducted between December 2019 and February 2020 to assess the degree to which the components of NDC in a box are used by NDC staff. A total of 332 authorized users, representing 124 States Signatories, responded to the survey and provided valuable input that will contribute to the development of NDC in a box. The latest available version of NDC in a box is in use by a large number of external users as demonstrated by abstracts submitted for the SnT2021 conference. Users receive support from the PTS via the NDC forum or the support function.

▼ *International Noble Gas Experiment and Atmospheric Radioxenon Background*

The 31 noble gas systems that are in provisional operation at IMS radionuclide stations continued to send data to the IDC in 2020. The 25 certified systems sent data to IDC Operations, while data from the remaining 6 non-certified systems were processed in the IDC test bed. The Commission made significant efforts to ensure a high level of data availability for all systems through preventive and corrective maintenance and regular interaction with station operators and system manufacturers.

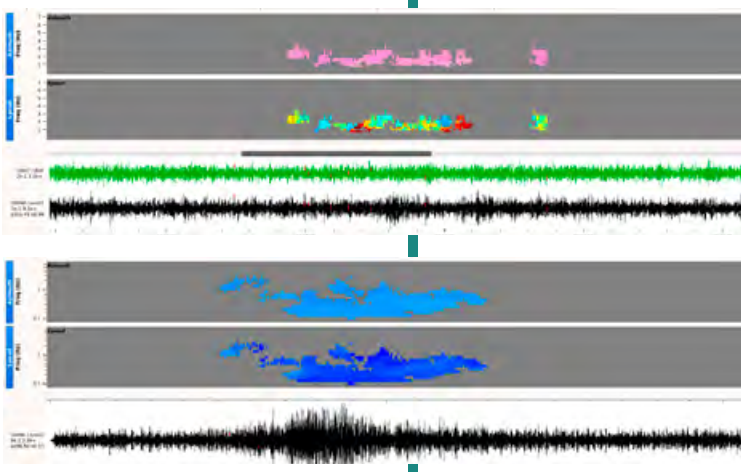
Although the background levels of radioxenon are currently measured at 33 locations as part of the International Noble Gas Experiment, they are still not understood in all cases. A good understanding of the noble gas background is crucial for the identification of signs of a nuclear explosion.

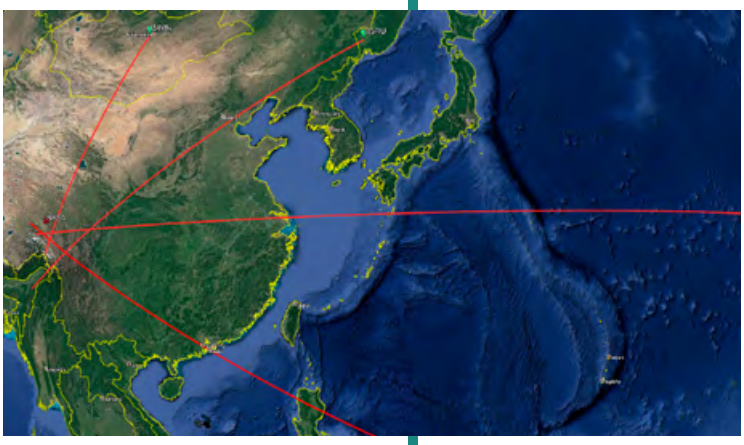
An initiative funded by the EU to improve understanding of the global radioxenon background, which started in December 2008, continued in 2020 with EU funding and Japanese voluntary contributions. The objective of this project is to characterize the global radionuclide background and to provide empirical data for validating the calibration and performance of the IMS verification system. In 2020, the Commission continued operating two transportable noble gas systems in Horonobe and Mutsu, Japan. The Commission plans to use the results from this campaign to develop and validate enhanced methods to better identify the source of events that cause the frequent radioxenon detections at radionuclide station RN38 in Takasaki, Japan. These methods will be applied to all IMS stations in order to enhance the capabilities to identify a radioxenon signal that might indicate a nuclear test. A third transportable noble gas system refurbished in 2019 was ready to be deployed to a new site in Fukuoka, Japan, but due to pandemic related travel restrictions this was not possible in 2020.

▶ Civil and Scientific Applications of the Verification Regime

In November 2006, the Commission agreed to provide continuous IMS data in near real time to recognized tsunami warning organizations. The Commission subsequently entered into agreements or arrangements with a number of tsunami warning centres approved by the United Nations Educational, Scientific and Cultural Organization to provide data for tsunami warning purposes. By

the end of 2020, 18 such agreements or arrangements had been made with organizations in Australia, Chile, France, Greece, Indonesia, Italy, Japan, Madagascar, Malaysia, Myanmar, the Philippines, Portugal, the Republic of Korea, the Russian Federation, Thailand, Turkey and the United States of America.





▶ *Infrasound stations IS39 (Palau) and IS34 (Mongolia) detected the fireball observed over China on 22 December 2020. Stations IS60 (USA) and IS46 (Russian Federation) also recorded related signals.*

IMS infrasound data and IDC products can provide valuable information on a global scale regarding bodies entering the atmosphere. Several large atmospheric airbursts related to near-earth objects entering the atmosphere were featured in the IDC products of 2020, and notably over southern China on 22 December 2020. The infrasound technology continued to attract interest beyond the verification regime. The Commission pursues its collaboration with the University of Oldenburg in Germany on a near real time monitoring system for atmospheric impacts from small near-earth objects, with the involvement of the United Nations Office for Outer Space Affairs and its partners.

Real time detection of a volcanic eruption can help reduce the air traffic hazard of ash clouds clogging jet engines. Eruptions around the world are recorded by IMS infrasound stations and reported in IDC products. It is now established that information obtained by infrasound technology is also useful to the civil aviation community. The Commission continues its collaboration with the Volcanic Ash Advisory Centre in Toulouse, France, and extends it to other partner Volcanic Ash Advisory Centres under the patronage of the WMO, the International Civil Aviation Organization and the Atmospheric dynamics Research InfraStructure in Europe community. The objective remains to develop an infrasound volcanic information system with updates set to be presented at the upcoming SnT2021 conference.

In the footsteps of the collaboration with the NDC of Costa Rica on infrasound technology, preparations were carried out for follow-up infrasound measurement campaigns and regional infrasound workshops and training sessions. However, those activities were postponed due to travel restrictions.

The Commission contributes to radiological and nuclear emergency response in the framework of its membership in the Inter-Agency Committee on Radiological and Nuclear Emergencies. In 2020, the Commission participated in the international ConvEx exercises and in the task group meetings for ConvEx-3 (2021).

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

▶ Enhanced Hydroacoustic and Seismic Waveform Modelling

Work continues on developing modelling capabilities to simulate hydroacoustic signals from T-station data. Current efforts build on previous work developing canonical solutions to seismoacoustic propagation, with an additional objective of improving similarities between simulated and observed waveforms by estimating geometry (sensor location, seabed layering, bathymetry) and environmental (oceanographic and geophysical) properties that enhance this similarity.

Development of Special Studies and Expert Technical Analysis Capabilities

Work continued in both gaining capabilities and clarifying procedures and processes for executing special studies and expert technical analysis. In October SHI and radionuclide experts joined in online meetings to present the latest research developments and discuss the practical aspects of executing a special study or expert technical analysis under the requirements laid out in the operational manual. Of particular interest was exploring numerous imagined event scenarios which clarified requirements and identified open questions. Together the experts also continued developing a list of suitable methods, discussed input to standard procedures and gave feedback on draft templates of the related IDC products.

Updating Documentation of Basic IDC Analysis Procedures

In line with the responsibilities of the IDC set forth in the draft IDC Operational Manual Rev. 6 and in particular the provision of implemented methods and algorithms to all States Parties, efforts have been made to update technical documents and version control these updates to ensure open and convenient tracking of individual changes in the documents.

Formats and Protocols for Messages, IDC-ENG-SPC-103.Rev.7. Efforts have continued to reflect the latest developments of IMS data and IDC products since 2016. The new revision will include the definition of the radionuclide laboratory report products for noble gas samples and will be released in 2021.

IDC Database Schema, IDC-ENG-MAN-104.Rev.6. The 2002 version which has been in use is outdated with respect to recent developments in analysis procedures and software. The new revision is the first review since 2002 and was released at the beginning of 2021.

IDC processing of SHI data user guide, IDC/OPS/MAN/001/Rev.1. This user guide was last updated in 2002 (Rev.1) and therefore does not reflect any of the more recent developments in the IDC processing pipeline. This user guide is being incrementally updated and a new version (Rev.2) will be released in 2021.

CTBT: Science and Technology Conferences

The report on SnT2019 was completed and published on the SnT portal. It summarizes all materials presented at the fifth event in the SnT series that was held in Vienna, Austria from 24 to 28 June 2019.

SnT2021 preparations started with an online meeting of the Scientific Programme Committee in June 2020. The conference goals, themes and topics were updated during the meeting.

The SnT2021 conference brochure was prepared, and the event was announced and broadly advertised to the CTBTO community and beyond. SnT conference management was moved to a new conference platform, Indico, at which point conference registration was opened. This new conference platform is widely used by the United Nations and scientific community, and simplifies the process of registration and abstract submission and review. Abstract submission concluded in December 2020 while registration remains open. Preparations were progressing at the end of 2020 with a strong focus on the backbone elements of the programme. For the first time, most of the conference is planned to be held online. Only the opening session on the first day (28 June 2021) will be hybrid, with limited presence at the Hofburg palace, while the other four days (29 June – 2 July) will be virtual and managed from within the Vienna International Centre (VIC). The virtual part will include panels, oral presentations, e-posters, side events and breakout rooms, vendor spaces and more.

Verifiably putting an end to nuclear explosions remains a near universal objective.

Lassina Zerbo, Executive Secretary

IV
ON-SITE INSPECTION

HIGHLIGHTS

- **Evaluation and reporting on the outcomes of the OSI action plan for 2016-2019**
- **The first comprehensive draft list of equipment for use during OSIs developed**
- **Impact of the COVID-19 pandemic on OSI activities**

INTRODUCTION

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 also request an OSI, which is the final verification measure under the Treaty.

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

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

Over the years, the Commission has continuously strengthened its OSI capabilities through the preparation and development of OSI elements, the conduct of field exercises and the evaluation of its OSI activities. With the conclusion and evaluation of the 2014 Integrated Field Exercise, the Commission started a new cycle of OSI development and implemented a new action plan for OSI activities in 2016-2019.

On-Site Inspection Action Plan for 2016-2019

2020 saw the conclusion of the comprehensive OSI action plan for 2016-2019, which was derived from the review and evaluation process of the 2014 Integrated Field Exercise. Together, the action plan projects contributed to furthering OSI capabilities towards the establishment of a balanced, coherent and robust verification regime when the Treaty enters into force.

The focus on 2020 was on the final oral and written reporting on both individual action plan projects which concluded in late 2019 or early 2020, as well as on the overall action plan itself, with a detailed Information Paper published in February 2021.

Policy Planning and Operations

OSI policy planning and operations efforts during 2020 were closely related to review the outcomes/results from the 2016-2019 OSI action plan and the conclusion of the action plan projects and the OSI exercise plan, including overall coordination of the action plan and the management of individual projects.

Policy planning and operations began conceptual planning for a future programme of work to further improve the organization's readiness to conduct on-site inspections by the time of entry into force of the CTBT. Policy planning and operations also supported WGB by making substantive contributions to the further development of the draft OSI Operational Manual.

Following recommendations from OSI Workshop 24, a technical report was drafted investigating the effects of extreme environmental conditions on an OSI with gaps identified.

The development of the Geospatial Information Management for OSI (GIMO) system was completed and ready for testing during the build-up exercises (BUEs). The inspection team hardware and software for inspection data flow management was procured, installed and ready for test and use during the BUEs.

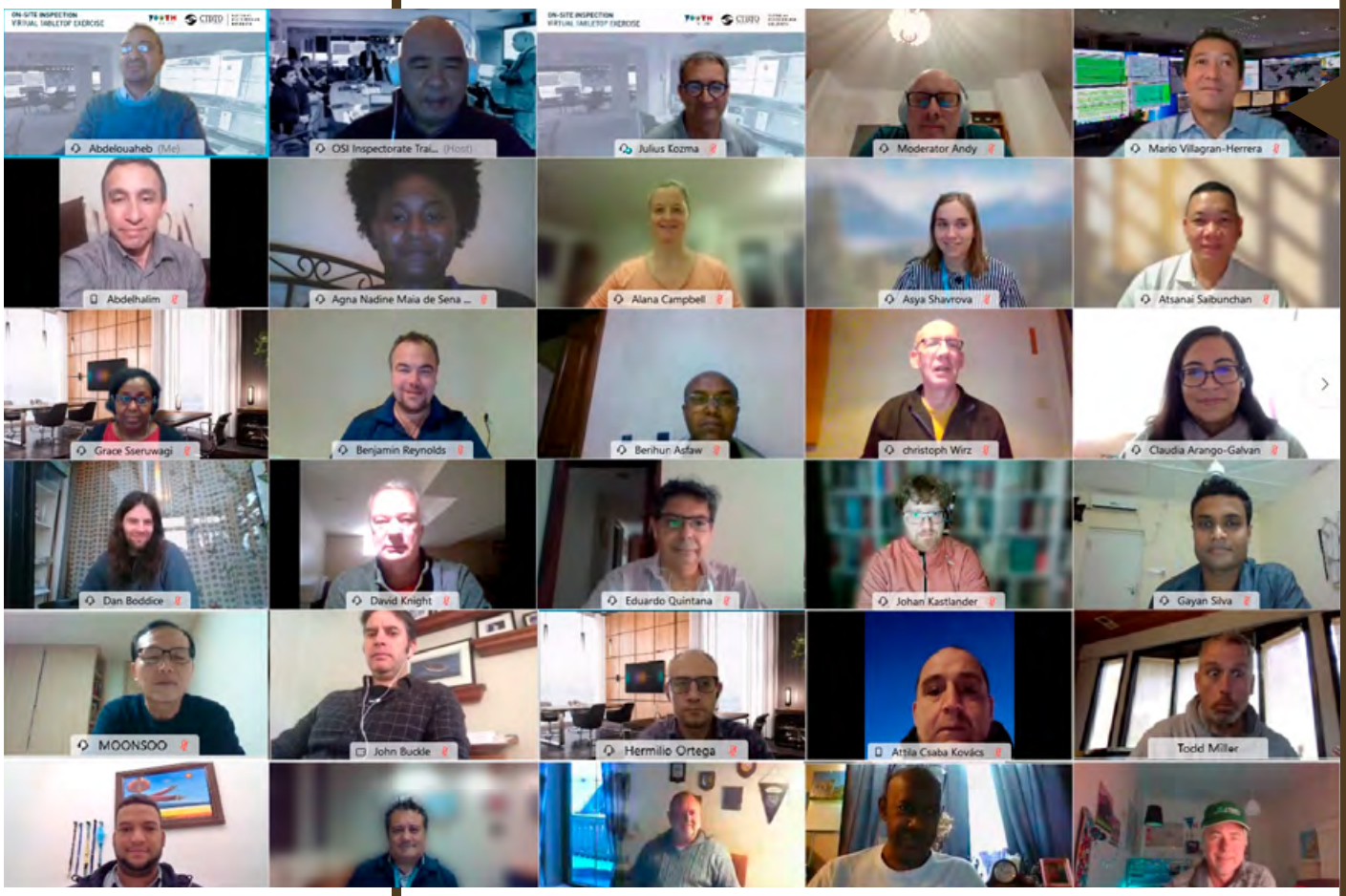
OSI communications equipment underwent maintenance and updating. A communication field test was prepared, however, unfortunately it was postponed due to the COVID-19 pandemic. The communication field test is to be conducted in 2021 as a prerequisite for the BUEs.

Rear view of new working area and receiving area servers.

OSI supported health and safety initiatives of the Commission during the COVID-19 pandemic with the distribution of protective face masks for staff members and operational areas with an interface to external stakeholders. Links were established with other international organizations in Vienna with respect to a coordinated response to the pandemic.

In addition, a Health and Safety Policy Statement was issued for the organization in line with the Medium Term Strategy 2018-2021.

Policy planning and operations subject matter experts presented webinars on communication and navigation, inspection team functionality, inspection team reporting and prepared another webinar on the Operations Support Centre, held in January 2021. Policy planning and operations also developed a webinar for the CTBTO Youth Group on launching an OSI, which was performed in October 2020.



▶ ***Virtual webinar on communications.***

A number of quality management system documents were reviewed and updated, notably the standard operating procedure (SOP) on OSI data and information management, the SOP on point of entry procedures, the SOP on negotiations and the SOP on chain of custody of electronic media.

New OSI mobile servers for the working area and receiving area purchased in 2019 were configured and OSI software was installed on both servers. The testing of software followed together with the testing of zero client workstations; due to pandemic restrictions the work will be finished in 2021.

On-Site Inspection Exercise Plan for 2016-2020

The OSI exercise plan for 2016-2020 outlined the intention of the PTS to conduct a series of exercises aimed at validating key products of projects under the OSI action plan for 2016-2019. The OSI exercise plan includes proven exercise concepts, in particular tabletop exercises and field exercises.

The first quarter of 2020 saw near final preparations for the conduct of two key field exercises covering the initial period (BUE-IN) and the continuation period and post-inspection activities (BUE-C) which were scheduled for June and September 2020 in Slovakia. Unfortunately, the COVID-19 pandemic forced the postponement of the two exercises.

Considerable effort was devoted in 2020 to developing and updating risk mitigation and contingency planning documentation, as well as a planning document to support the high level considerations on the conduct or cancellation of the BUEs. Following consultation with Slovak authorities, the current planning scenario (January 2021), subject to widespread vaccination and/or swift, reliable testing and treatment availability, as well as the possibility of international travel and conditions, is to conduct these exercises consecutively in July 2021.

The scenario developed by the external Scenario Task Force, comprising national technical experts, was the subject of a second rigorous peer review in April 2020. Originally scheduled to be conducted in Vienna and Slovakia in March, the event was one of the first PTS activities swiftly rescheduled and conducted exclusively online. The peer review confirmed the technical assumptions of the scenario making only minor recommendations for consideration or adjustment. The scenario remains valid and ready for execution during the rescheduled BUEs.

Equipment, Procedures and Specifications

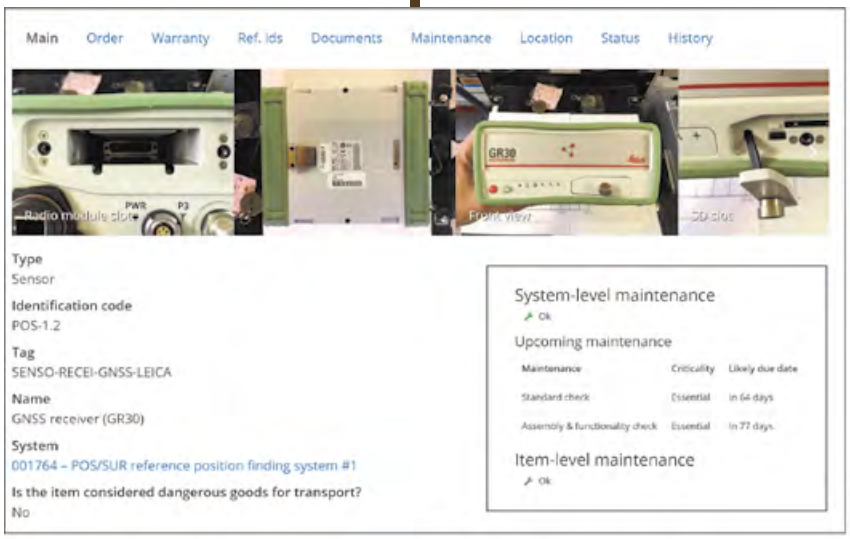
The OSI action plan 2016-2019 resulted, inter alia, in the further development of equipment, procedures and specifications for the inspection techniques. Upon conclusion of this plan and the publication of Information Papers on each of the relevant OSI action plan projects early in 2020, the Commission began to consolidate the findings of these projects and to revise or draft OSI equipment specifications for submission to WGB in accordance with guidance provided by the OSI Task Leaders and WGB on the structure of the draft list of equipment for use during OSIs. By the end of 2020, Information Papers relating to OSI equipment specifications were published or drafted for all OSI techniques with the exception of drilling.

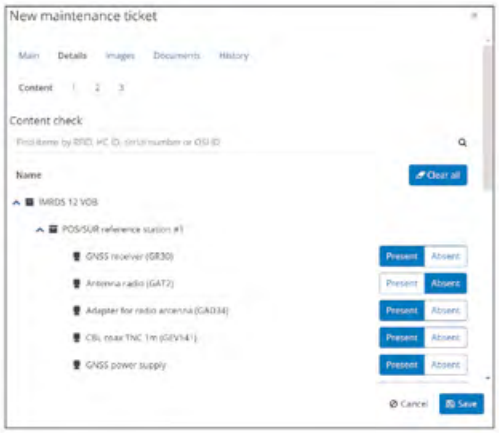
In addition, the first comprehensive draft list of equipment for use during OSIs, to be developed and prepared for the approval of the initial session of the Conference of the States Parties in accordance with paragraph 15 (a) (ii) of the Annex to the Resolution Establishing the Preparatory Commission, was drafted at the end of 2020. It contains proposed specifications relating to the core equipment for the inspection activities and techniques specified in paragraph 69, Part II, Protocol to the CTBT, with the exception of drilling (paragraph 69 (h)) and, upon its publication early in 2021, will be offered for in-depth technical discussion with national experts with the objective to consolidate the draft list prior to its consideration by States Signatories at subsequent sessions of WGB.

Because operational activities for the ongoing operationalization of the TeST Centre were limited since March 2020 due to the COVID-19 pandemic, detailed technical reporting on OSI technology development was brought forward in order to preserve and institutionalize current OSI capabilities. The drafting of related documentation has begun for a number of OSI techniques and will be finalized in 2021 to serve as a reference for demonstrating the rationale and maturity level of each technique in an OSI context and to establish routine capabilities to effectively store, maintain, mobilize and operate inspection equipment.

The operationalization of the TeST Centre, which began in 2019, slowed down as a result of the COVID-19 pandemic induced lockdowns and operational limitations. Despite this, significant progress was made on the system relating to Equipment and Instrumentation Management for OSI (EIMO). EIMO was brought into full production and further expanded to enhance functionality and usability. The custom browser based system is used for recording and tracking OSI inspection gathering and support configurations, systems and items. This encompasses, amongst others, the task of setting maintenance plans and recording all related activities undertaken at an item or system level.

Modified versions of EIMO now are also available for use at the point of entry to support equipment checking and in the working and receiving areas at the base of operations to support the management of equipment configurations and to facilitate the planning of field teams and missions. Since EIMO has been fully integrated with GIMO, it allows surrogate inspectors to resource field missions based on actual equipment availability. For this, EIMO was the subject of the first OSI webinar which was held in July 2020. Overall, by the end of 2020, more than 50% of all deployable OSI equipment has been configured. This will ultimately lead to notably improved physical arrangements of these assets facilitating their maintenance, calibration and certification as well as their preparation for quick deployments in line with the OSI preparedness and deployment concept. The revision of this concept has begun accordingly, along with equipment mobilization plans for the launch and pre-inspection phases of an OSI for testing during forthcoming field activities and exercises.





▶ ***Screenshots showing the EIMO platform.***

▼ Airborne Techniques and Visual Observation

The airborne systems simulator, designed to support the development and testing of airborne OSI equipment configurations as well as facilitating ground based training for airborne operations, was delivered and installed at the TeST Centre. The interior of a decommissioned helicopter was completely transformed and now provides a realistic and flexible configuration enabling simulations of different airframe types. All original cabling and unnecessary elements were removed while the cockpit, windows and interior lining were enhanced but still retain the feel of a helicopter. The exterior of the airframe was repaired and repainted with hardpoints added to mimic a range of different airframes. These hardpoints allow testing and training on the installation of external equipment such as laser range finders and radar altimeters. Three dimensional printed versions of airborne technical equipment such as photogrammetric cameras and optical sensors are now available for use in the simulator allowing testing and training of procedures on realistic alternatives rather than the actual items.

▶ *Airborne simulator in front of the TeST Centre in Seibersdorf, Austria.*

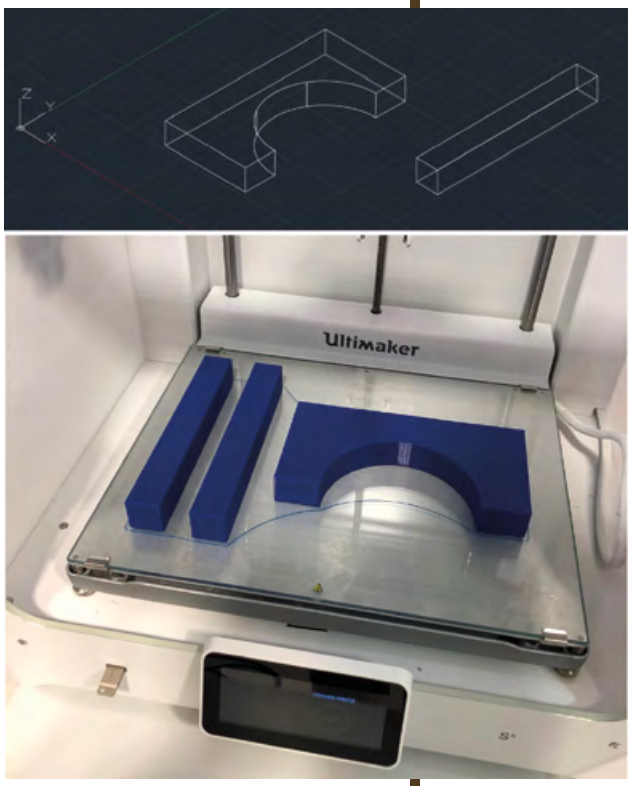
▼ Geophysical Inspection Techniques

In order to maintain a capability to transmit data collected for passive seismological monitoring for aftershocks between the inspection area and the base of operations during an OSI, the Commission has upgraded the set-up of the OSI telemetry system. This included the installation of new VPN licenses on the existing VML modems in the TeST Centre, remote technical support and the change of the frequency range for Long-Term Evolution transmission.

Data flow management is an inherent part of an OSI. In order to enable the real time acquisition of data from geophysical techniques, notably passive seismological monitoring, the Commission has procured a new server system for the base of operations. The new server allows the inspection team to manage and process large data volumes without any loss or disclosure of information. For this, the inspection team deploys and uses a secure local area network at its base of operations which consists of a mobile cluster of servers, workstations and other related infrastructure, including optical cables and switches.

▼ Measurements of Radioactivity and Radionuclide Particulate Related Inspection Techniques

Further enhancements of radionuclide particulate capabilities were achieved through the amendment of selected hardware of the OSI field laboratory. They aimed at facilitating the installation and operation of the germanium detectors to reduce the required time and to improve the lead shielding, providing a better sensitivity to OSI-relevant radioactivity within samples. For this, a digital three dimensional version of the lead shield design was created which will support improvements of sample measurement performance and contribute to the future integration of processing and measurement components within the next-generation transportable pods. In addition, most components of a test bed were acquired comprising commercially off the shelf available computers and software. This will support the long term sustainment of germanium detectors and other core radionuclide equipment, allow for performance monitoring and recalibration, and validate future operational hardware and software upgrades.



▶ *Example components for lead shields for the OSI field laboratory are being designed and fabricated on a 3-D printer.*

Software enhancements for the field laboratory application were also made to incorporate lessons learned at the 2019 advanced training course on radionuclide and noble gas techniques. They aimed at improving the integration of the chain of custody and data flow from sample processing and analysis into the overall mission data management, as well as providing a simplified and robust graphical user interface to the laboratory custodian. While final software development and access to operational equipment for test purposes were delayed due to the COVID 19 crisis, the software upgrades were delivered in 2020 and will be fully installed for validation in an operational configuration in 2021.

To ensure the availability of OSI radionuclide equipment and techniques for their efficient deployment during the planned BUEs, activities focused on finalizing preparations of field systems including regular maintenance, calibrations and upgrades as appropriate. For instance, following the current practice of calibration checks to assess ageing and characterize gamma radiation monitoring detectors operating sodium iodide crystals, five units, including two car borne systems, were recalibrated. In addition, eight multichannel analysers, including spares used with high resolution detectors, had their firmware upgraded to correct for known deficiencies. As for radiation protection, numerous handheld radiation measurement devices including electronic personal dose meters, dose rate monitors and small and large area contamination probes were calibration checked or recalibrated.

▼ Noble Gas Related Inspection Techniques

Following its finalized engineering design in 2019, the prototype for liquid argon scintillation was constructed and tested in 2020. Improvements in the engineering for the stability of the system at liquid argon temperatures were identified and are being implemented. Additionally, the experimental results obtained are also being simulated with a Monte Carlo simulation for nuclear physics using the Geant4 software toolkit. These simulations will help identify improvements for the optimal geometry of the detection system. The delivery of the improved system and theoretical results are expected in the second quarter of 2021.

Training on the new SAUNA-F(ield) that was funded by the EU was integrated into the new flight pod for rapid deployments took place early in 2020. The system was tested in the course of the entire year and its performance was assessed. This resulted in an enhanced understanding of the requirements for rapid deployment as well as operational requirements of the flight pods in field conditions.

Enhanced capabilities for sample chain of custody, data processing (integrated with the OSI data flow) and reporting have also been achieved. They include software applications for laboratory data and operations management which will be further improved in 2021 to facilitate the operation of inspector operated systems that are relatively easy to use and follow a QA/QC protocol.

▶ Logistics and Operations Support

OSI action plan projects related to OSI logistics and operations support have been closed and the last deliveries have either been received or scheduled for 2021 due to delays caused by COVID-19 restrictions. Testing and confirmation of the delivered products will be done in 2021 and confirmed in suitable field activities such as the BUEs.

The conceptual design of a comprehensive security system for the base of operations was finalized in 2018 and the company that won the bid for the provision of the system completed the final engineering design in 2019. Unfortunately, due to the COVID-19 pandemic the company could not deliver the system in 2020, so the final development was moved to another subsidiary under the same parent company. The new company is reviewing the project and expected to confirm the engineering design and deliver a prototype deployable security and surveillance system in 2021.

▶ View of the hybrid power unit, integrated in an OSI rapid deployment pod to support field power distribution with solar energy at the base of operations.

The OSI baseline hybrid power capability for the base of operations was delivered in the fourth quarter of 2020 with the on-site training to be conducted in 2021. The main unit is integrated into one of the rapid deployment pods and complements the existing diesel power generation for operation in an integrated mode or independent use. Further testing of the smaller solar power generation units for remote use will be conducted in 2021 following the delivery of the on-site training.

The inventory and reorganization of OSI equipment that began as part of reorganizing the equipment storage and work areas of the TeST Centre is progressing with the introduction of EIMO. Maintenance plans and life cycle management information are now fully integrated and allow for more complete inventory management. As a part of this inventory and reorganization, the managed replacement of base of operations infrastructure with modularized units was initiated and will allow for standardized and interoperable modules across the different areas within the base.

▶ On-Site Inspection Documentation

Activities during 2020 involved providing continuing support to WGB and finalizing outcomes from action plan projects, including further development and revision of OSI Quality Management System (QMS) documents. Preparations were made to support the BUEs including the planned conduct of OSI Workshop 25 to review the evaluation of the exercises; however, these were postponed until 2021 because of the COVID-19 pandemic.

▼ *Action Plan Projects*

The OSI action plan projects related to documentation were completed. Two studies were carried out under action plan project 1.9 Quality Management System: a study on quality control and quality management at OSI field laboratories and a study on OSI processes and records management. Information Paper 1563 was issued in September 2020 on this project.

▼ *Quality Management System*

The PTS continued to revise the existing OSI QMS documents, as well as draft new documents in 2020, as part of the preparation for the launch phase (BUE-L). Furthermore, work commenced on the update of all existing OSI QMS forms and templates.

▼ *Improved On-Site Inspection e-Library*

The management and maintenance of the OSI e-Library continued in 2020. Work also began on updating the OSI e-Library to the newest version of Alfresco. OSI e-Library section sites were migrated to the PTS QMS Alfresco as part of the update.

▼ *Support to Working Group B*

The PTS continued to provide technical and administrative assistance to WGB in its elaboration of the draft OSI Operational Manual. However, the curtailed work programme of WGB meant that little progress was made on the draft OSI Operational Manual.

V
IMPROVING PERFORMANCE AND EFFICIENCY

HIGHLIGHTS

- **Further development and consolidation of the Quality Management System**
- **Enhancement of the performance monitoring tool and refinement of key performance indicators**
- **Technical evaluation of IDC progressive commissioning and progress in the operationalization of OSI capability**

INTRODUCTION

At all stages of the process of establishing the Treaty 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.

Continual improvement is essential for the QMS and, together with rigorous performance monitoring and evaluations, ensures that the work to establish the verification regime complies with the requirements of the Treaty, its Protocol and the relevant guidance of the Commission.

Evaluation

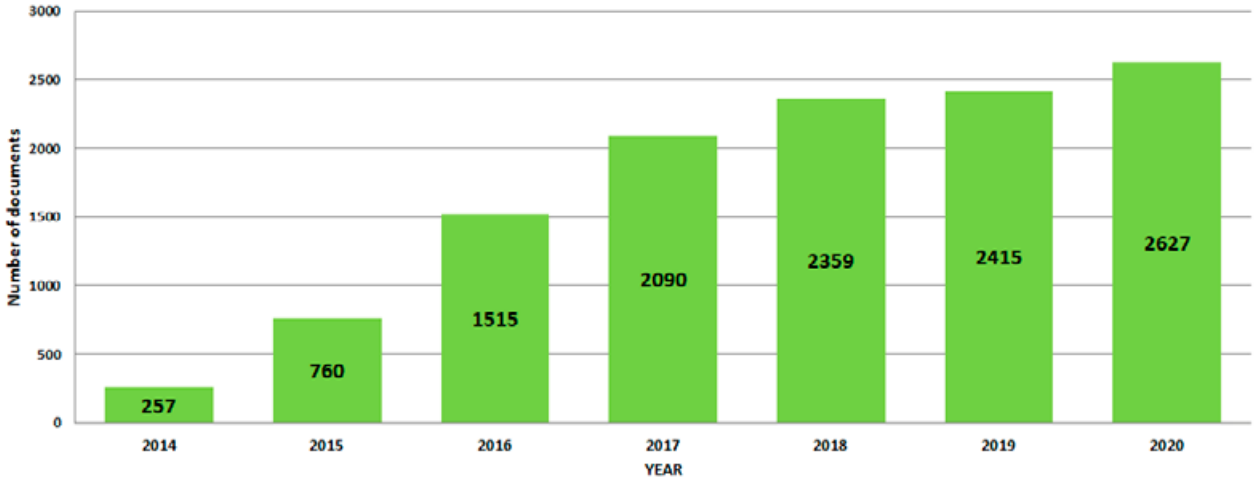
The evaluation of the fourth experiment of a cycle of four experiments covering all functionalities of the IMS, IDC and GCI components in the context of the progressive commissioning of the IDC was completed. The comprehensive evaluation was performed by an external evaluation team, comprising seven evaluators from States Signatories, to assist the QMPM of the PTS in a comprehensive evaluation of the experiment and in the elaboration of the final evaluation report.

The report on the evaluation of Experiment 4 of IDC progressive commissioning was issued and included the results of the 24 validation tests performed during Experiment 4, of which one was successfully implemented. The remaining tests were only partially implemented, resulting in 46 recommendations to improve system performances, procedures, documentation and testing capabilities.

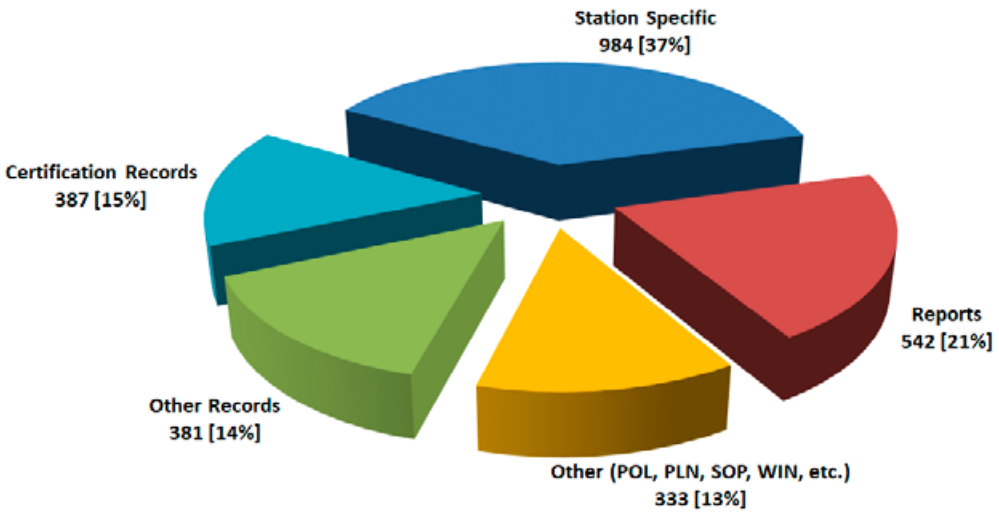
Furthermore, a comprehensive review of all evaluations of the cycle of four experiments was performed with the aim to consolidate the evaluation methodology, evaluation results and lessons learned, in preparation for future experiments that will be conducted as part of the IDC progressive commissioning.

The Evaluation Information Management System prepared for the OSI BUEs was tailored for the evaluation of future OSI exercises, based on lessons learned from past exercises.

Number of Documents in the Quality Management System Repository



Distribution of Quality Management System Documents



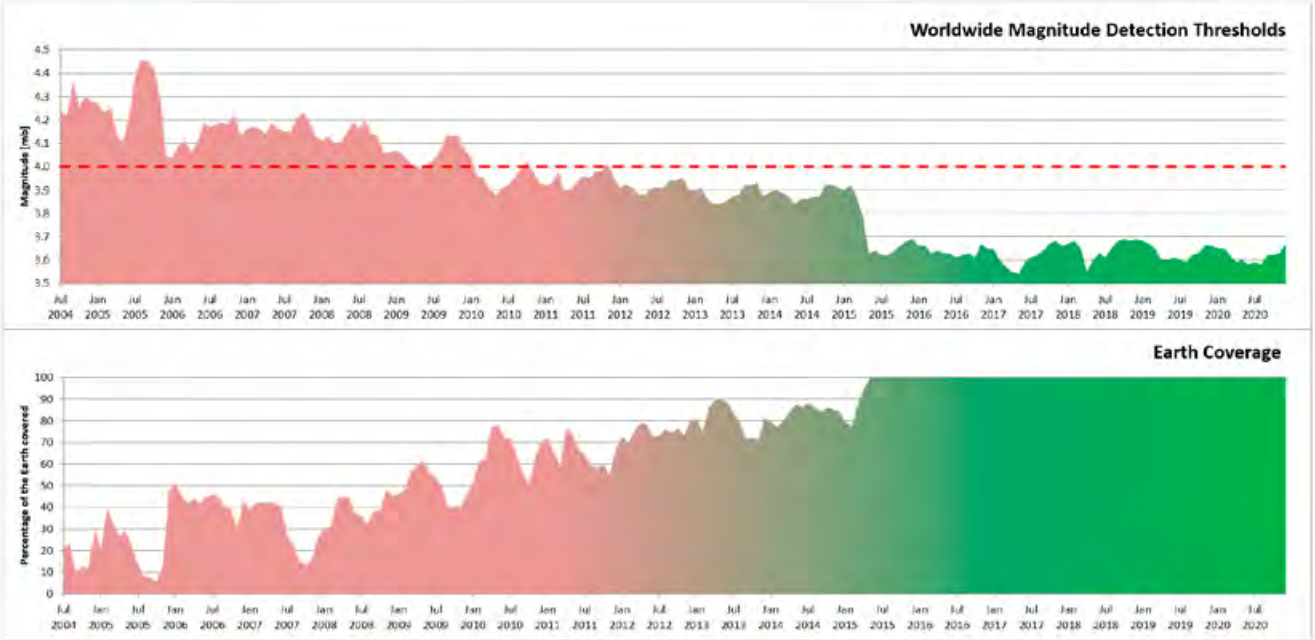
Performance Monitoring

QMPM improved its approach for monitoring the further development of OSI capability, including the implementation of the OSI action plan, taking into account the objectives defined in the concept for the preparation and conduct of future OSI BUEs.

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

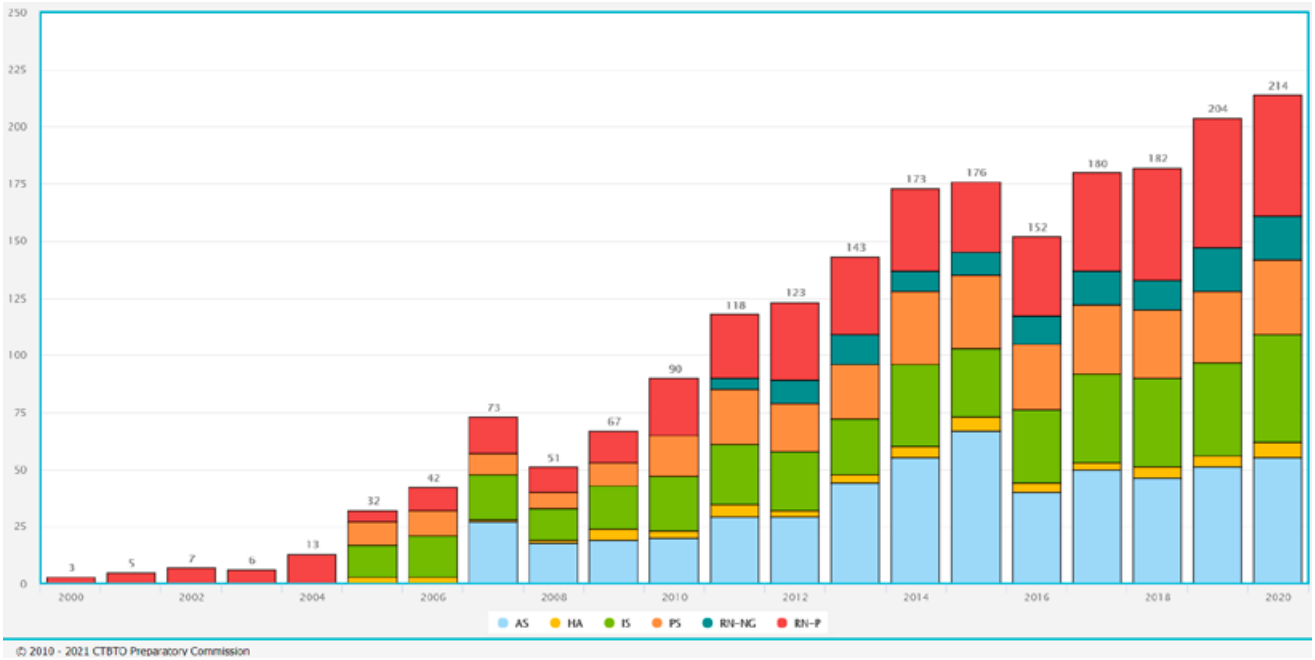
The PTS continues to enhance the performance reporting tool (PRTool) for performance monitoring of the quality of processes data, and products related to the development and provisional operation of the verification regime. A technology refreshment of the PRTool is underway to ensure the long term sustainability of PTS performance monitoring.

2004-2020 Continuous Assessment of Global Seismic Detection Capacity



Top: Time evolution of worldwide magnitude detection thresholds.
Bottom: Time evolution of the percentage of the total surface of the earth for which events of magnitude mb=4.0 can be detected at 90% confidence level.

Number of Facilities Meeting Data Availability Objective



Quality Management

The PTS continued to develop its QMS, fostering a quality culture in PTS staff and pursuing the implementation of a continual improvement process with a focus on the verification regime. With more than 2600 documents filed, the QMS documents management system provides univocal access to the latest approved versions of documentation, in particular, with a significant number of procedures finalized in 2020.

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

Client orientation is an essential principle of the QMS. Therefore the Commission continued to prioritize feedback from NDCs, which are the main users of its data, products and services, and to encourage them to actively contribute through the established channels to review implementation of their recommendations. Links between NDC recommendations and results from the IDC experiments have been established and future experiments within the progressive commissioning of the IDC will be used to support closing NDC recommendations.

“Reducing nuclear threats through cooperative disarmament, non-proliferation and arms control measures remains an urgent priority.”

Lassina Zerbo, Executive Secretary

VI INTEGRATED CAPACITY DEVELOPMENT

HIGHLIGHTS

- **Continued capacity development activities**
- **Ensuring integration of NDC capacity building with policy and educational outreach activities**
- **Further development of online events and e-learning**

INTRODUCTION

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

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

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

Activities

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

Due to the COVID-19 pandemic, many of the Commissions' capacity development events were moved online in 2020. Through virtual videoconferencing, the Commission was able to provide and conduct online training courses, expert meetings and workshops. Recordings of these technical training courses are being archived in order to engage the next generation, and 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 has significantly increased due to online attendance, even if maintaining audience engagement is a challenge.

Training course on NDC Capacity Building - Access and Analysis of Radionuclide IMS Data and IDC Products, 9-27 March 2020.

International Data Centre and National Data Centre Training Courses and Workshops

Integrated capacity development and training activities in 2020 continued, to the extent possible, despite the unprecedented challenges brought about by the COVID-19 pandemic. In 2020, NDCs technical staff and experts from States Signatories participated in seven (two in person and five online) NDC training events and in a series of webinars on radionuclide software. In particular, the first NDC training event for Arabic speaking NDCs took place in January 2020, at the Red Sea, Egypt. The Commission also organized six technical expert meetings (online) and a series of webinars for station operators.

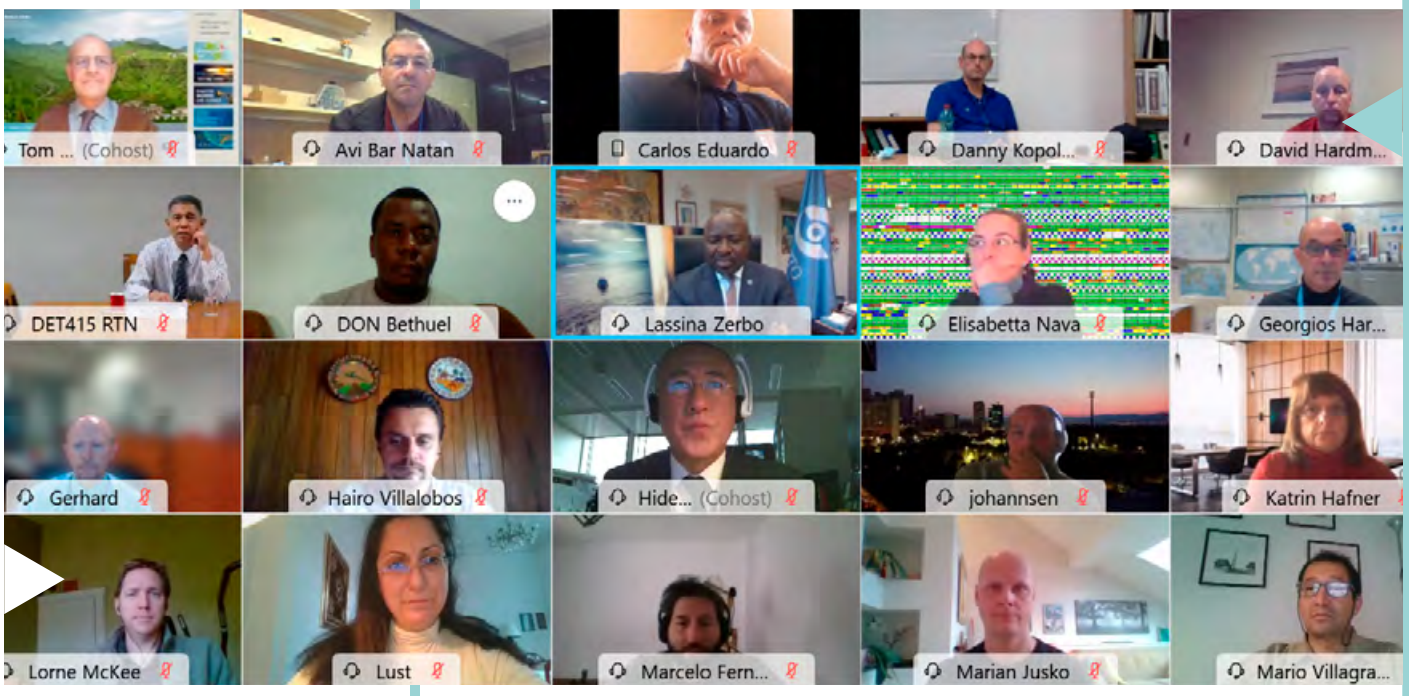
The online technical meeting on SHI software engineering at the IDC took place from 22 to 24 June 2020. This technical meeting focused on IDC SHI re-engineering phase 3 efforts, in particular: reviewing the current status of work, including progress updates and discussion of the project plan, projected milestones, and updated deliverables; presenting the results of work done within the PTS on setting up the testing environment for the Geophysical Monitoring System; development of integration plans for additional modules such as DTK-PMCC; and discussing technical and scientific issues arising

from the evaluation, integration and deployment of re-engineering phase 3 deliverables.

The series of webinars on NDC capacity building: radionuclide processing and radionuclide software products, were held from 28 September to 27 October 2020. The series provided an overview of the ongoing radionuclide software developments in the IDC and a demonstration of the RN Toolkit, a Web based application for analysing particulates and noble gas detections at IMS stations and a demonstration of the iNSPIRE and GRANDSim software. One hundred eighty-eight participants from the wider CTBTO radionuclide community attended the radionuclide webinar series. The objectives were to strengthen the capacity of States Signatories' participation in radionuclide verification technology, enhance their use of IMS data and products for civil and scientific applications and familiarize participants with several in-house radionuclide software tools for NDCs.

The online virtual expert meeting on advances in waveform processing and special studies took place from 19 to 23 October 2020. Ninety-two experts from 35 States Signatories attended the meeting. The objective of this technical expert meeting was twofold. Part one of the meeting was dedicated to exploring advances in waveform processing that may improve the IDC waveform pipeline processing, including tools and methodologies for testing and validation. The second part of the meeting was dedicated to discussions on waveform special studies and expert technical analysis.

The online technical expert meeting on special studies and expert technical analysis with radionuclides and atmospheric transport modelling methods took place from 19 to 23 October 2020. Sixty-four experts from 23 States Signatories attended the meeting. The objectives of this technical expert meeting were to review methods that may be suited for special studies and expert technical analysis, explore the potential use of various non-IMS data for a State Requested Methods Report and advance common understanding of procedures and methods to be developed.



Specialized Technical Meeting on Preventive and Predictive Maintenance of the International Monitoring System, 17-19 November 2020.

An online specialized technical meeting on preventive and predictive maintenance of the International Monitoring System was held from 17 to 19 November 2020. One hundred and sixty-eight experts from 46 States Signatories and the PTS attended the meeting. The specialized technical meeting objectives were to provide a platform to present measures and tools that will lead to enhanced monitoring and sustainment of the IMS both on cutting edge developments in state of health monitoring, and tools for station operators, NDC staff, contractors and PTS staff, in particular on notification and predictive analysis and on potential sustainability enhancements for the IMS station network in areas such as equipment.

Noting the postponement of the technical training for IMS station operators due to the COVID-19 pandemic, the PTS continued to engage with station operators through a series of webinars. These aimed to bring them together in order to facilitate interaction with the PTS on matters related to the operation and maintenance of IMS facilities.

Activities under the EU Council Decision VII project continued to support capacity building in Africa, South-East Asia, the Pacific and the Far East and the Middle East and South Asia regions.

Eight sets of the new capacity building system (CBS) equipment were procured by the PTS in 2020 and began to be delivered to NDCs in accordance with the received requests. Six of the eight sets of CBS were procured using EU Council Decision VII funding. Due to travel restrictions related to the COVID-19 pandemic, a remote installation procedure for the CBS was introduced to assist NDCs in commissioning the new systems. Three sets have already been successfully installed with remote assistance from the PTS. Two systems were delivered to NDCs whose staff are working on setting up the equipment.

Two additional sets of CBS procured under EU Council Decision V funding were shipped to NDCs to replace obsolete systems. Their installations were conducted with on-site and remote assistance from the PTS.

Approximately 50 participants subscribed to the NDC e-learning course on access to and application of IMS data and IDC products in 2020.

Capacity building system installation in Afghanistan.

On-Site Inspection Training Courses and Workshops

The third training cycle for OSI inspectors is principally designed to develop and validate the training curricula for use after entry into force of the treaty. It also serves to build knowledge of OSI verification techniques in State Signatories. The last two on-site inspection training activities of the third training cycle scheduled for this period were postponed due to the COVID-19 pandemic, namely, the OSI next-generation field laboratory familiarization course and the leadership skills course. The pandemic has required a shift from a blended learning approach to a fully online teaching model and preparations have been made to deliver remote learning in the second and third quarters of 2021.

Noting the training schedule gap with the postponement of the BUEs, the PTS continued to engage with the surrogate inspector trainees from all training cycles with the development of a series of monthly webinars, from July 2020 to March 2021. The webinars will cover OSI training topics that change monthly with the aim of providing refresher training and keeping the trainees engaged with OSI topics remotely. By December 2020, 4 OSI specific webinars were conducted with an aggregate participant number of 488 surrogate inspectors representing 56 Signatory States.

In anticipation of the increased demand in remote training and online teaching in the coming months due to the COVID-19 pandemic, a PTS-wide training of trainers course focusing on the design and delivery of online training was conducted online from July to August 2020. Thirty-five training providers and subject matter experts from all divisions of the PTS participated in a six week fully online course that provided best practices and guidance on the design and implementation of digital and online training.

A cloud based remote e-training system on inspection team functionality and the GIMO system that was launched in September 2018 continued to support the activities of the third training cycle in 2020.

From March to April 2020, a fully online course on GIMO was provided to all rostered surrogate inspectors of all training cycles, using the PTS WebEx web conferencing platform. The integration of geospatial data simulation into this remote training platform allowed for an interactive training scenario with critical inspection team functionality concepts such as: search logic updates and the proposal and prioritization of missions that allowed trainees to conduct virtual operational steps such as inspection team meetings and the narrowing of search zones. This marked the first online deployment of this training system, which simulates the daily operations cycle of an individual inspector and uses data simulation models to conduct virtual field missions.

Participation of Experts from Developing Countries

The Commission continued to implement the project to facilitate the participation of experts from developing countries in its official technical meetings. The aims of this project are to strengthen the universal character of the Commission and to build capacity in developing countries. A detailed annual report on the status of implementation of the project was issued in November 2020 (CTBT/PTS/INF.1568). In November 2018, the Commission extended the project for a further three years (2019-2021), subject to the availability of sufficient voluntary contributions.

In 2020, the project supported the participation of experts from 11 States: Chile, Costa Rica, Libya, Mexico, Namibia, Nepal, Niger, South Africa, Sri Lanka, the Sudan and Uzbekistan. These experts took part in the Fifty-Second and Fifty-Third Sessions of WGB, including formal meetings and meetings of expert groups. They also benefitted from technical discussions with the PTS on key verification related issues.

Since its inception in 2007, the project has supported 54 experts from 40 States: 12 in Africa (Algeria, Burkina Faso, Ethiopia, Kenya, Libya, Madagascar,

Morocco, Namibia, Niger, South Africa, Sudan and Tunisia), 1 in Eastern Europe (Albania), 10 in Latin America and the Caribbean (Argentina, Bolivia, Brazil, Chile, Costa Rica, the Dominican Republic, Ecuador, Mexico, Paraguay and Peru), 7 in the Middle East and South Asia (Iraq, Jordan, Kyrgyzstan, Nepal, Sri Lanka, Uzbekistan and Yemen) and 10 in South-East Asia, the Pacific and the Far East (Indonesia, Malaysia, Mongolia, Myanmar, Papua New Guinea, the Philippines, Samoa, Thailand, Vanuatu and Viet Nam). Eighteen of the supported experts are women. Ten of these States are or were least developed countries.

Voluntary contributions from Australia, China, Germany, Kazakhstan and the EU were used to finance the project in 2020, and some of these funds were carried over to 2021. The Commission continues to seek additional voluntary contributions to ensure the financial sustainability of the project.

“Building capacities in all areas related to the CTBT ensures the Treaty’s continued viability.”

Lassina Zerbo, Executive Secretary

VII
OUTREACH

HIGHLIGHTS

- **Growing high level engagement with States and active youth outreach activities**
- **Comprehensive public and media outreach strategy**
- **Increased virtual outreach activities**

INTRODUCTION

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

Towards Entry into Force and Universality of the Treaty

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. Eight of the 44 States have not yet ratified.

As of 31 December 2020, 184 States had signed and 168 States had ratified the Treaty, including 36 Annex 2 States.

Despite the lack of ratifications by the remaining eight Annex 2 States, the Treaty is already widely considered to be an effective instrument of collective security and an important pillar of the nuclear non-proliferation and disarmament regime. Political support for the Treaty, for its urgent entry into force and for the work of the Commission continued to be strong in 2020. This was shown by the emphasis placed on the Treaty at numerous high level events and by many senior governmental officials and non-governmental leaders.

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.

Group of Eminent Persons and CTBTO Youth Group

The Group of Eminent Persons (GEM) was established by the Executive Secretary in 2013 to advance entry into force of the Treaty. The group examines political and technical developments related to the CTBT and identifies concrete action and new initiatives that could be explored to accelerate entry into force of the Treaty.

GEM members restated their "unwavering commitment" to promoting the Treaty as a pillar of the global non-proliferation and disarmament architecture.

GEM members actively engaged in activities that enhanced the visibility of the CTBT in international meetings and forums. They published articles and opinion pieces in support of the CTBT. Despite the absence of regular physical meetings, several GEM members used other virtual means to be in close contact with the Commission. The group presented a number of proposals regarding the challenging situation posed by the COVID-19 pandemic, and possible contingency measures. The GEM also expressed their appreciation for the work of the PTS to keep the verification system up and running, and highlighted the lessons learned. A publication on how the verification system can be used as an example to design an early warning system for pandemics was released by a GEM member.

Twenty years after the opening for signature of the CTBT, it is clear that entry into force and implementation will be in the hands of the next generation of leaders and policy makers. Therefore the CTBTO Youth Group (CYG) was launched in 2016.

The objectives of the CYG are to revitalize the discussion around the CTBT among decision makers, academia, students, subject experts and the media; to raise awareness of the importance of the nuclear test ban; to build a basis for knowledge transfer to the younger generation; to involve new technologies in the promotion of the CTBT (social media, digital visualization and interactive means of delivering information); and to place the CTBT on the global agenda.

The group is open to all students and young professionals who are pursuing careers dedicated to global peace and security and who wish to actively engage in promoting the CTBT and its verification regime.

Since its launch in 2016, the CYG has grown to over 990 members. A considerable number of its members come from the Annex 2 States whose ratification is needed for the CTBT to enter into force.

As the 2020 Science Diplomacy Symposium was postponed due to the COVID-19 pandemic, the work of the CYG migrated to an online format. The CYG organized 11 webinars that brought together over 1290 attendees. Together with the OSI Division, the CYG Task Force organized the first ever virtual tabletop exercises. Further initiatives included intergenerational dialogue and outreach activities that built bridges with other youth led organizations.

Interacting with States

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

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

The Executive Secretary participated in several bilateral meetings and other high level events at which he met several heads of State and Government. These included the President of Armenia, the President of Burkina Faso, the Prime Minister of the Central African Republic, the President of France and the President of Kazakhstan.

Promoting parliamentary engagement, the Executive Secretary interacted with a number of parliamentarians from States Signatories.

During his international visits, engagements in Vienna as well as at virtual meetings, the Executive Secretary also interacted with several foreign ministers and other ministers of States Signatories and observers. They included the foreign ministers of Algeria, Armenia, Belgium, Bosnia and Herzegovina, China, Finland, the Netherlands, Republic of Korea, the Russian Federation and Turkmenistan.

Executive Secretary Lassina Zerbo and the Minister of Mines and Geology of the Central African Republic, Léopold Mboli Fatran.

The Executive Secretary undertook a mission to the Republic of Ghana from 3 to 6 March 2020 to address a regional workshop on strengthening the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and to engage with civil society.

From 6 to 10 March 2020, the Executive Secretary undertook a mission to the Central African Republic during which he met with the Prime Minister, the Minister of Mines and Geology and the Minister of Scientific Research and Technological Innovation.

On 13 May 2020, the Executive Secretary held a virtual meeting with the Minister of Foreign Affairs of Turkmenistan.

On 9 July 2020, the Executive Secretary participated in a ministerial webinar hosted by Minister of Foreign Affairs of the Netherlands along with the Minister of Foreign Affairs and Defence of Belgium, the Minister of Foreign Affairs of Finland and Minister of State at the Federal Foreign Office of Germany.

On 6 August 2020, the Executive Secretary delivered a video statement marking the 75th anniversary of the atomic bombings of Hiroshima and Nagasaki.

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

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

During these meetings and conferences, the Executive Secretary interacted with a number of heads and other senior officials of international and regional organizations.

On the margins of the Munich Security Conference in Germany from 14 to 16 February 2020, the Executive Secretary met the President of France, the President of the Republic of Kazakhstan, the President of the Republic of Armenia, the Prime Minister of Canada, the Chancellor of the Republic of Austria, the Minister of Foreign Affairs of China, the Minister of Foreign Affairs of the Russian Federation, the Speaker of the United States House of Representatives and the State Secretary of the Federal Foreign Office of Germany.

▶ ***Executive Secretary, Lassina Zerbo, with French President, Emmanuel Macron, and the Speaker of the United States House of Representatives, Nancy Pelosi, at the Munich Security Conference.***

On 29 April 2020, the Executive Secretary took part in a virtual dialogue organized by the International University for Humanities and Development of Turkmenistan.

On 13 May 2020, in the context of a ministerial webinar, the Executive Secretary interacted with the United Nations Under-Secretary-General and High Representative for Disarmament Affairs.

On 12 August 2020, the Executive Secretary opened a joint VIC based organizations (VBOs) webinar to mark International Youth Day with a video address.

On 26 August 2020, the Executive Secretary addressed the United Nations General Assembly in virtual format in the context of the International Day against Nuclear Tests.

As part of the European Forum Alpbach, the Executive Secretary took part in a virtual panel discussion including the Minister of Foreign Affairs of Algeria and the former President of Finland, on 29 August 2020.

The CTBTO hosted a CYG webinar entitled "UN at 75: making youth voices heard" on 10 September 2020 with the United Nations Under-Secretary-General and Special Adviser on Preparations for the Commemoration of the Seventy-Fifth Anniversary of the United Nations.

The CTBTO hosted a webinar discussion on "The CTBT and the 10th NPT Review Conference" on 6 October 2020. Opening remarks were delivered by the Executive Secretary and the United Nations Under-Secretary-General and High Representative for Disarmament Affairs. The panel discussion included the Deputy Federal Government Commissioner for Disarmament and Arms Control and Special Representative for Cyber Foreign Policy and Cyber Security of the Federal Foreign Office of Germany, the EU Special Envoy for Non-Proliferation and Disarmament, the Permanent Representative of Australia to the United Nations, and the President-designate of the Tenth NPT Review Conference.

On 10 October 2020, the Executive Secretary addressed Armenia's Summit of Minds virtually.

On 19 November 2020, the Executive Secretary participated in the virtual Astana Club Meeting.

The Executive Secretary also attended and addressed virtually the Halifax International Security Forum, held in the United States of America on 21 November 2020.

The Executive Secretary also attended several other conferences, meetings and seminars where he gave keynote speeches or participated in panels or discussions on the Treaty. During these conferences, meetings and seminars around the world and at meetings in Vienna, the Executive Secretary engaged with a number of prominent figures from academia, leading think tanks and other non-governmental entities.

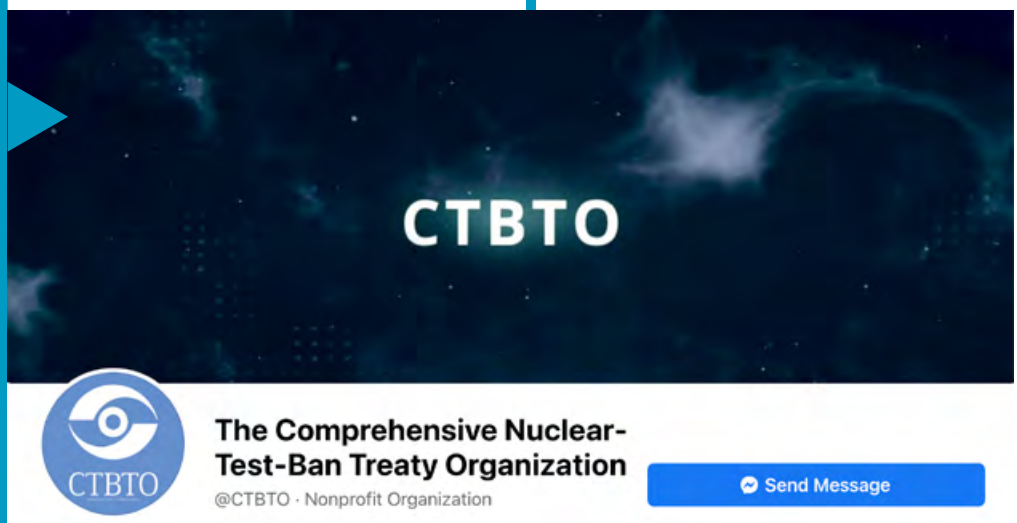
Public Information

Restrictions due to the COVID-19 pandemic accentuated the importance of online communication. Despite the postponement or cancellation of several key events scheduled for 2020 (notably the Tenth NPT Review Conference and the Science Diplomacy Symposium), the PTS ensured a steady feed of high quality items to the CTBTO's public website and social media channels (Twitter, Facebook, YouTube and Flickr). It also provided extensive social media coverage of interventions by the Executive Secretary and other key figures in online events. Wherever possible, video streaming and significant statements were made available via the website.

The Commission recorded around 776 000 visits to the CTBTO public web site over the year, of which nearly 280 000 were new users, an increase of 16% on 2019. The number of followers for the main CTBTO Twitter account also increased by more than 10% from late 2019 to a total of over 21 300 followers by the end of 2020. In order to reach a wider audience, many key Twitter posts were published in English, French and Spanish. As of December 2020, the CTBTO Facebook posts reached a total of 176 851 users. Flickr saw a total of 19 000 views.

The PTS produced a rich stream of multimedia products over the year, ranging from short social media videos on CTBTO staff and IMS station operators working through the pandemic, to videos on how the CTBTO helps to protect the oceans, and the certification of a radionuclide station in Niger. Thirty-three videos were posted to the CTBTO YouTube channel in 2020, gaining almost 77 000 views.

Two successful animated films were produced with the educational channel Minute Earth thanks to EU extrabudgetary funding. One highlights the physics behind the CTBT's hydroacoustic monitoring network, while the other explains how CTBT data can be used to predict the start of the monsoon in India. Each of these received more than 300 000 views and well over 500 comments and were also issued in French and Spanish.



▶ *Facebook page of the CTBTO.*

A short video marking the 75th anniversary of the bombing of Hiroshima and Nagasaki, featuring archive footage and remarks by the Executive Secretary, gained more than 14 000 views on Twitter and a combined total of more than 2250 engagements on Twitter and Facebook.

A 15 second video produced for the International Day against Nuclear Tests (IDANT) received nearly 20 000 views and was widely retweeted. The video was tweeted directly on the United Nations Secretary-General's own account, gaining it a further 60 000 views and nearly 1000 retweets.

IDANT was also marked with real time social media coverage of the Executive Secretary and other speakers at the United Nations General Assembly plenary session and at a dedicated session at the European Forum Alpbach. All key elements, including a joint statement from the CTBTO and African Commission on Nuclear Energy, were also promoted on the CTBTO website.

The CTBTO participated in a UN75 information campaign that ran prominently for a month in October on video screens across Vienna's public transport system.

After a gap of several years, a special edition of the CTBTO Spectrum magazine was published highlighting issues vital to the Tenth NPT Review Conference and the essential role of the CTBT within the nuclear non-proliferation and disarmament regime. The full edition is available on the CTBTO website, and individual articles were promoted on Twitter and Facebook.

▶ Global Media Coverage

Significant media coverage of the CTBTO was achieved despite muted media interest during 2020, as COVID-19 and other major stories dominated the world news agenda and key relevant events were postponed or cancelled. Highlights included interviews with the Executive Secretary in The Guardian (United Kingdom), Libération (France) and Die Presse (Austria), and publication of an op-ed piece through Kyodo News (international).

The Treaty and its verification regime featured in a wide range of articles, blogs and broadcast pieces around the world. Outlets included AFP, Al Arabiya, Al Jazeera, ANI News, Arms Control Today, Arms Control Wonk, The Asahi Shimbun, Asia Times, Associated Press, The Astana Times, BBC, BelTA,

Brookings Institution, The Bulletin of the Atomic Scientists, Catholic News Service, CGTN, Channel 13, China Daily, CNN, The Conversation, Deutsche Welle, Eurasia Review, European Leadership Network, EU Today, Forbes, France 24, Fox News, The Hill, The Hindustan Times, IDN-InDepthNews, The Irish Times, Kazakh TV, Kommersant, The Korea Times, Kyodo News, La Tercera, Manila Times, Mehr News Agency, Mirage News, Modern Diplomacy, The National Interest, National Post, The News International, The New York Times, NHK World, NK News, Nuclear Engineering, ORF, Physics Today, Popular Mechanics, Die Presse, Radio Free Europe, Reuters, RNZ, RT, RTBF, Science Magazine, Sky News, Sputnik, Der Standard, TASS, Tehran Times, The Times of India, Urdu Point, Vatican News, VERTIC, VICE, VOA Korea, Vox, The Wall Street Journal, War on the Rocks, The Washington Post, The Washington Times, The Wire, Xinhua News Agency, Yonhap News Agency, 24 Horas/TVN and 38 North. IDANT was reported extensively by media worldwide, with over 80 articles in the official languages of the United Nations.

Significant media coverage of the CTBTO was achieved despite muted media interest due to COVID-19 dominating the world news.

A television package produced by the PTS for the 75th anniversary of the bombing of Hiroshima and Nagasaki was distributed to media through the United Nation's UNiFeed service and aired by more than 20 broadcasters worldwide.

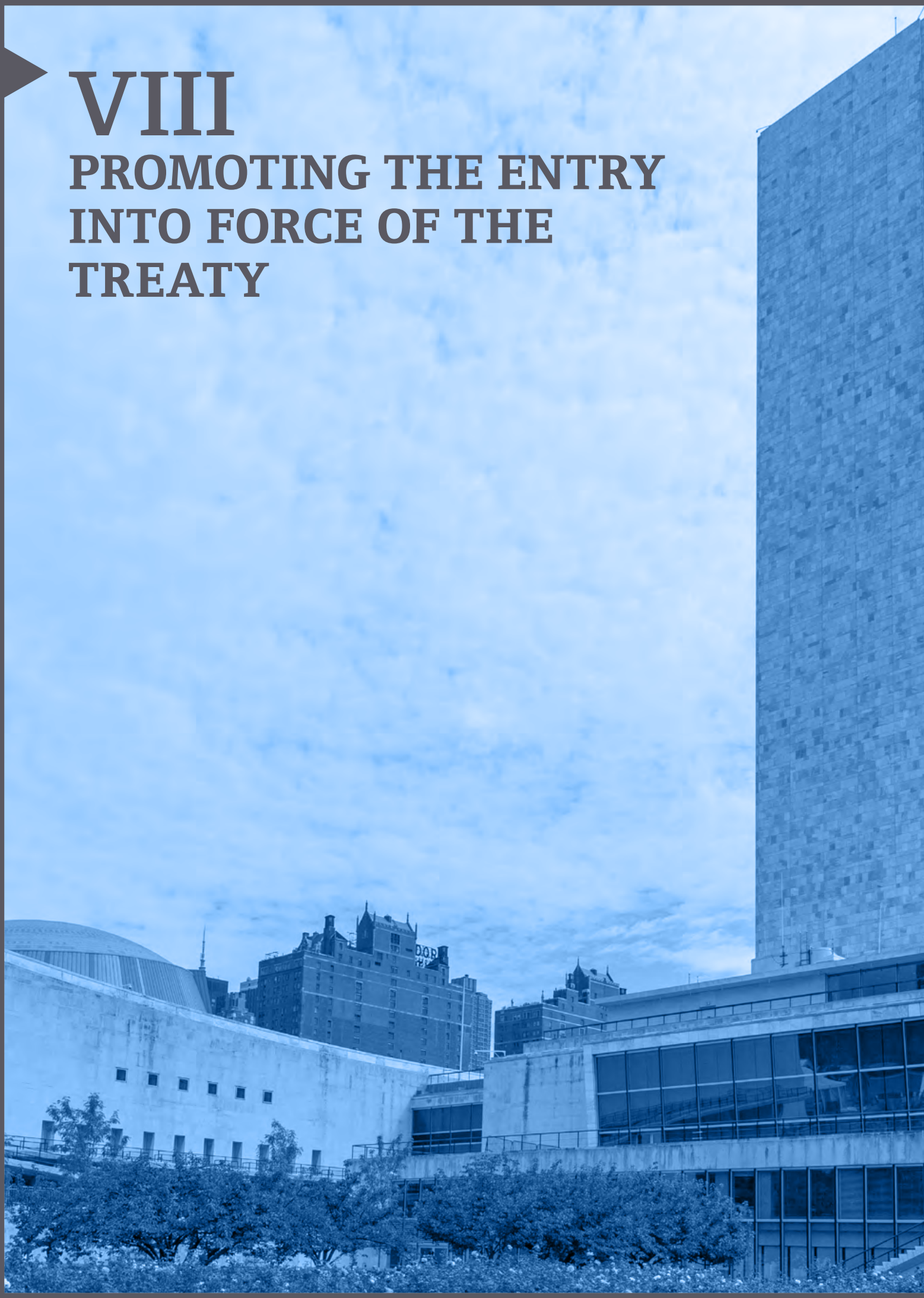
The CTBT verification regime featured prominently in a Netflix science documentary series, Connected, available to millions of viewers globally. It included footage of analysts at work in the IDC, station operators at various IMS stations around the world and an interview with the Executive Secretary.

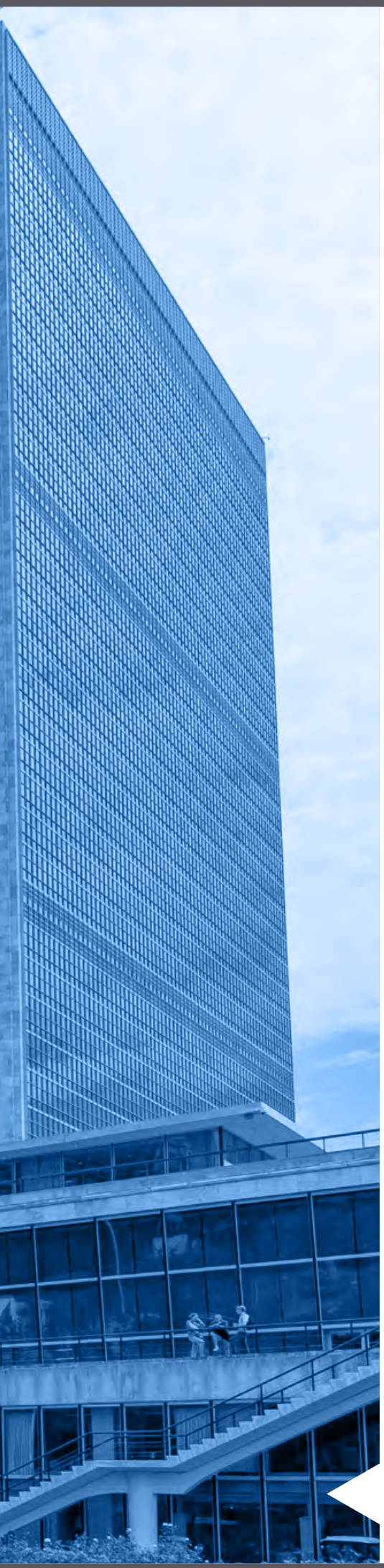
National Implementation Measures

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

In 2020, the Commission continued to promote the exchange of information between States Signatories on national implementation measures. It also made presentations on aspects of national implementation at workshops, seminars, training courses, external events and academic lectures.

VIII
PROMOTING THE ENTRY INTO FORCE OF THE TREATY





HIGHLIGHTS

- **Continued strong political support for the Treaty and the work of the Commission**
- **Video message by the Group of Friends of the CTBT**

INTRODUCTION

Every two years, the States that have ratified the Treaty convene a Conference on Facilitating the Entry into Force of the CTBT (also known as an Article XIV conference). In the years between Article XIV conferences, foreign ministers of States Signatories are invited to meet on the margins of the United Nations General Assembly 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.

Conditions for Entry into Force

The entry into force of the Treaty requires ratification by all 44 States listed in its Annex 2. These so-called Annex 2 States are States that formally participated in the final stage of the negotiation of the Treaty in the Conference of Disarmament in 1996 and possessed nuclear power reactors or nuclear research reactors at that time. As of 31 December 2020, 36 of these 44 States had ratified the Treaty. Of the eight Annex 2 States that had yet to ratify the Treaty, three still had not signed.

Ministerial Meeting of the Friends of the CTBT

Due to the COVID-19 pandemic, the Foreign Ministers of the Friends of the CTBT could not, for the first time since 2002, hold their biennial Ministerial Meeting during the high level week of the United Nations General Assembly session in New York. It was decided to instead release a video message.

The video featured short quotations from the Foreign Ministers of Australia, Canada, Finland, Germany, Japan and the Netherlands, as initiators of the Ministerial Meeting of the Friends of the CTBT, as well as the Secretary-General of the United Nations and the Executive Secretary of the CTBTO.

The contributors underscored the dangers of nuclear testing, including heightened global tensions and the devastating enduring impacts on people and the environment. They also emphasized the significance of the Treaty, as an excellent example of multilateralism in practice and an effective response to the nuclear threat. It was noted that the common goal is a world free of nuclear weapons and the CTBT is a key contribution towards that end. Civil and scientific applications of the verification regime of the Treaty were also highlighted.

They therefore called for the entry in force of the Treaty and pledged their commitment and support towards that goal.

“The Commission’s duties focus on the Treaty’s entry into force, which will take place after it has been ratified by the 44 States listed in its Annex 2.”

IX
POLICY MAKING

HIGHLIGHTS

- **An increased number of meetings of the Commission and its subsidiary bodies despite COVID-19 restrictions**
- **Adoption of important decisions by the Commission**
- **Financing of an Article XIV conference in 2021**

INTRODUCTION

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

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

In addition, an Advisory Group of experts serves in a supporting role, advising the Commission through WGA on financial and budgetary matters.

Meetings of the Commission and Its Subsidiary Bodies in 2019

Body	Session	Dates	Chairperson
Preparatory Commission	Fifty-Fourth	25-26 June	Ambassador Faouzia Boumaiza Mebarki (Algeria)
	Resumed Fifty-Fourth	10, 20 and 24 July 9-10 September 8, 15 and 19 October	
	Fifty-Fifth	14-21 December	
Working Group A	Fifty-Seventh	1 June	Ambassador Nada Kruger (Namibia)
	Fifty-Eighth	28-29 October	Acting Chairperson Ambassador Ganeson Sivagurunathan (Malaysia)
Working Group B	Fifty-Fourth	17-27 February	Mr Joachim Schulze (Germany)
	Fifty-Fifth	24 August-3 September	
Advisory Group	Fifty-Fourth	11-14 May	Mr Michael Weston (United Kingdom)
	Fifty-Fifth	5-8 October	

Meetings in 2020

The Commission and its subsidiary bodies each met in two regular sessions in 2020.

Among the major issues addressed by the Commission during 2020 were the promotion of the Treaty; the United Nations General Assembly resolution on the CTBTO; progress made on the completion of the IMS network; capacity building activities of the Commission; the NPT Review Conference in 2021; business continuity; the 2021 Budget update proposals; guidance on the future use of radioxenon background measurement systems; developing guidelines for holding non-scheduled sessions of the Commission; method of work of the Commission; and the appointment of the Executive Secretary and the Chairperson of WGB.

Supporting the Commission and Its Subsidiary Bodies

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

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

In 2020, due to COVID-19 restrictions, most of the sessions of the Commission and its subsidiary bodies were held either virtually or in a hybrid format (virtually and in person). In addition, the number of meetings of the Commission and its subsidiary bodies witnessed a considerable increase.

▼ *Virtual Working Environment*

Through the ECS, the Commission provides a virtual working environment for those who are unable to attend its regular meetings. Using state of the art technology, the ECS records and transmits the proceedings of each official plenary meeting live around the globe. Meetings are then archived for reference purposes. In addition, the ECS distributes supporting documents for each session to States Signatories and alerts participants of new documents by email.

The ECS is a single sign-on infrastructure of the Commission 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 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.

▶ *Due to COVID-19 limitations, the Fifty-Fourth Session of the Preparatory Commission took place in a virtual format in June 2020.*

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

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

Appointment of Facilitators for Several Issues

In order to improve the work of the Commission and reach consensus on some key issues, the Commission decided to appoint the following facilitators:

- Ambassador Rapulane Sydney Molekane (South Africa) and Ambassador Benno Laggner (Switzerland), facilitators on guidance on the issue of noble gas background measurement;
- Ambassador Gloria Navarrete Pinto (Chile), facilitator of the Commission for holding non-scheduled sessions of the Commission;
- Ambassador Nicole Roberton (New Zealand) and Ambassador Maria Cleofe Rayos Natividad (the Philippines), facilitators on the method of work of the Commission.

Appointment of the Executive Secretary and the Chairperson of Working Group B

The process for the appointment of the Executive Secretary was inclusive. The Commission decided to continue its consideration of the issue. The Commission also decided to defer appointment of the Chairperson of WGB to its resumed session in order to reach consensus.

Executive Secretary Lassina Zerbo delivering his opening statement at the Fifty-Fifth Session of Working Group B in August 2020.

“The CTBT’s entry into force would mark a milestone on the way to a world free of nuclear weapons.”

Abdullah Ensour, Former Prime Minister of Jordan

X
MANAGEMENT

HIGHLIGHTS

- **Improving administrative and human resources policies, procedures and processes**
- **Allocation of 80% of the budget to verification related activities**
- **Further strengthening of oversight**

INTRODUCTION

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

The PTS also provides a wide variety of services including general services from arrangements concerning shipments, customs, visas, identity cards, laissez-passer, tax, travel and low value purchases to 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 way.

Management also involves coordinating with the other international organizations located in the VIC over planning of office and storage space, usage of common space, maintenance of the premises, common services and security.

Throughout 2020, the Commission continued to focus on smart planning to streamline its activities and to increase synergy and efficiency. It also prioritized results based management.

Oversight

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

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

In 2020, Internal Audit concluded and issued six audit reports in line with the approved work plan. Based on the audits performed, Internal Audit identified opportunities to mitigate risks and strengthen the overall control environment of the PTS and provided several recommendations to management.

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

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

During 2020, the Internal Audit Charter and the Internal Audit Manual were reviewed and updated in order to remain relevant and current. Changes were considered necessary to include best practices from other similar organizations, to align with the International Standards for the Professional Practice of Internal Auditing and to incorporate lessons learned from the COVID-19 pandemic.

Internal Audit continued to improve the quality of its services through specific activities. These include continuous monitoring as per internal audit quality assurance and improvement standards, as well as exchange of methodologies and best practices through participation in periodic surveys and regular online meetings of the Representatives of Internal Audit Services of United Nations Organizations.

Finance

2020-2021 Programme and Budget

The Budget for 2020 amounted to $67 210 100 and €56 275 800, 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 2020 Budget was $123 485 900. This represented a nominal growth of 1.8% but was almost constant in real terms (a decrease of $90 900).

On the basis of the actual average exchange rate in 2020 of €0.8778 to $1, the final total US dollar equivalent of the 2020 Budget was $131 320 100. Of the total Budget, 81% was originally allocated to verification related activities, including $15 471 803 for the Capital Investment Fund, which is dedicated to the build-up and sustainment of the IMS, and $8 589 463 for the multiyear funds that are dedicated to other long term verification related projects.

The Budget for 2021 totalled $68 101 500 and €57 001 100, corresponding to slightly less than zero real growth. At the budget exchange rate of €1 to $1, the total US dollar equivalent of the 2021 Budget was $125 102 600. This represented a nominal growth of 1.3% but was almost constant in real terms (a decrease of $71 100).

Distribution of the 2020-2021 Budget by Area of Activity

Area of Activity	2020 Budget (US$ millions)[a]	2021 Budget (US$ millions)[b,c]
International Monitoring System	42	39.8
International Data Centre	49.7	48.7
On-Site Inspection	12.4	11
Evaluation and Audit	2.4	2.3
Policy Making Organ Support	4.2	3.8
Administration, Coordination and Support	16	15.1
Legal and External Relations	4.6	4.4
Total	**131.3**	**125.1**

a) To convert the euro component of the 2020 Budget, an average exchange rate of €0.8778 to $1 was used.

b) To convert the euro portion of the 2021 allotment, the budgetary exchange rate of €1 to $1 was used.

c) Amounts include the 2014 cash surplus allocated to the multiyear funds in accordance with CTBT/PC-47/2.

Assessed Contributions

As of 31 December 2020, the collection rates of the assessed contributions from States Signatories for 2020 were 91.6% of the US dollar portion and 90.5% of the euro portion. The number of States that had paid their 2020 assessed contributions in full as of 31 December 2020 was 101.

Expenditure

The expenditure for the Programme and Budget in 2020 amounted to $109 752 015, of which $14 627 085 was from the Capital Investment Fund, $5 861 146 was from the multiyear funds, and the remainder from the General Fund. For the General Fund, the unused budget was $14 748 750.

Automation

The Finance Process Automation and Streamlining Project, aimed at streamlining activities in the finance area, was launched in 2020. A key project objective is to reduce reliance on manual processes, i.e. by replacing operator typing of invoice data into the Enterprise Resource Planning module using optical character recognition software; replacing phone calls and emails with electronic notifications wherever possible; and making the physical circulation and signing of documents redundant with workflow notifications and electronic approvals. A number of improvements were completed in 2020, such as the implementation of an accounts payable automation system, deployed in November 2020, while a number of additional changes are in the implementation phase and will be delivered in 2021.

General Services

During the reporting period, the cooperation and dialogue with the other VBOs was further consolidated. The PTS actively participated in all inter-VBO committees, both decision making and advisory. During the reporting period, the PTS continued to seek the best value for money from the respective service providing VBO. In this spirit, in 2020 the PTS successfully introduced new telephone technology in a joint effort with other VBOs and shifted to a more modern, efficient and cost effective service scheme.

Following the outbreak of the COVID-19 pandemic, and consistent with the approach of the PTS as a whole, General Services introduced working modalities aimed at ensuring a timely and uninterrupted provision of support and services in all areas of its work, including the processing of legitimation cards, United Nations laissez-passer and shipments of household goods. It also supported the implementation of the arrangements needed to comply with the applicable physical distancing measures in the workspace to provide a safe and healthy work environment, such as office moves and partitioning.

The PTS further consolidated the cross-Divisional arrangements in place to optimize the use of available space and accommodate pressing archiving needs to guarantee safe storage of the records and documentation of the Commission.

During the reporting period, General Services provided the necessary support related to travel and booking arrangements, including those following the COVID-19 pandemic and the measures adopted in response to it. In addition to this, General Services completed the booking of accommodation for participants in the SnT2021 conference, securing terms and conditions allowing it to cancel bookings made in a cost effective manner, if so needed.

General Services also continued to facilitate and support the activities and needs of the TeST Centre at Seibersdorf, Austria. In 2020 the PTS introduced a standard bus shuttle service to transport PTS staff from the VIC to the TeST Centre and back on a regular basis.

In 2020 the PTS made further progress in the process of modernization of its transport fleet, as required by the administrative regulations in place.

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

Procurement

In January 2020 the PTS launched a project to streamline Enterprise Resource Planning processes and design and implement online efficiencies identified through the Procurement Streamlining Project. During the said period it introduced several additional functionalities that provide significant benefit, allowing the PTS to address audit recommendations and optimize its resources. The said project will continue into 2021 with the implementation of additional value-added enhancements for transparency and efficiency.

After the implementation of restrictions to its on-site work following the COVID-19 pandemic, the PTS introduced a series of new procurement processes with speed and agility, thereby adapting to the new reality and the work requirements associated with it. Changes were implemented swiftly, many of them in a matter of days, allowing the PTS to continue to work in a smooth and uninterrupted manner.

The Commission obligated $57 701 193 through 786 procurements for high value purchases and $802 138 through 452 contractual instruments for low value purchases.

As of 31 December 2020, 147 IMS stations, 28 noble gas systems, 13 radionuclide laboratories and 3 radionuclide laboratories with noble gas capability were under contract for testing and evaluation or for PCAs.

Resources Mobilization

Due to long term financial constraints affecting many member states which have been exacerbated in 2020 due to the COVID19 pandemic, raising extra-budgetary resources for projects that converge with the strategic goals of the Commission has become a necessity to carry out several activities. As part of this effort, a Voluntary Support Forum was initiated in 2014 as a forum for interaction with the donor community. The forum attempts to consolidate efforts to mobilize extrabudgetary funding, to strengthen interaction with donors and to increase transparency and accountability regarding the use of voluntary contributions. Due to the COVID-19 pandemic, the 2020 Voluntary Support Forum was rescheduled to 2021. Since 1999, the Commission has received approximately $95 million in cash contributions and $66 million in contributions in kind. In 2020, the Commission welcomed the receipt of a number of voluntary contributions from several notable donors (Australia, Canada, China, France, Germany, Japan, Kazakhstan, the Netherlands, the United States of America, and the European Union).

Human Resources

The organization secured the human resources for its operations by recruiting and retaining highly competent and diligent staff. Recruitment was based on obtaining the highest standards of professional expertise, experience, efficiency, competence and integrity. Full attention was paid to the principle of 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.

Throughout the year, the PTS continued its efforts to improve human resources policies, procedures and processes. As of 31 December 2020, there were 277 regular fixed term staff members of the PTS from 90 countries, compared with 273 staff members from 83 countries on 31 December 2019. In 2020, there were 182 staff members in the Professional and higher categories, while in 2019 there were 181.

Fixed Term Staff Members by Field of Work as of 31 December 2020

Field of Work	Professional	General Service	Total
QMPM Section	3	1	4
IMS Division	35	25	60
IDC Division	76	16	92
OSI Division	18	7	25
Subtotal, verification related	*132*	*49*	*181*
Share, verification related	*72.53%*	*51.58%*	*65.34%*
Office of the Executive Secretary	4	2	6
Internal Audit	4	-	4
Human Resources Services	4	7	11
Division of Administration	20	21	41
Legal and External Relations Division	18	16	34
Subtotal, non-verification-related	*50*	*46*	*96*
Share, non-verification-related	*27.47%*	*48.42%*	*34.66%*
Total	182	95	277

Fixed Term Staff Members by Grade and Gender, 2019 and 2020

Grade	Male				Female			
	2019		2020		2019		2020	
D1	3	1.84%	3	1.83%	3	2.73 %	1	0.88%
P5	19	11.66%	18	10.98%	6	5.45 %	6	5.31%
P4	45	27.61%	42	25.61%	16	14.55 %	16	14.16%
P3	44	26.99%	47	28.66%	16	14.55 %	19	16.81%
P2	14	8.59%	14	8.54%	15	13.64 %	16	14.16%
Subtotal	125	76.69%	124	75.61%	56	50.91 %	58	51.33 %
G7	-	-	-	-	1	0.91 %	1	0.88 %
G6*	4	2.45%	5	3.05%	-	-	-	-
G6	16	9.82%	18	10.98%	8	7.27 %	8	7.08%
G5	13	7.98%	13	7.93%	31	28.18 %	30	26.55%
G4	5	3.07%	4	2.44%	14	12.73 %	16	14.16%
Subtotal	38	23.31%	40	24.39%	54	49.09 %	55	48.67%
Total	163	100%	164	100%	110	100%	113	100%

*Internationally recruited

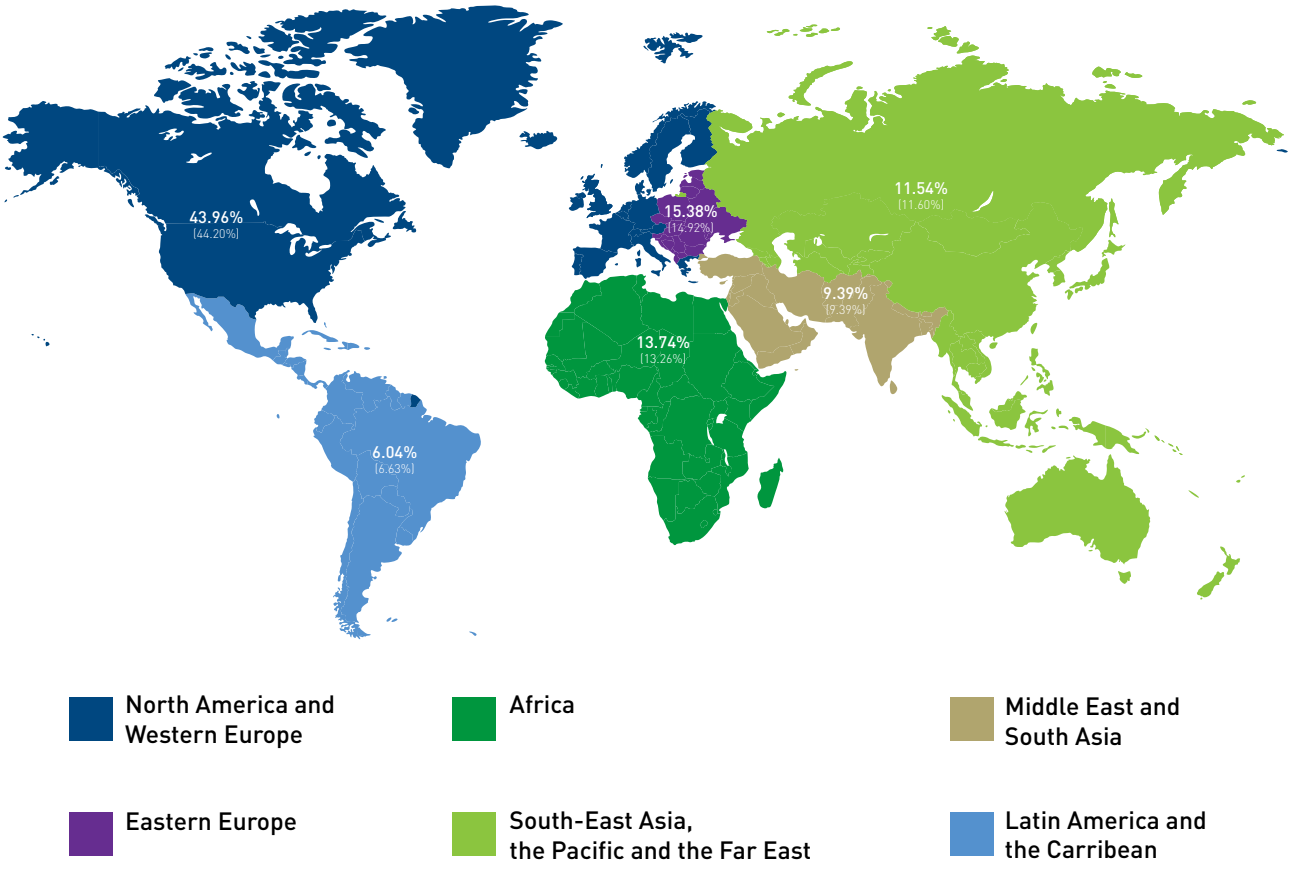
Fixed Term Staff Members by Grade, 2019 and 2020

Grade	2019		2020	
D1	6	2.20%	4	1.44%
P5	25	9.16%	24	8.66%
P4	61	22.34%	58	20.94%
P3	60	21.98%	66	23.83%
P2	29	10.62%	30	10.83%
Subtotal	181	66.30%	182	65.70%
G7	1	0.37%	1	0.36%
G6*	4	1.47%	5	1.81%
G6	24	8.79%	26	9.39%
G5	44	16.12%	43	15.52%
G4	19	6.96%	20	7.22%
Subtotal	92	33.70%	95	34.30%
Total	273	100%	277	100%

*Internationally recruited

Fixed Term Professional Staff by Geographical Region as of 31 December 2020

(Percentages as of 31 December 2019 are shown in brackets)



We have reviewed and updated our business continuity plan, improving our readiness to respond to unpredictable circumstances.

Lassina Zerbo, Executive Secretary

XI
SIGNATURE AND RATIFICATION

As of 31 December 2020

184 States Signatories
168 Ratified / 16 Signed But Not Ratified

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

ANNEX 2

44 States

36 Ratified / 5 Signed But Not Ratified / 3 Not Signed

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

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

SIGNATURE AND RATIFICATION OF THE TREATY BY GEOGRAPHICAL REGION

AFRICA

54 States

46 Ratified / 5 Signed But Not Ratified / 3 Not Signed

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

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

EASTERN EUROPE

23 States
23 Ratified

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

LATIN AMERICA AND THE CARIBBEAN

33 States
31 Ratified / 2 Not Signed

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

MIDDLE EAST AND SOUTH ASIA

26 States

16 Ratified / 5 Signed But Not Ratified / 5 Not Signed

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

NORTH AMERICA AND WESTERN EUROPE

28 States

27 Ratified / 1 Signed But Not Ratified

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

SOUTH EAST ASIA, THE PACIFIC AND THE FAR EAST

32 States

25 Ratified / 5 Signed But Not Ratified / 2 Not Signed

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

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