



CTBTO
PREPARATORY COMMISSION

ADVANCING VERIFICATION CAPABILITIES

ANNUAL REPORT 2019



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MESSAGE

FROM THE EXECUTIVE SECRETARY

I have the pleasure to present the 2019 Annual Report of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), which offers highlights of its major activities.

The activities of the Organization in 2019 were guided by the strategic goals of its 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 that end, we focused on strengthening political support for the Treaty and furthering its entry into force and universalization. We continued to expand our high level engagement with States and promoted the roles of youth and women in the outreach activities of the Organization. In order to enhance our robust verification regime, sustainment and further development of the International Monitoring System (IMS) as well as on-site inspection (OSI) capabilities were a high priority.

In 2019 the CTBT enjoyed strong support from States Signatories and remained a uniting factor in advancing the goal of a nuclear free world. On various occasions, world leaders, State officials and civil society representatives highlighted the significance of the Treaty as one of the main pillars of the nuclear non-proliferation and disarmament regime. They renewed the call for entry into force of the CTBT and appreciated the work of the Organization. The expertise of the Commission and its potential for involvement in the denuclearization process of the Korean Peninsula was also emphasized.

The significance of the CTBT and the need for its entry into force was a common theme at many important events, including the 2019 Preparatory Committee for the 2020 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (29 April to 10 May, New York, United States of America); the Forty-Fifth Parliamentary Assembly of the Francophonie (7 to 8 July, Abidjan, Côte d'Ivoire); the Fiftieth Pacific Islands Forum Leaders meeting (13 to 16 August, Funafuti, Tuvalu); the United Nations General Assembly high level meeting devoted to the International Day against Nuclear Tests (9 September, New York, United States of America); the high level week of the seventy-fourth session of the United Nations General Assembly (24 to 30 September, New York, United States of America); the eleventh Ministerial Meeting of the Article XIV conference (25 September, New York, United States of America); and the Non-Aligned Movement Summit (25 to 26 October, Baku, Azerbaijan).

On 25 September, ministers and other high ranking officials from around 85 States attended the eleventh Article XIV conference in New York to discuss ways and means to encourage further signature and ratification of the Treaty. The Foreign Ministers of Algeria and Germany presided over the conference. The participants highlighted the correlation between the CTBT and the Treaty on the Non-Proliferation of Nuclear Weapons and viewed the CTBT as one of the key pillars of the international disarmament and non-proliferation architecture. The conference unanimously adopted a Final Declaration that reaffirms the vital importance and urgency of the entry into force of the CTBT and urges all States to remain seized of the issue at the highest political level.

The Treaty was ratified by Zimbabwe on 13 February 2019. This brought the number of signatures to 184 and the number of ratifications to 168.

In 2019, I met with a number of Heads of State and Government, Foreign Ministers and other senior State officials, including the Presidents of Burkina Faso, Ghana, Kazakhstan and Zimbabwe, as well as the Prime Ministers of the Solomon Islands, Tonga and Tuvalu. I also held talks with Foreign Ministers and other high ranking officials including from Armenia, Australia, Austria, Azerbaijan, Bahrain, Belgium, Burkina Faso, Cameroon, China, Costa Rica, the Dominican Republic, Ecuador, Estonia, Finland, France, Germany, the Islamic Republic of Iran, Japan, Kazakhstan, the Republic of Korea, Madagascar, Malta, Mongolia, New Zealand, Nigeria, Norway, Pakistan, the Russian Federation, Rwanda, Slovakia, Sweden, Switzerland, Syria, the United States of America and Zimbabwe.

Promoting parliamentary engagement, I met the Speaker of the Senate of the Parliament of Kazakhstan, the Speaker of the House of Representatives of Japan, Parliamentary Vice-Minister for Foreign Affairs of Japan, members of the National Assembly of the Republic of Korea and the chair of the National Defense Committee of the Republic of Korea.

On 29 August, I had the honour, together with the late Director General of the International Atomic Energy Agency, Mr Yukiya Amano, to be awarded the Nazarbayev Prize for a Nuclear-Weapons-Free World and Global Security. I share this recognition with States Signatories and the staff of the Organization.

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, especially in States that have not yet signed or ratified the Treaty.

To keep pace with the scientific and technological evolution affecting our verification regime, the seventh CTBT: Science and Technology conference was held from 24 to 28 June 2019. The conference set a record in terms of participation, themes, panel discussions and the number of oral presentations and posters.

The conference brought together around 1200 scientists, technologists, state representatives, academics, students, journalists and representatives of organizations. Over 800 presentation abstracts and 330 posters were submitted, while 120 oral presentations were given. These figures are reflective of the growing level of enthusiasm and interest in this conference series. Promoting youth and female engagement, as well as multilingualism, in Treaty related matters were among the salient features of this year's conference.

The scope and coverage of our integrated capacity development programme continued to grow. A large number of experts, mainly 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 in meeting the verification requirements of the Treaty, as well as protecting the investment of the Commission. In 2019 the Commission made further progress with the installation and certification of facilities in a number of States, thus reaching the milestone of 300 certified IMS facilities. The figure represents 89% of the network foreseen by the Treaty. This achievement will improve both the coverage and the resilience of the network and will assist the Commission in providing a wide range of data and data products to States Signatories on a continuous basis.

As for OSI activities during 2019, we continued to implement the OSI action plan for 2016-2019 and the OSI exercise plan for 2016-2020. I should note that all 43 projects were successfully concluded. Accordingly, 86% of the recommendations from previous build up exercises and the 2014 Integrated Field Exercise, as contained in the OSI database of issues and lessons identified, have been addressed. OSI activities also included training courses in the third OSI training cycle for future inspectors.

With the inauguration of the CTBTO Technology Support and Training (TeST) Centre on 19 June 2019, yet another major multiyear project of the Commission was completed. Despite challenges including an ambitious time schedule and a tight budget, we managed to complete the Centre on time and on budget.

The final outcome of our efforts in this area is an example of efficiency and good value for money. The TeST Centre will serve as a multipurpose building that will host the Equipment Storage and Maintenance Facility and also be used for workshops, seminars and training courses. This will increase efficiency and save on venue rental costs for such activities.

Our renovated CTBTO Operations Centre was officially opened on 20 May 2019. The Centre is an integrated facility for monitoring and supporting the operations of the International Data Centre, IMS and OSI, thus allowing for further efficiency gains and savings.

Throughout the year and across the Organization we continued to build synergies, streamline our activities and build on previous efforts to apply best practices and procedures of other international organizations.

I would like to once again express my appreciation to States Signatories for their highly valuable support in 2019. I am also grateful to our staff for their dedication and hard work in serving the cause of the Treaty and meeting the needs of the Organization.



Lassina Zerbo
Executive Secretary
CTBTO Preparatory Commission
Vienna, April 2020

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ABBREVIATIONS

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

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 object 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.

An aerial photograph of a forest with a network of thin lines connecting various trees, suggesting a monitoring system. The lines radiate from several central points, creating a web-like structure. The forest is dense with green trees, and the ground is a mix of light-colored soil and darker patches. A white rectangular box is superimposed over the center of the image, containing the text 'THE INTERNATIONAL MONITORING SYSTEM' in bold, white, uppercase letters.

**THE
INTERNATIONAL
MONITORING
SYSTEM**

HIGHLIGHTS

Reaching the milestone of 300 certified IMS facilities

Sustainment of the IMS network, ensuring a high level of data availability

Identifying the root causes of IMS stations' downtime

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 ('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 2019, following outreach to host States, the Commission made further progress with the installation and establishment of facilities in a number of States. Installation of infrasound station IS25 (France) and radionuclide station RN55 (Russian Federation) was completed. Three IMS facilities were certified (radionuclide station RN48 (Niger), infrasound station IS1 (Argentina) and RL14 (South Africa)) bringing the total number of certified IMS stations and laboratories to 300 (89% of the network foreseen by the Treaty), thus improving both the coverage and resilience of the network.

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 2019 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.

The Commission continued to assess the quality of the laboratory analysis of noble gas data through yearly informal proficiency test exercises (PTEs). The IMS laboratories demonstrated very good performance in 2019. The noble gas proficiency test framework is reaching enough maturity and will become official in 2020. PTEs are a key element of quality assurance and quality control (QA/QC) of IMS laboratories.

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



The radionuclide station in Niger (RN48) was certified in 2019.

STATUS OF THE INSTALLATION AND CERTIFICATION OF INTERNATIONAL MONITORING SYSTEM STATIONS AS OF 31 DECEMBER 2019



286 INSTALLED & CERTIFIED **11** INSTALLED **5** UNDER CONSTRUCTION **3** UNDER NEGOTIATION **16** NOT STARTED

50 PRIMARY SEISMIC STATIONS

- 44 Installed & Certified
- 1 Installed
- 1 Under Construction
- 1 Under Negotiation
- 3 Not Started

120 AUXILIARY SEISMIC STATIONS

- 108 Installed & Certified
- 7 Installed
- 2 Under Construction
- 0 Under Negotiation
- 3 Not Started

11 HYDROACOUSTIC STATIONS

- 11 Installed & Certified

60 INFRASOUND STATIONS

- 52 Installed & Certified
- 2 Installed
- 1 Under Construction
- 0 Under Negotiation
- 5 Not Started

80 RADIONUCLIDE STATIONS

- 71 Installed & Certified
- 1 Installed
- 1 Under Construction
- 2 Under Negotiation
- 5 Not Started

40 NOBLE GAS SYSTEMS

- 25 Installed & Certified
- 31 Installed

16 RADIONUCLIDE LABORATORIES

- 14 Certified Particulate Capability
- 4 Certified Noble Gas Capability

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, 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 2019, 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 2019 was US\$19 595 994. This amount covers the costs related to PCAs for 181 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 2019, 130 out of 165 stations 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 rebuild. 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 in 2019 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 solutions to improve the robustness and resilience of IMS facilities.

The Commission has 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 preventative 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 (CLS) function was established in 2019 and is designated to be a centre of expertise and experience, providing cross-Divisional integrated logistical support. The management and operation of the CTBTO Technology Support and Training (TeST) Centre in Seibersdorf, Austria, also comes under the CLS umbrella.

The Commission continued to develop its capability for supportability analysis to improve planning for recapitalization and sustainment while ensuring overall station operational availability. This activity involved

regular analyses of sparing, lifetime buy and modelling of sustainment data. The Commission continued to develop business intelligence based reports, merging data from various sources, to provide oversight and support decision making.

IMS configuration management was administered ensuring that proposed changes at IMS stations are rigorously assessed to determine their effect and if they can contribute to reducing costs, effort and unforeseen loss of data availability. Furthermore, the changes strengthen overall 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.

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 2019, numerous maintenance requests were addressed, including long running data availability problems at four IMS facilities. The PTS also conducted preventive and corrective maintenance visits at 11 certified IMS facilities. This low figure reflects continued reliance on station operators, contractors and other sources of support to perform such tasks.

The Commission continued to establish and manage long term support contracts with IMS equipment manufacturers and support providers. Some of these contracts were used to address support requirements for on-site inspection (OSI). In addition, the organization established and maintained a number of contracts with suppliers of equipment, material and technical services on a call-off basis. Both long term and call-off contracts ensure that necessary support can be provided to IMS monitoring stations in a timely and efficient manner.

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 2019, 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 2019 in the creation and maintenance of the 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 2019, 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.

Many recapitalization projects were in progress or completed at certified IMS facilities in 2019, involving a substantial investment in human and financial resources. In six cases, namely IS31 (Kazakhstan), IS32 (Kenya), AS85 (Russian Federation), AS110 (United States of America), RN33 (Germany) and RN56 (Russian Federation), recapitalization was followed by revalidation to ensure that the stations continued to meet technical requirements. Revalidation of major upgrades of noble gas systems at three certified radionuclide stations (RN68 (United Kingdom) and RN77 and RN79 (United States of America)) and revalidation of two radionuclide laboratories (RL1 (Argentina) and RL12 (New Zealand)) were also completed.



Recapitalization was followed by revalidation - IS31 (Kazakhstan).

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 2019, 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 2019 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.

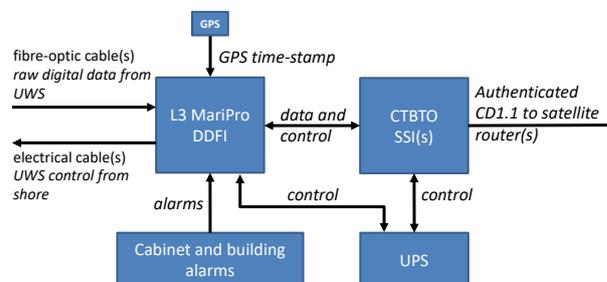
In 2019, the Commission concentrated its engineering efforts on the following:

- Development of standard processes continued for type approval, device acceptance, initial calibration and on-site calibration of seismoacoustic measurement systems with support from the scientific community and national metrology institutes.
- Type approval of new generation of seismoacoustic equipment.
- Collaboration with the International Bureau of Weights and Measures continued on measurement science for IMS seismoacoustic monitoring technologies.
- Further development of the standard station interface (SSI) software to fulfil the latest IMS requirements for authentication and calibration, improve software robustness, improve the graphic interface and enhance the provision of valuable state of health information to station operators.
- A set of standard solutions for IMS power systems was developed, tested and approved with the objective of improving IMS station power availability and quality.
- Digital meteorological data recording solutions continued to be deployed at IMS infrasound stations to improve the availability and quality of meteorological measurements.
- Efforts for the sustainment of the hydroacoustic network continued through station performance

monitoring and identification of options for modular design(s). A hybrid modular design concept was identified as the optimal approach to enable reparability of individual nodes and underwater system sub-components, while at the same time maintaining the advantages of the proven and safe linear deployment of the present systems. The prototype requirements and possible test beds for at sea testing were identified. The procurement process for the engineering study and pertinent components to establish the feasibility of a prototype node concept progressed.

- The development of the new Central Recording Facility Digital Data Formatter Interface (DDFI) Enhanced Backfilling and Diagnostic Capability Engineering Services is foreseen to enhance the resilience and further reduce data loss of IMS hydroacoustic hydrophone stations. Additional capabilities for complete remote diagnostics of the DDFI and underwater system will also be developed. This project encompasses development work on both the DDFI and the SSI side.
- Started the evaluation of two next-generation noble gas systems following the guidelines of the acceptance process established in 2018 for their testing and integration.

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 quality of data processing and of data products.



High level schematic of the data flow inside an IMS hydroacoustic hydrophone station Central Recording Facility.

Auxiliary Seismic Network

The Commission continued to monitor the operation and sustainment of auxiliary seismic stations in 2019. 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.



Corrective maintenance action at AS030 (Ethiopia) under EU funding.

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 2019 continued to focus on measures for data surety and calibration.

The Commission further developed its calibration methodologies. In particular, on-site infrasound calibration capability was established at four infrasound stations during 2019 (IS1 (Argentina), IS31 (Kazakhstan), IS32 (Kenya) and IS48 (Tunisia)). The Commission also continued

the scheduled calibration of primary and auxiliary seismic, infrasound stations and T phase stations and advanced the deployment of the SSI calibration module throughout the IMS seismic network.

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 2018 PTE and conducted the 2019 PTE. The Commission also undertook a laboratory surveillance visit to radionuclide laboratory RL9 (Israel).

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.



Corrective maintenance action at AS120 (Zimbabwe) under EU funding.

PROFILES OF THE MONITORING TECHNOLOGIES





Seismic Stations

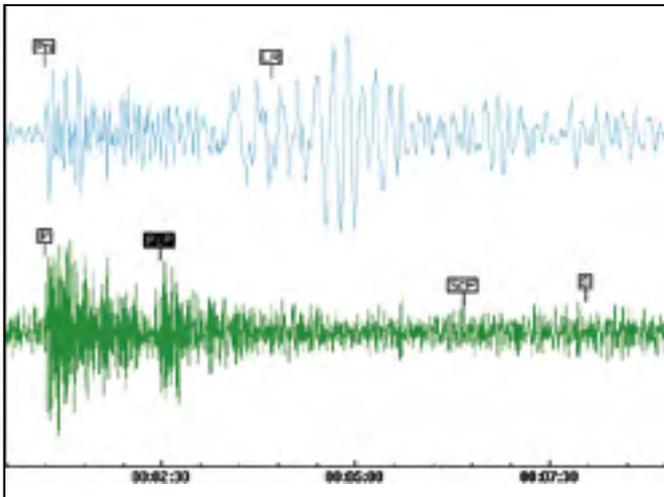
The objective of seismic monitoring is to detect and locate underground nuclear explosions. Earthquakes and other natural events as well as anthropogenic events generate two main types of seismic wave: body waves and surface waves. The faster body waves travel through the interior of the earth, while the slower surface waves travel along its surface. Both types of 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.

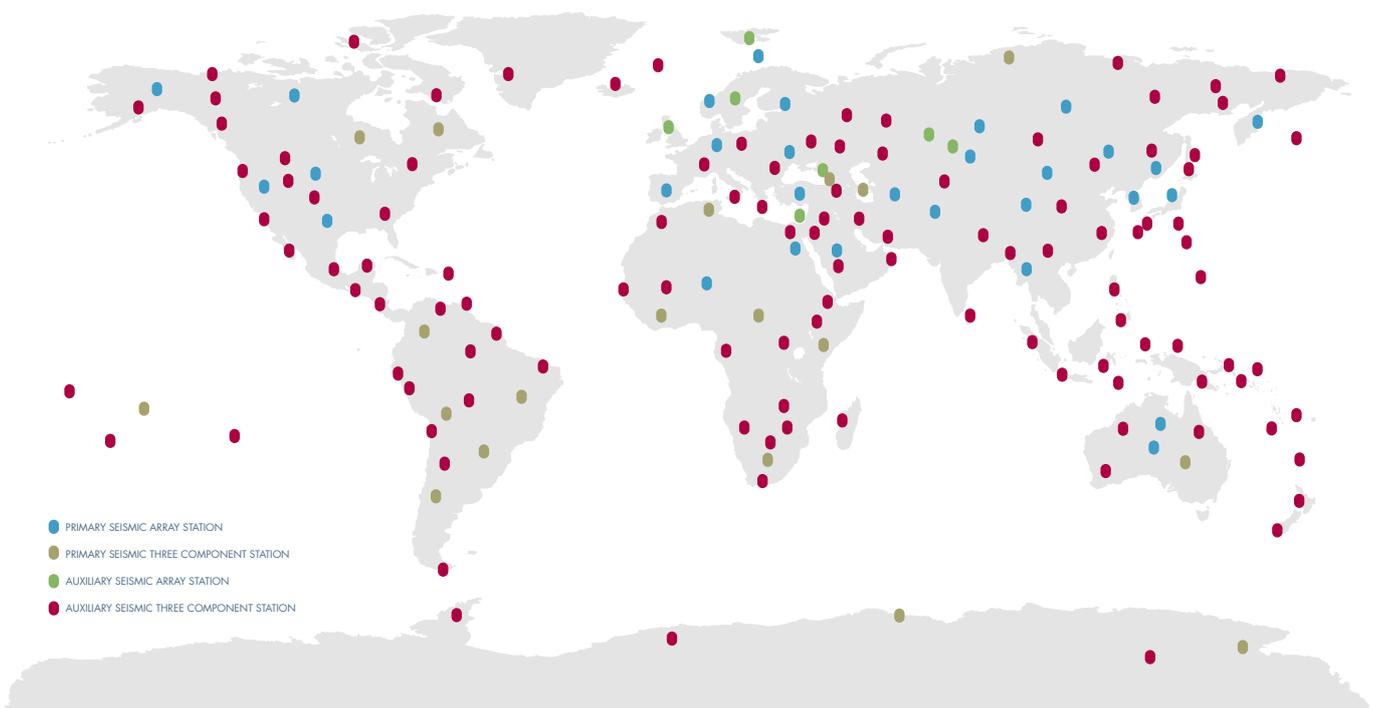
The IMS has primary and auxiliary seismic stations. Primary seismic stations send continuous data in near real time to the IDC. Auxiliary seismic stations provide data on request from the IDC.

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 seismic network is mostly composed of arrays (30 of 50 stations), while the auxiliary seismic network is mostly composed of 3-C stations (112 of 120 stations).



Example of seismic waveform.





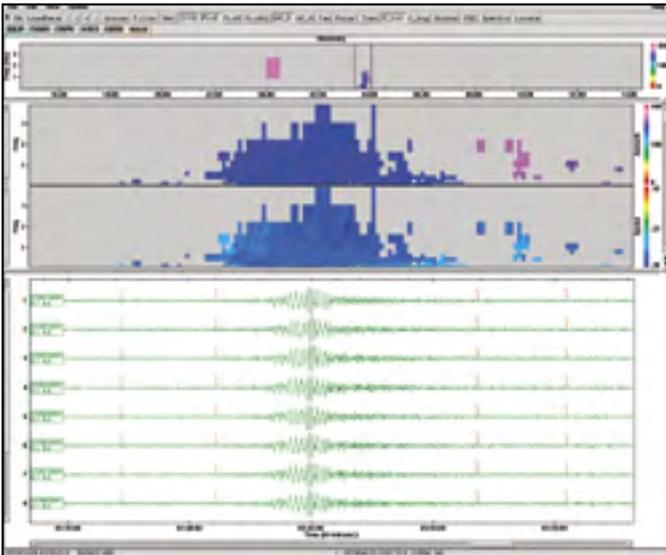
Infrasound Stations

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

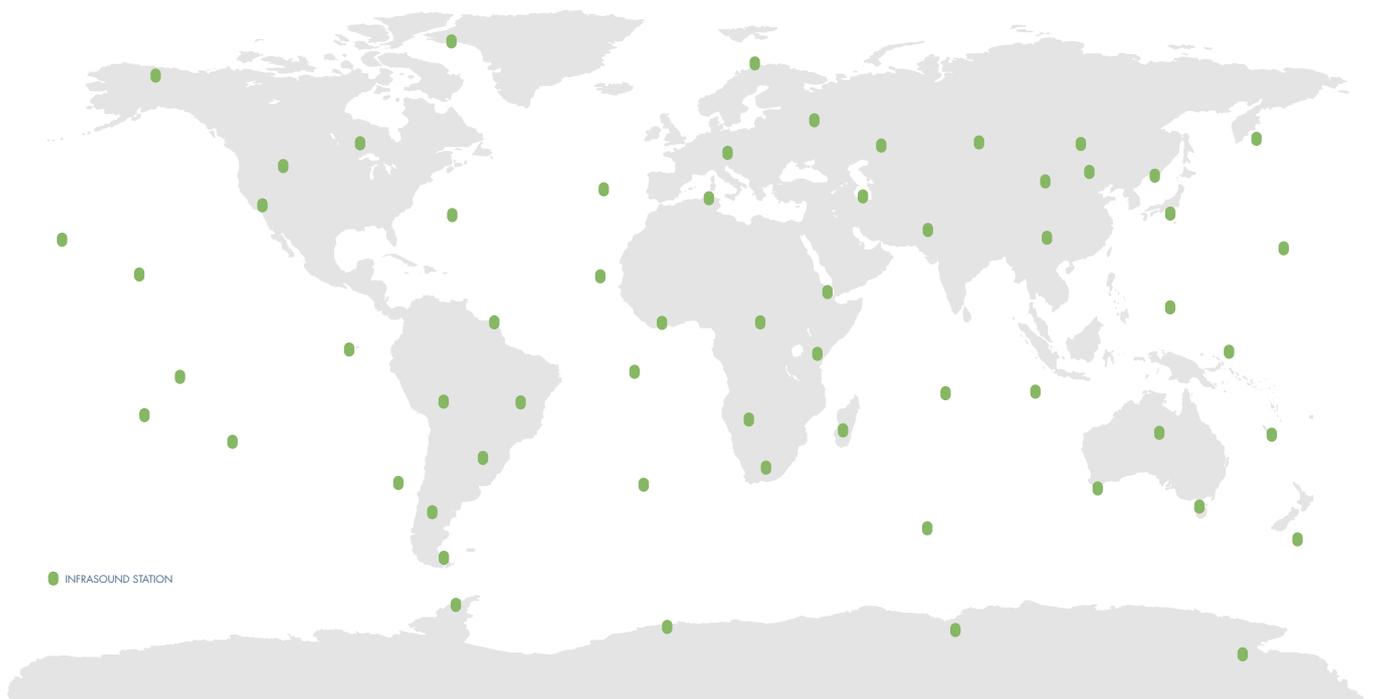
Infrasound waves cause minute changes in the atmospheric pressure that are measured by microbarometers. Infrasound has the ability to cover long distances with little dissipation, which is why infrasound monitoring is a useful technique for detecting and locating atmospheric nuclear explosions. In addition, 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.

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.



Example of infrasound waveform.





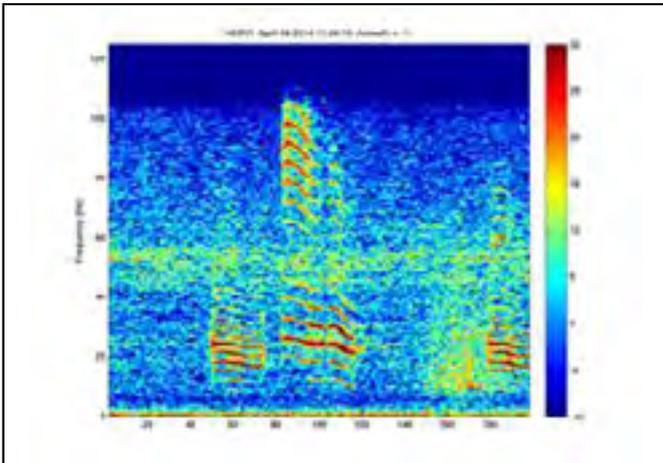
Hydroacoustic Stations

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

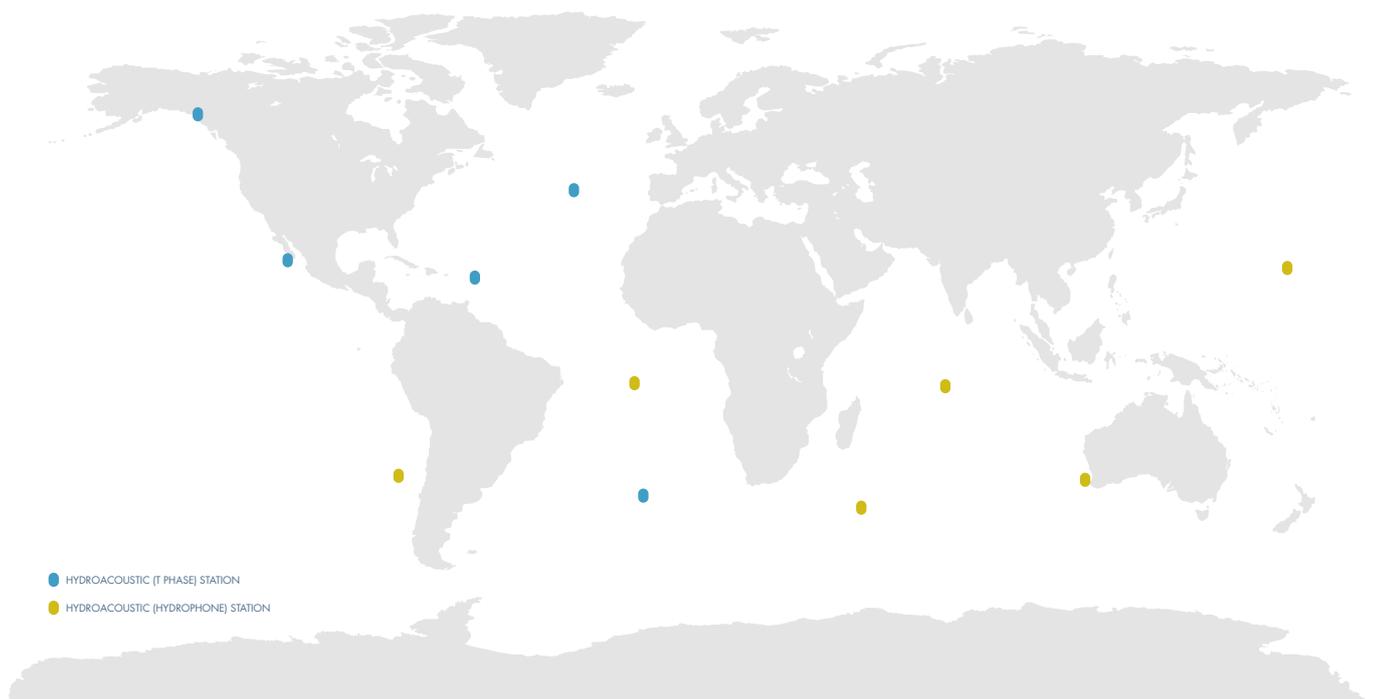
Hydroacoustic monitoring involves recording signals that show changes in water pressure generated by sound waves in the water. Owing to the efficient transmission of sound through water, even comparatively small signals are readily detectable at large distances. Thus 11 stations are sufficient to monitor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

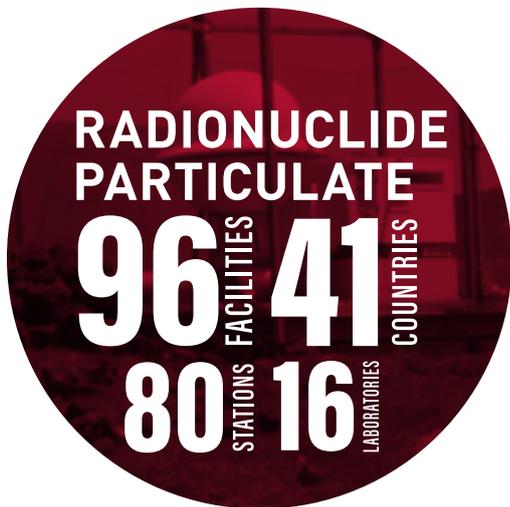
There are two types of hydroacoustic station: underwater hydrophone stations and T phase stations on islands or on the coast. Underwater hydrophone stations are among the most challenging and costly monitoring stations to build. They must be designed to function in extremely inhospitable environments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

The deployment of the underwater parts of a hydrophone station (i.e. placing the hydrophones and laying the cables) is a complex undertaking. It involves the hiring of ships, extensive underwater work, and the use of specially designed materials and equipment.



Example of hydroacoustic waveform, Pacific whale vocalization spectrogram.





Radionuclide Particulate Stations

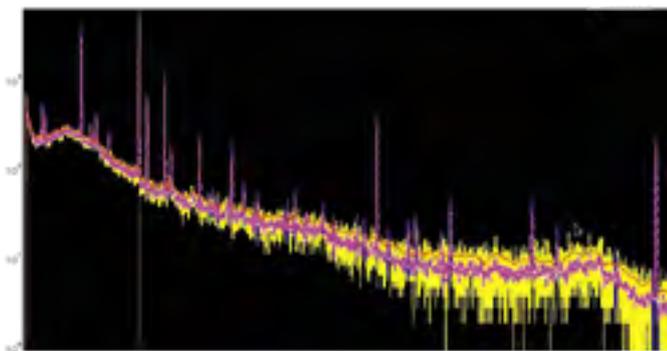
Radionuclide monitoring technology complements the three waveform technologies employed in the Treaty verification regime. It is the only technology that is able to confirm whether an explosion detected and located by the waveform methods is indicative of a nuclear test. It provides the means to identify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

Radionuclide stations detect radionuclide particles in the air. 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.

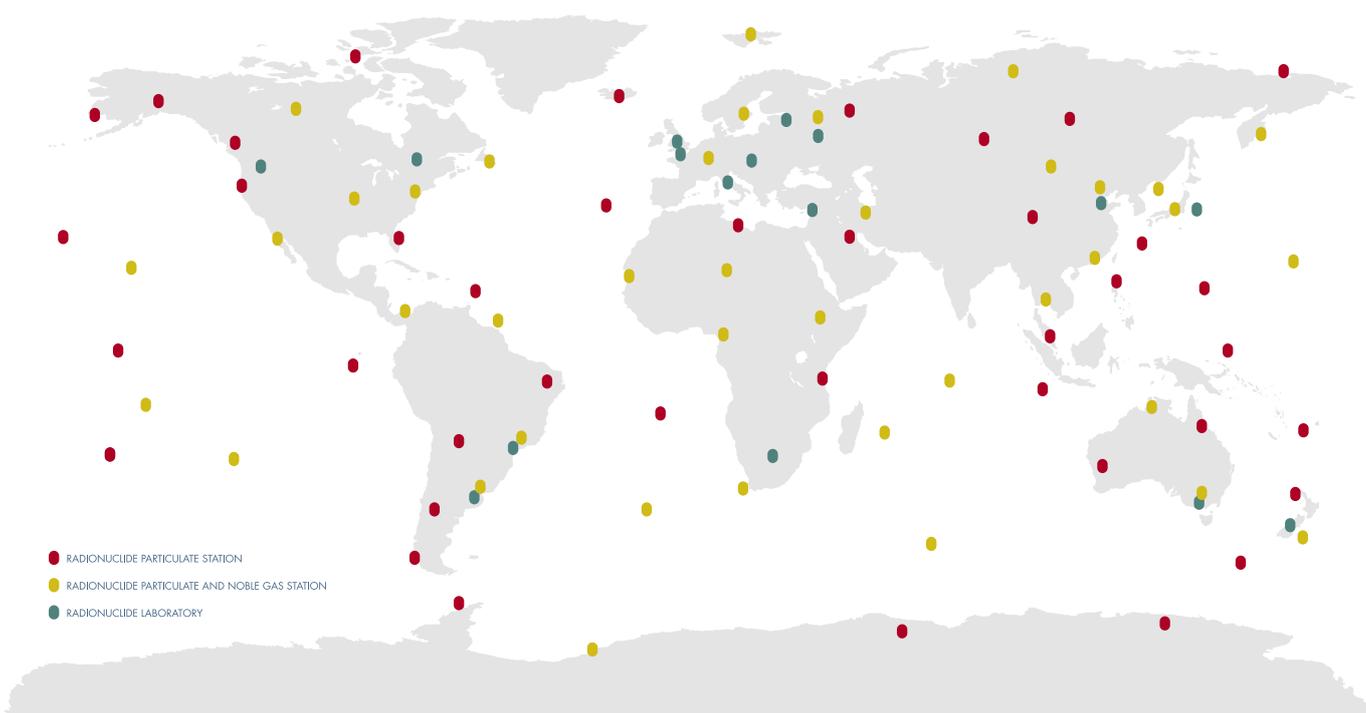
Noble Gas Detection Systems

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.



Example of gamma spectra.



All of the noble gas detection systems in the IMS work in a similar way. Air is pumped into a charcoal-containing purification device in which xenon is isolated. Contaminants of different kinds, such as dust, water vapour and other chemical elements, are eliminated. The resulting air contains higher concentrations of xenon, in both its stable and unstable (i.e. radioactive) forms. The radioactivity of the isolated and concentrated xenon is measured and the resulting spectrum is sent to the IDC for further analysis.

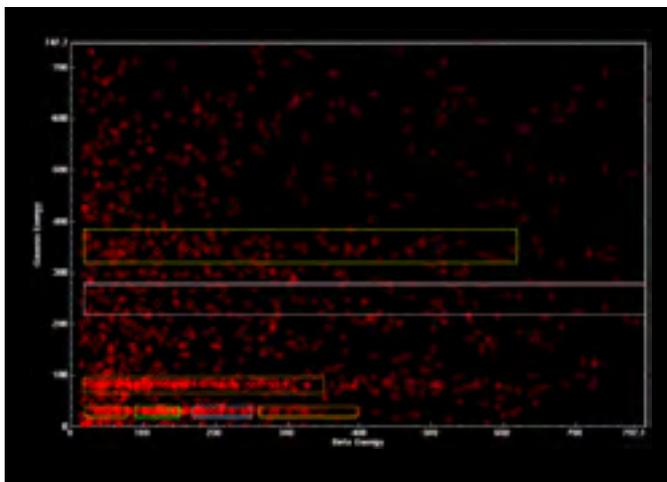
Radionuclide Laboratories

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

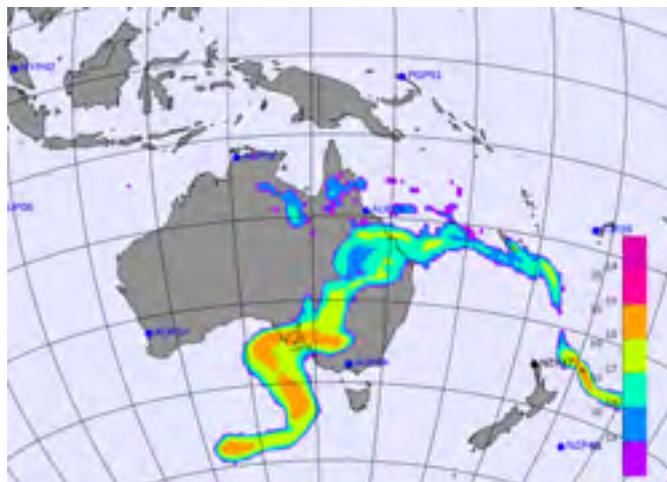
The radionuclide laboratories are certified under rigid requirements for analysis of gamma spectra. The certification process provides assurance that the results provided by a laboratory are accurate and valid. These laboratories also participate in the annual PTEs organized by the Commission. In addition,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



South African radionuclide laboratory (ZAL14) – operating shield door.



Example of beta-gamma spectra.



Example of atmospheric transport modelling.

A large satellite dish antenna structure is the central focus, set against a dark blue twilight sky. The dish is supported by a complex metal framework. In the foreground, a person stands with their back to the camera, looking towards the structure, providing a sense of scale. To the left, there are some trees and a fence. To the right, there is a structure with a red and white striped awning. The overall scene is dimly lit, emphasizing the silhouette of the antenna.

THE GLOBAL COMMUNICATIONS INFRASTRUCTURE

HIGHLIGHTS

High GCI availability maintained through 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

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.

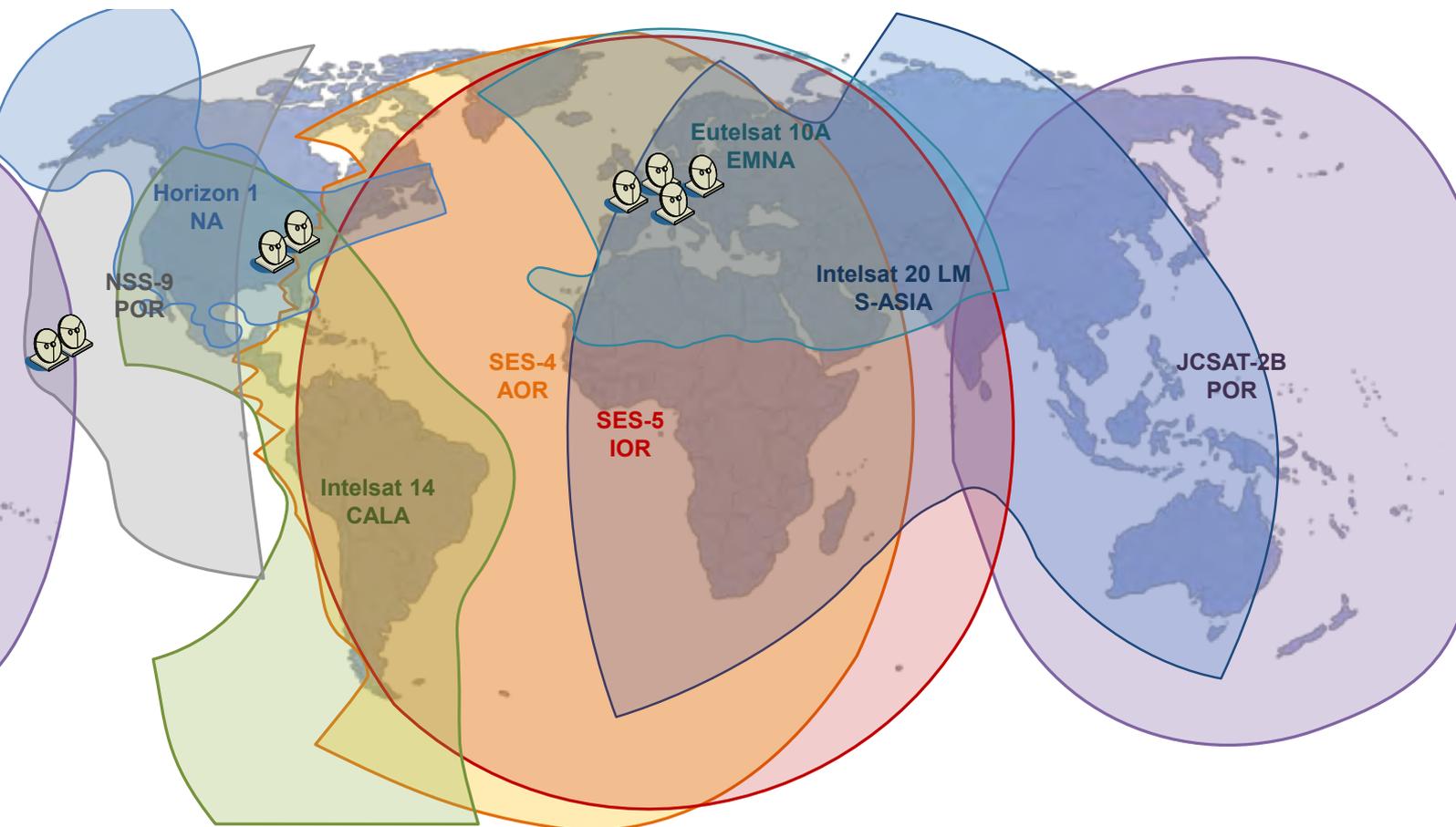
At the end of 2019, the GCI network included 264 redundant links. Of these, 206 are primary VSAT links backed up by 3G (117 links), BGAN (77 links), VPN (6 links) or VSAT (6 links). There are also 41 VPN links with VPN or 3G backup, 10 links with 3G primary and BGAN backup and 7 terrestrial multiprotocol 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 one year using a rolling 12 month availability figure. In 2019, the absolute availability was 98.32%. 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





GCI III installation on the roof of the Vienna International Centre, Austria.



**THE
INTERNATIONAL
DATA CENTRE**



HIGHLIGHTS

Establishment of an integrated CTBTO/
PTS Operations Centre

Conduct of Experiment 4 as part of IDC
commissioning under the PTS
performance monitoring and testing
framework

IDC software enhancement

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 more than 15 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.

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). 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.

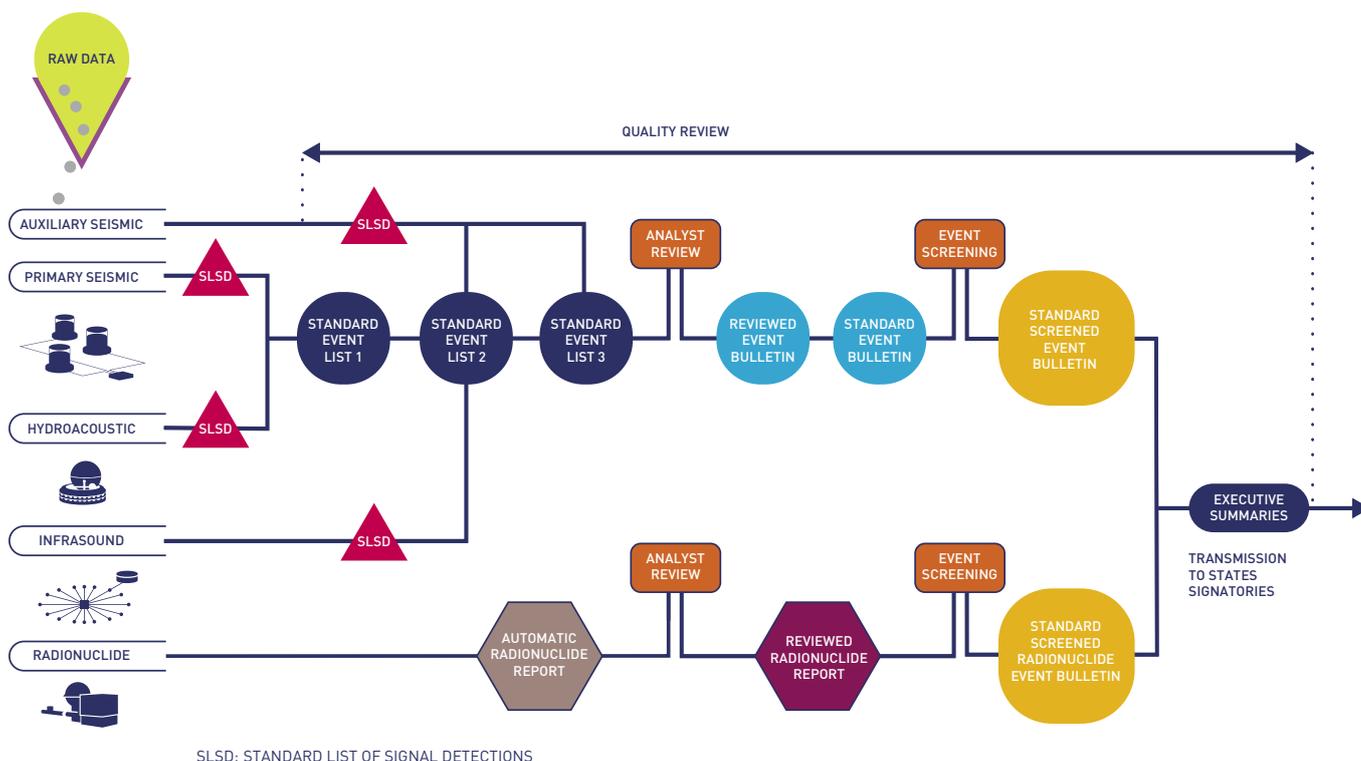
Radionuclide Measurements and Atmospheric Modelling

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.

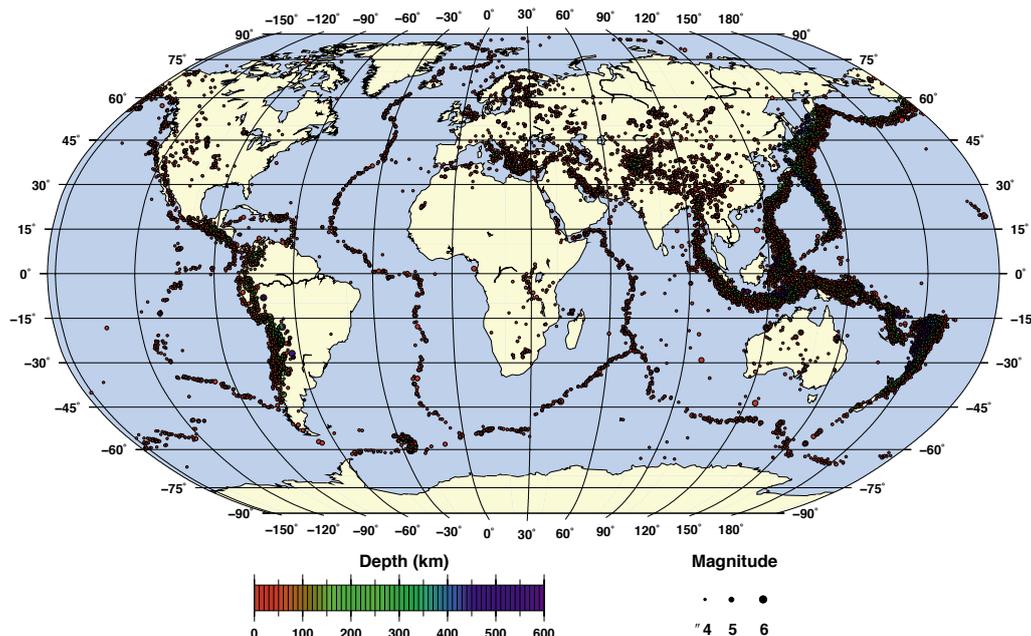
The Commission performs daily atmospheric backtracking calculations for each of the IMS radionuclide stations with near real time meteorological data obtained from the European Centre for Medium-Range Weather Forecasts (ECMWF) and from the National Centres for Environmental Prediction (NCEP). Images 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

INTERNATIONAL DATA CENTRE STANDARD PRODUCTS



2019 REVIEWED EVENT BULLETIN (35 394 EVENTS)



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.

Establishment of Integrated Operations Centre

In May 2019, the PTS established a state of the art CTBTO/PTS Operations Centre (COPC). The COPC is an expansion of the previous IDC Operations Centre that now provides an integrated operations facility for monitoring the operations of the IMS and the IDC. The centre also serves as the location for a potential deployment of the ad hoc OSI Operations Support Centre (OSC).

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:

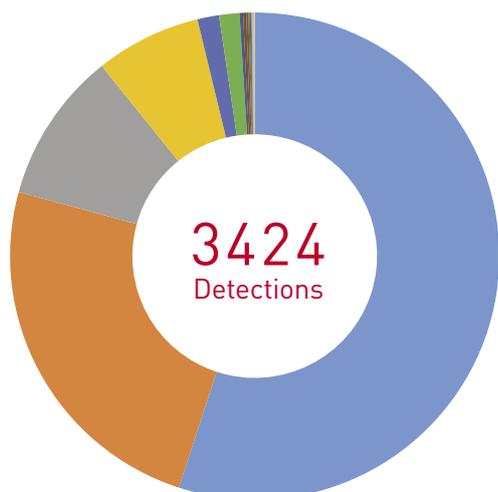
- The Progressive Commissioning Plan itself;
- Draft Operational Manuals, which set requirements;
- The validation and acceptance test plan;
- A review mechanism, which allows States Signatories to determine if their verification requirements can be met by the system.

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.

During 2019, the PTS conducted Experiment 4, a two week test of various capabilities of the IDC and IMS. The experiment used a subset of the tests described in the validation and acceptance test plan as its basis and provided valuable information that will be used in conducting and evaluating future experiments and tests of IDC capabilities as part of the IDC progressive commissioning process.

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 involved technical meetings, interaction on the Experts Communication System (ECS) and discussions during sessions of Working Group B (WGB).

TREATY RELEVANT RADIONUCLIDES DETECTED IN 2019



| | | |
|--|-------------|------------|
| NA-24 (1884) | TC-99M (46) | CO-57 (2) |
| CS-137 (829) | SB-122 (8) | EU-155 (2) |
| CO-60 (343) | I-133 (7) | NB-95 (2) |
| I-131 (239) | ZN-69M (5) | ND-147 (2) |
| CS-134 (49) | CO-58 (3) | ZN-65 (2) |
| Nuclides with one occurrence: AG-111, AU-198, BA-133, CE-143, CE-144, CR-51, FE-59, I-130, K-42, MN-54, PD-112, SC-46, Y-93, ZR-89, ZR-95, ZR-97 (1) | | |

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.

To ensure an effective information security programme, the Commission continued to roll out 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 Commission also developed a framework for security policies which serves as a foundation for the phased implementation of best practices.

Software Enhancements

The IDC is continuing with the migration to open source software and unifying the review tools used by analysts for radionuclide data. The new tool under development, the iNTEGRAted Software Platform for the Interactive Review (iNSPIRE), is intended to replace the Saint2 and Norfy software applications. An updated release of iNSPIRE, with all previously reported issues corrected and new features implemented, was prepared for further testing before deployment in IDC operations. This first release covers the functionalities for beta-gamma noble gas data analysis.

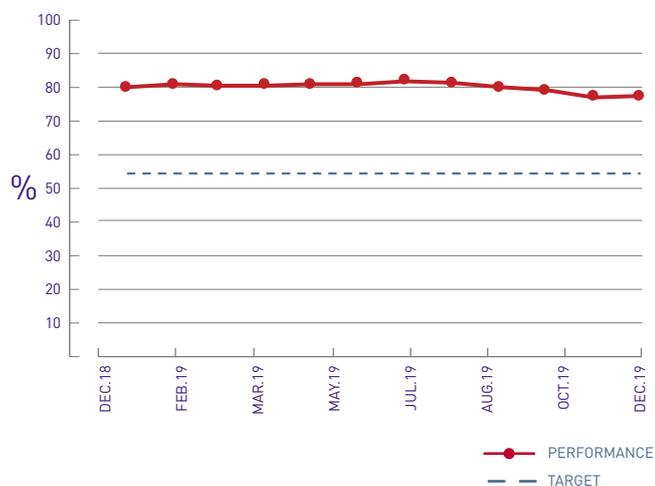
With the aim of further enhancing the quality of IDC products by reducing the rate of false positives in sample spectra of beta-gamma coincidence based noble gas systems, an alternative configuration of the so called standard Net Count Calculation (NCC) method was deployed in IDC operations.

To ensure synergy between IDC software developments and radionuclide applications of NDC in a box, an updated version of the radionuclide software modules that included features implemented in IDC operations in 2017 was incorporated into the new release of NDC in a box in May 2018. The improvements and new features were aimed at improving the quality of automatic processing results and significantly reducing the workload of NDC analysts.

Within the ongoing acceptance testing by the Commission of next-generation noble gas systems, SAUNA III started phase 2 in Charlottesville (United States of America) in July 2019 and the next-generation SPALAX system started sending data from Ottawa (Canada) in December 2019. The systems were successfully configured in the IDC test bed where the data is processed automatically and reviewed interactively for continuous assessment of system performance. Timely feedback is provided to the vendors as appropriate. The IDC has also validated detector calibrations of two other systems: Xenon International (United States of America) and MIKS (Russian Federation).

The IDC is developing a new software application for radionuclide data processing. The 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

CORRECTLY CATEGORIZED AUTOMATICALLY PROCESSED RADIONUCLIDE SPECTRA



language based licence-free application using shared libraries with iNSPIRE. A first release which handles data from beta-gamma coincidence based noble gas systems, including high resolution detectors (next-generation SPALAX), is deployed in the IDC development environment.

With the aim of replacing the current Monte Carlo N-Particle transport licence based code Virtual Gamma Spectroscopy Laboratory, the IDC initiated the development of an open source Monte Carlo (Geant 4) 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. In addition, the new tool will be integrated in future releases of the radionuclide NDC in a box software package. A first release of GRANDSim with particulates functionality is installed in the IDC development environment.

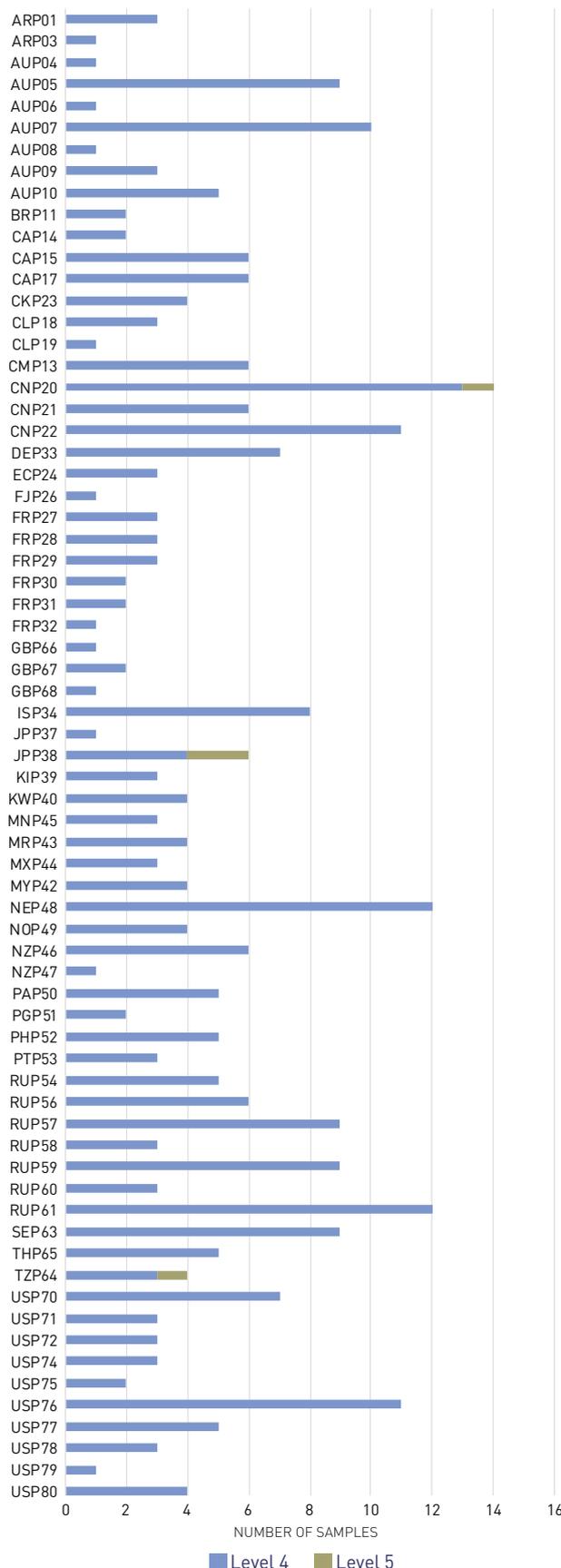
A major upgrade to the seismic, hydroacoustic and infrasound components of the NDC in a box software package was released in June 2019. This release integrates major updates of Seiscomp3, Geotool, DTK-(G)PMCC and uses a simplified distribution method, responding to a request from NDCs. Monthly configuration updates have already included updates to SeisComp3 and DTK-GPMCC. 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 to assess the degree to which the components of NDC in a box are used by NDC staff. A total of 416 authorized users, representing 113 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 was used for numerous training sessions, such as the advanced infrasound training with the support of the Commissariat à l’Energie Atomique et aux énergies alternatives (CEA), held in Bruyères le Châtel, France, on 14 to 18 October 2019.

The Commission continued to make progress on improving regional seismic travel times (RSTT) with the organization of a workshop in Chiang Mai, Thailand, from October to November 2019, and the planned implementation of the travel time corrections based on the RSTT model in combination with the NET-VISA software used by analysts to complement the SEL3 bulletin.

The Commission also continued to develop new automatic and interactive software that uses state of the art machine learning and artificial intelligence. The NET-VISA software is run in parallel to SEL3 processing and results have been presented to analysts since 2018, improving the missed events rate by a factor of about 10%. A further step is being tested where the software is used in all three Standard Event Lists, and the automatic events in SEL1 and SEL2 form the basis to request data from auxiliary seismic stations, paving the way to full replacement of the global association software.

RADIONUCLIDE EVENTS RECORDED BY IMS STATIONS IN IDC OPERATIONS IN 2019



Note: An event is level 4 if the sample contains an anomalously high concentration of a relevant anthropogenic radionuclide; it is level 5 if the sample contains a number of anthropogenic radionuclides at anomalously high concentration and at least one is a fission product.

The redesigned detector and interactive review tools based on progressive multichannel correlation DTK-PMCC and DTK-GPMCC, respectively, made major steps forward in 2019, both towards full compliance 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 in the autumn of 2019. The implementation in IDC Operations started and will be completed in 2020. The processing of data from hydrophone triplets has been evaluated offline in the IDC development pipeline.

Phase 2 of IDC re-engineering, a project initiated in January 2014, was completed in April 2017 and delivered a software architecture that is intended to guide the further development and sustainment of waveform processing software. The IDC is now in Phase 3 of re-engineering. The initial two releases of open source geophysical monitoring system software have been received, and the PTS is performing testing and integration of the December 2019 delivery. IDC components will be progressively integrated into the system over the coming years until the re-engineered system is fully functional and has replaced the phase 2 architecture.

In March 2019 the atmospheric transport modelling (ATM) pipeline was migrated to new servers. There were several upgrades to the ATM software to facilitate the transition and the future maintenance of the pipeline. It includes a new configuration management approach, preparation for continuous delivery, an operating system upgrade to Red Hat Enterprise Linux 7 and numerous other improvements. An updated ATM configuration with increased temporal (from three hours to one hour) resolution is in development in IDC.

Work on enhancements of WEB-GRAPE (desktop version) continued. In July 2019, the new WEB-GRAPE version 1.8.5, and related documentation were disseminated on the secure web portal. The new version 1.8.5 is compiled with interactive data language version 8.7. It includes several enhancements such as parallelization of the NET-MDC (network coverage) calculation in order to improve performance.

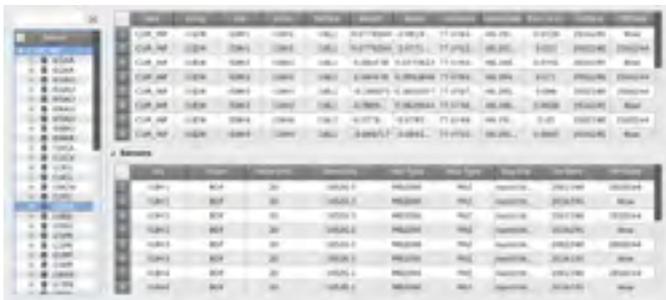
The work to enhance the WEB-GRAPE Internet based service resumed in October 2018. One of the main objectives is containerization of the application which will allow demand based automatic resource allocation, i.e. managing periods of peak loads. At the same time the work on implementing the new functionality, existing in the WEB-GRAPE desktop version, called network coverage, is progressing.

International Noble Gas Experiment and Atmospheric Radionon Background

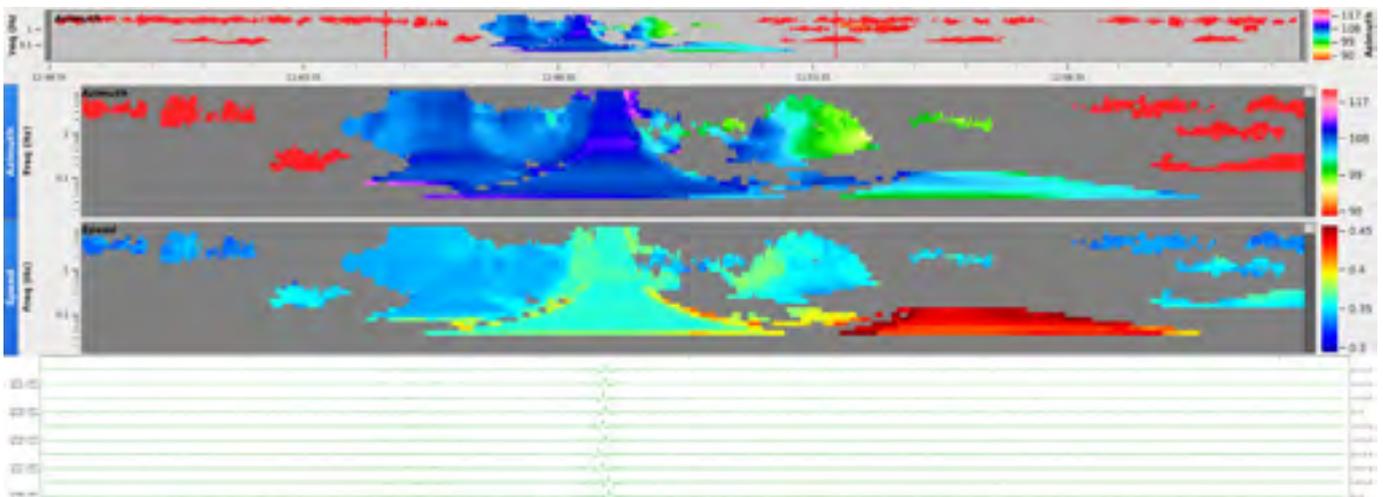
The 31 noble gas systems that are in provisional operation at IMS radionuclide stations continued to send data to the IDC in 2019. The 25 certified systems sent data to IDC Operations, while data from the remaining 6 non-certified systems were processed in the IDC test bed. The Commission made significant 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 radionon 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 radionon background, which started in December 2008, continued in 2019. 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 2019, 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 for better identifying the source of events that cause the frequent radionon detections at radionuclide station RN38 in Takasaki, Japan. These methods will be applied to all



Redesigned interface from DTK-GPMCC for accessing and interactively modifying array station information.



Main window of the redesigned interactive review software for waveform data, DTK-GPMCC. Example for station IS37 in Norway with summary panel (top), attributes panels with back-azimuth and trace velocity (middle) and filtered array waveforms (bottom).

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 will be deployed to a new site in Fukuoka, Japan, 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 Organisation to provide data for tsunami warning purposes. By the end of 2019, 17 such agreements or arrangements had been made with organizations in Australia, 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.

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 2019. The infrasound technology continued to attract interest beyond the verification regime. The Commission collaborated with the University of Oldenburg in Germany on a near real time monitoring system for atmospheric impacts from small near-earth objects, and the results were presented at the CTBT: Science and Technology 2019 conference (SnT2019) in the scientific session, and during a panel discussion dedicated to 'Civil Applications: Towards Monitoring Near Earth Objects Impacting the Atmosphere'.

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 eruption of the Stromboli volcano, Italy, on 3 July 2019 was used as a training exercise for the intermediate infrasound training held in Bucharest, Romania from 15 to 19 July 2019.



The eruption of the Stromboli volcano, Italy, on 3 July 2019 was used as a training exercise for the intermediate infrasound training held in Bucharest, Romania from 15 to 19 July 2019. The figure displays the obtained eruption location from IMS infrasound observations and visual observation of the eruption (Source: © Y. Xu & S. Berziga / Licet Studios).

The Commission collaborated with the Volcanic Ash Advisory Centre in Toulouse, France, under the patronage of the WMO, the International Civil Aviation Organization and the Atmospheric dynamics Research InfraStructure in Europe project to develop an infrasound volcanic information system. Progress was presented in scientific sessions of SnT2019 and during a panel discussion dedicated to civil applications of IMS data.

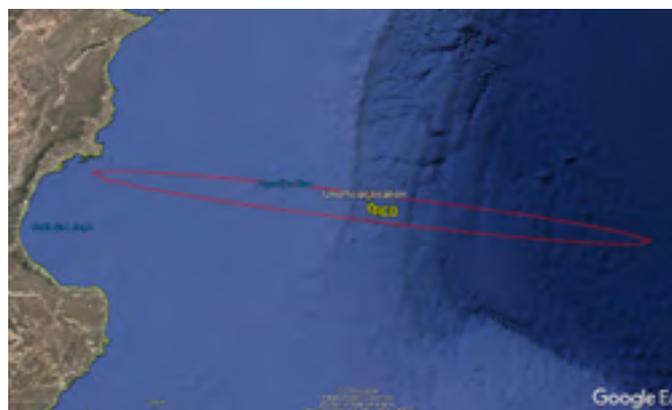
At the end of 2018, the Commission began its collaboration with the NDC of Costa Rica, leading to the installation of a portable infrasound array at the La Selva Biological Station. The data from the campaign was used for the Latin American and Caribbean Regional Infrasound Workshop and Integrated Training that was held in San Jose, Costa Rica, from 25 February to 1 March 2019. The collaboration lasted until October 2019 and results were presented at the Infrasound Technology Workshop 2019, held from 10 to 14 November 2019 in Aqaba, Jordan.

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 2019, the Commission participated in the international ConvEx exercises and in the first task group meeting for ConvEx-3 (2021).

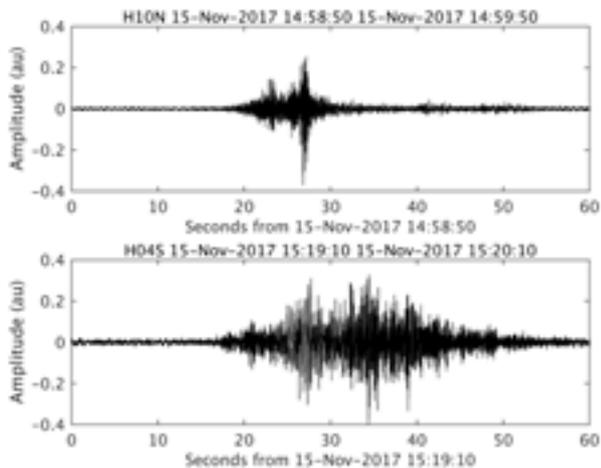
The range of scientific applications of IMS data is increasing, including to studies of marine life, the environment, climate change and other areas. Several new contracts for cost-free access to specific IMS data through the virtual Data Exploitation Centre were signed with academic institutions.

SEARCH FOR THE ARGENTINIAN SUBMARINE ARA SAN JUAN

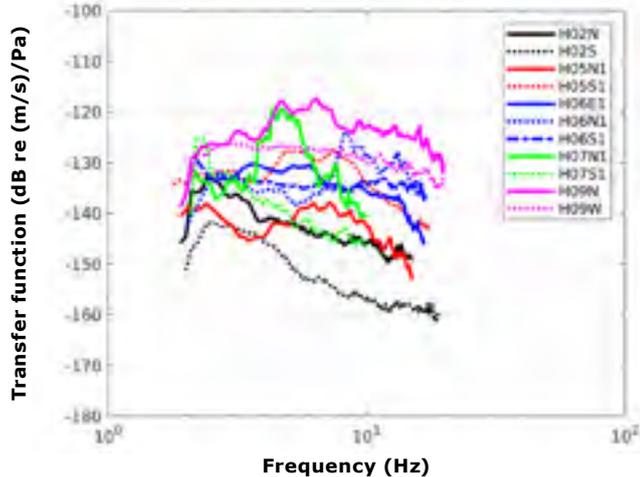
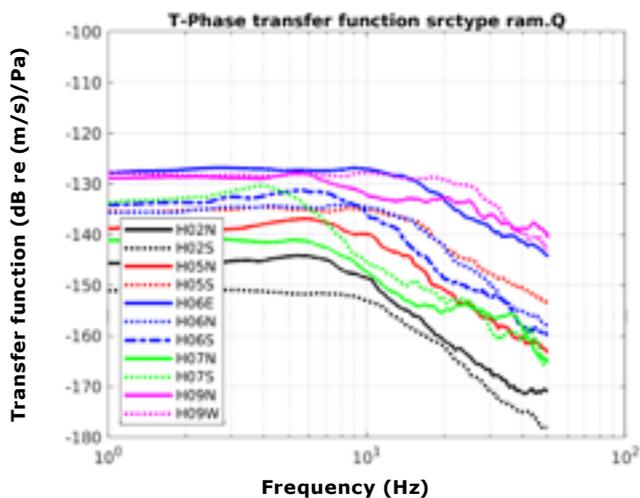
The joint effort of the IDC and the IMS in data analysis and interpretation relating to the Argentinian submarine *ARA San Juan* continued in 2019. Data analysis was further refined and increased complexity in ocean acoustic propagation modelling was performed to assist in the interpretation of data and to support hypotheses about the unusual signal recorded by hydroacoustic stations HA10 and HA4 on 15 November 2017. Fruitful scientific interaction, exchange of expertise and collaboration with experts of the Argentinian Navy continued in 2019 particularly during



Estimated location of the unusual signal recorded by hydroacoustic stations HA10 and HA4 on 15 November 2017 (red dot) and the associated error ellipse (red ellipse). The white error ellipse is the result of adding non-IMS seismometer data to the location estimation based on IMS hydroacoustic data. The yellow dot indicates the reported location of the *ARA San Juan* announced on 16 November 2018.



Time series recorded at the IMS hydroacoustic station H10N (upper) and H04S (lower) originating from the same event on 15 November, 2017.



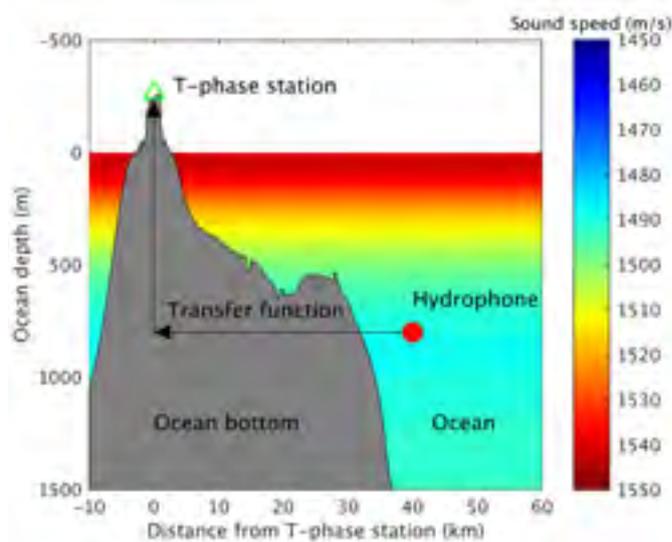
Calculated (above) and observed (below) smoothed signal amplitude transfer functions at all the IMS T phase stations.

the International Hydroacoustic Workshop held at the Commission's premises in Vienna from 8 to 11 July 2019. The scientific findings obtained from the data analysis and computations were presented on numerous occasions to both scientific and non-expert audiences.

ENHANCED HYDROACOUSTIC AND SEISMIC WAVEFORM MODELLING

The project on "Canonical Solutions for Seismo-Acoustic Propagation in Coastal Environments to Support Analysts in Identifying Phases at T-stations" concluded on 23 November 2019.

The project used traditional underwater signal propagation models, and the recently developed numerical model SPECFEM based on spectral finite elements that handles combined acoustic and elastic computational domains. The model was applied to simplified synthetic scenarios and more complex scenarios simulating the environment in the vicinity of the deployed IMS T phase stations. The results provide insight into environmental parameters responsible for the conversion of in-water acoustic waves to elastic waves recorded at the station and allow better understanding of the way in-water (pressure) transform to in-ground seismic waves and vice versa.



An illustration of the proposed methodology to detect and classify hydroacoustic events originating in the ocean by measuring in-ground seismic signals at T phase stations (green triangle).

CTBT: SCIENCE AND TECHNOLOGY 2019 CONFERENCE

The SnT2019, the fifth in the series, was held in Vienna from 24 to 28 June 2019. The conference achieved its major goals including strengthening the engagement of the scientific communities working in test ban monitoring, including young scientists, and to enhancing the geographic and gender representations of these communities. Participants identified and discussed opportunities and possible solutions to continuously improve nuclear test monitoring and verification, how scientific developments and cooperation can support national needs and frame policy objectives in support of the CTBT, and how to promote the wider civil and scientific applications of techniques and data used for test ban verification. The conference covered five main themes: (1) the earth as a complex system, (2) events and nuclear test sites, (3) verification technologies and technique application, (4) performance optimization and (5) CTBT in a global context. Topics within each theme were elaborated on through discussions and presentations. The programme also featured 21 panel discussions, two of which were multilingual. The number of presentations was notably very high, with 120 oral presentations and 342 poster presentations.



The CTBT: Science and Technology conference took place from 24 to 28 June 2019 in the Hofburg Palace, Vienna, Austria.



The conference attracted a record number of participants.



Closing Session and Award Ceremony, Hofburg Palace, Vienna, Austria.



The CTBT: Science and Technology conference 2019 was the fifth in the series of conferences.

A person wearing a full-body yellow hazmat suit, including a hood and a white respirator mask, is walking through a field of dry grass. They are holding a handheld electronic device with a screen and buttons. A piece of equipment with a wheel and a yellow component is visible in the lower right corner. The background shows a flat, open landscape under a hazy sky.

ON-SITE INSPECTION

HIGHLIGHTS

Implementation of the OSI action plan for 2016-2019 and the OSI exercise plan for 2016-2020

Training courses of the third training cycle for inspectors

Construction of a permanent Technology Support and Training Centre incorporating an Equipment Storage and Maintenance Facility

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 an OSI can be invoked by any State Party 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 (IFE), 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

Activities during 2019 focused on continuing the implementation of the OSI action plan for 2016-2019 and the activities of the OSI exercise plan for 2016-2020, which is derived from the review and evaluation process of the 2014 IFE. Action plan projects and exercises aim to further OSI capabilities towards the establishment of a balanced, coherent and robust verification regime when the Treaty enters into force, within an integrated PTS-wide development, testing, training and exercise framework. The plans were presented to the Forty-Sixth Session of WGB and approved by the Commission at its Forty-Sixth Session in June 2016.

The OSI action plan for 2016-2019 comprises 43 projects categorized into five categories: policy development, methodology and documentation, operations and operations support, techniques and equipment development, and inspectorate development and infrastructure development.

During 2019, 22 projects were under implementation. All 43 projects of the action plan were completed, addressing 85% of the recommendations from previous build-up exercises (BUEs) and the 2014 IFE as contained in the OSI database of issues and lessons identified.

POLICY PLANNING AND OPERATIONS

OSI policy planning and operations efforts during 2019 were closely related to the implementation of OSI action plan projects and the OSI exercise plan, including overall coordination of the action plan and the management of four individual projects.

The inspection team functionality manual and the SOP on field team functionality were formally approved. Following recommendations from OSI Workshop-24, a report was drafted investigating the effects of extreme environmental conditions on an OSI with gaps identified.

The last phase of the Geospatial Information Management for OSI (GIMO) system was completed on the basis of recommendations and lessons from the 2014 IFE. An advanced version of GIMO was successfully tested during the first BUE covering the launch phase (BUE-L). The OSI databank was updated and integrated with other OSI databases and GIMO.

The OSI OSC was integrated into the new COPC at the Vienna International Centre (VIC). The COPC incorporating the OSC was inaugurated in May 2019 and successfully tested during BUE-L.

OSI communications equipment underwent maintenance and updating, and some of it was used in training and testing activities. An expert meeting on the use of the OSI VSAT system for satellite communication during OSI activities was conducted in Vienna. An assessment of the equipment and identification of hardware and contractual issues for the use of VSAT in a GCI III environment in the next BUEs was conducted. A roadmap for the implementation of VSAT communication in the BUEs was developed.

Capability gaps in the health and safety equipment portfolio were filled on the basis of recommendations from OSI Workshop-23. Medical equipment upgrades were procured and brought into service. An updated health and safety standard and manual were drafted and entered the review process.



GATR Antenna Systems deployable satellite communication terminal at the TeST Centre.

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 legal agreement with Slovakia on the hosting of field exercises covering the initial period (BUE-IN) and the continuation period and post-inspection activities (BUE-C) in June and September 2020, respectively, was concluded. Several coordination meetings and visits have been held with the host country authorities, including on scenario development, site modifications, aerial overflights, equipment certification, seismic survey measurements and site preparations.

The BUEs scenario task force continued developing a contiguous technically realistic, rationally coherent, temporally logical and intellectually motivating scenario for the three BUEs. A scenario peer review was conducted by a group of experts from States Signatories with their recommendations implemented in the scenario.

The first BUE covering the launch phase of an OSI was conducted from 11 to 15 November in the VIC and at the TeST Centre. It involved 70 participants, including 19 experts from 14 States Signatories and staff from the entire PTS. The BUE served as a means to test PTS support to launch an OSI, from

the submission of an OSI request up to the deployment of the inspection team. Several key infrastructures and OSI developments were successfully tested during the exercise, among them the OSI OSC at the COPC, the rapid deployment capabilities at the TeST Centre, GIMO and many more. The OSC activities included, inter alia, identifying available inspectors from across the globe on short notice, designing an appropriate inspection team structure, arranging visas and transportation to Vienna for out-briefings and onward deployment; preparing the logistics and operations support plan which covers preparations to transport tonnes of sophisticated equipment as well as possible on-site support provided by the State to be inspected; gathering and analysing all available relevant information, receiving technical briefings from the IDC, preparing an initial inspection plan and a logistics and operations support plan for negotiation with the State to be inspected and providing detailed reports and files to the Director General in support of deliberations with the Executive Council.

EQUIPMENT, PROCEDURES AND SPECIFICATIONS

Further development of equipment, procedures and specifications for the inspection techniques continued throughout 2019 in line with the schedule of related OSI action plan projects. As projects concluded, the Commission began to

submit revised equipment specifications 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. Specifications submitted in 2019 relate to equipment for ground based position finding, visual observation and multispectral including infrared (MSIR) imagery as well as for airborne MSIR measurements. These specifications, along with those to be submitted in 2020 for almost all other inspection techniques permitted by the Treaty, will be consolidated in the first comprehensive draft of the OSI equipment list for consideration by WGB.

Motivated by the construction of the TeST Centre and the findings of OSI action plan projects related to establishing capabilities to rapidly deploy inspection techniques and support their application in the field, the OSI equipment database project commenced in 2019. It progressed from a concept to a production level software that allows OSI equipment and software to be organized into systems and configurations in preparation for and during deployment. The database provides user friendly interfaces and workflows to facilitate management, maintenance, calibration and certification of equipment. The database also includes the application of radio-frequency identification technology to track container movements within the TeST Centre and during an inspection and related testing, training or exercising. It is fully integrated with the OSI GIMO system and was effectively used with a limited functionality during BUE-L at the VIC in November.



Inspection planning at the Operation Support Centre during the build-up exercise launch phase.

The PTS used the TeST Centre in 2019 to store, inter alia, 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 responsible technical staff of the PTS provided significant support to the third OSI training cycle through planning, preparation and facilitation of the technical training courses on geophysical, airborne and radionuclide related inspection techniques.

While the use of the TeST Centre was expanding throughout the year in line with its increasing level of functionality, the Commission continued to cooperate closely with the Austrian authorities to alleviate remaining resource and operational constraints particularly during the early stages of 2019. This cooperation allowed the PTS to again use facilities and resources of the Austrian Ministry of Defence for developing OSI capabilities with a focus on OSI rapid deployment, sustainability and recovery.

In 2019 the PTS provided contributions to the General Assembly of the European Geophysical Union in April held in Vienna, Austria, the IMS radionuclide laboratory workshop in June held in Vienna, Austria and the International Noble Gas Experiment Workshop in December held in Freiburg, Germany.

Airborne Techniques and Visual Observation

While the submission to WGB of revised equipment specifications for visual observation and airborne techniques for consideration was a key achievement this year, significant advances were also made on the OSI airborne systems simulator project. The simulator progressed towards completion through the conversion of a decommissioned helicopter airframe into a custom structure to facilitate the testing of OSI airborne equipment and for the training of surrogate inspectors. The cabin was transformed into an optimal training space allowing layout changes to mimic different airframe types. For example, part of the cabin floor can be removed to resemble an airframe with a hatch. The exterior of the airframe was customized to allow external components to be attached such as distance meters, pods and antennas.

As part of ongoing efforts to expand the range of airframes on which OSI airborne systems can be deployed, final modifications were completed for the deployment of equipment on board the Eurocopter AS350. The configuration was deployed on an AS350 in September in Canada as part of the OSI third training cycle advanced course on airborne techniques.



MSIR configuration on an AS350 helicopter during the 2019 OSI third training cycle advanced course on airborne techniques in Canada.

Geophysical Inspection Techniques

Following the testing of OSI geophysical inspection techniques for shallow applications in 2018, another field test of OSI geophysical techniques was conducted in 2019, this time with a focus on deep applications. Nine experts from eight States Signatories participated in this activity in September 2019 near Felsopeteny in Hungary. This activity was designed to test equipment and procedures for resonance seismometry, active seismic surveys and electrical conductivity measurements in field conditions. An extensive two week programme at the location of a natural cave (with a diameter of 30 metres and depth of 80 metres, approximately) allowed an assessment of functionality and operational use of all tested methods and provided valuable field data as well as information for the assessment of technical specifications of equipment and methodology. The test also contributed to the preparation of BUEs in 2020.

An expert meeting on resonance seismometry was held at the TeST Centre in Seibersdorf in November 2019. The purpose of the meeting was to review progress achieved during the implementation of the relevant OSI action plan project. Sixteen experts from ten States Signatories participated in the meeting to discuss numerical modelling and data processing methods, update the technology evaluation matrix for geophysical inspection techniques, draft input for the concept of operations and revise the equipment specifications documented in the report of OSI Workshop-23.



Electrical conductivity measurements during the 2019 OSI field test on geophysical inspection techniques in Hungary.

Measurements of Radioactivity and Radionuclide Particulate Related Inspection Techniques

The acquisition of core equipment for the radionuclide particulate component of the OSI field laboratory was completed in 2019 with the delivery and validation of more compact and robust electrical cooling units for germanium detectors. In parallel, the Commission's car borne and pedestrian applications of OSI ground based gamma radiation monitoring (GRM) systems have been calibrated for sensor efficiencies and their operational parameters documented for the range of relevant energies and amplitudes that might be encountered during an OSI. Test reports were issued for five types of low resolution sodium iodide and neutron sensors under a quality control procedure designed to set the baseline for long term performance monitoring of these GRM sensors deployed during an OSI. Two GRM car borne configurations delivered were brought into OSI operational status.

A meeting with developers of measurement restriction methods applied to the field of sample analysis by high resolution gamma spectroscopy was held in the margins of the Fifty-Second Session of WGB. It provided a status review of current capabilities, including ongoing research and development efforts. Key findings and recommendations on the proposed way forward to develop measurement restrictions during an OSI will be part of the relevant OSI action plan project report.

The design and development of the field application for OSI environmental sampling techniques, initiated in 2018, was completed and tested for all types of particulates and noble gas sampling media this year. The new application manages the chain of custody of samples and guides the operator through the collection of the relevant mission data, while geospatial information is automatically registered through on board or additional global navigation satellite system capabilities. Fully integrated within the new OSI GIMO system, the field application records the handover of samples and metadata delivered to the field laboratory custodian.

To build on this experience and complement the field application for OSI environmental sampling, a new laboratory application for the OSI field laboratory was designed and developed in 2019 to support samples related data flow during an inspection and in synergy with other relevant GIMO modules. This application interfaces the deliverables (samples, data) from environmental sampling missions with the OSI field laboratory procedures, provides the laboratory custodian with management tools for sample processing, measurement and analysis and records key events in the chain of custody of samples. This new application was demonstrated at the TeST Centre during the training course on radionuclide techniques and will be refined in the early stages of 2020.

Noble Gas Related Inspection Techniques

Following initial work in 2018 on improved noble gas separation and detection, 2019 saw the initiation of the development of a proof of concept for noble gas separation by use of pressure swing adsorption in order to explore the possibilities for higher separation efficiencies. Furthermore, the engineering design for argon detection based on liquid

argon scintillation was finalized and the delivery of a prototype for laboratory and field testing is expected during the first quarter of 2020.

A major achievement this year regarding noble gas related inspection techniques has been the completed upgrade of the OSI SAUNA system and its subsequent integration into the new flight pod for rapid deployment and set-up in the field. The factory and system acceptance test was conducted at the premises of the contractor prior to the shipment of the integrated system to Vienna just before the end of the year. The project was financially supported by the EU under Council Decision VII and will conclude in 2020 with the delivery of training.



Integration of the upgraded OSI SAUNA system into the new flight pod.

OPERATIONS AND OPERATIONS SUPPORT

OSI action plan projects related to operations and operations support are being closed and will be finalized pending the last deliveries expected to arrive in the first quarter of 2020. Testing and confirmation of the delivered products will be done in 2020 and confirmed in the exercise setting of the BUEs planned for 2020.



Moving equipment into the new TeST Centre.

The conceptual design of a comprehensive security system for the base of operations was finalized in 2018. The company that won the bid for the provision of the system completed the final engineering design in 2019. It is scheduled to deliver the deployable security and surveillance system early in 2020 prior to testing in the second quarter of 2020.

The study of the potential use of third party contracts and standing arrangements in support of an OSI has been closed in a non-completed state. This will need further work from a suitably qualified expert that could not be recruited in 2019. The needs analysis of support requirements for an OSI is completed and can be used as a starting point for further work on how standing arrangements or third party contracts may support the provision of such requirements in an OSI.

Delivery and inventory of the base of operations infrastructure upgrade has been completed. The study on hybrid power generation capabilities contributed to this upgrade as it led to a prototype which was successfully tested at the new TeST Centre. A subsequent order for an OSI baseline hybrid capability for testing in the field environment has been placed.

The regular scheduled maintenance, calibration and certification of all major auxiliary OSI equipment components (e.g. generator sets, uninterruptible power supplies) was completed under the necessary routine operational support activities.

Early in 2019, the temporary storage area was vacated and the new TeST Centre was occupied. The organization and operationalization of this facility has been developed throughout the year and OSI staff have been contributing to the project team that is providing the logistics support services. The full inventory and reorganization of OSI equipment has begun as part of the reorganization of both the equipment storage and work areas and will continue into 2020 as the facility becomes fully operational.

ON-SITE INSPECTION DOCUMENTATION

Activities during 2019 involved providing support to WGB and implementing action plan projects, including further development and revision of OSI Quality Management System (QMS) documents, issuance of the report for OSI Workshop 24, population of the documentation room at the TeST Centre, closure of action plan projects and the preparation for BUE-L.

Action Plan Projects

The OSI action plan projects related to documentation were completed. Several documents were drafted as part of the action plan projects 1.8 Reporting and 2.7 OSI Administration and Document Control, including a SOP on developing and handling the final inspection report and OSC documentation control related procedures. 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. Action plan project 2.11 Improved OSI e-Library drew to a close with the launch of the improved OSI e-Library.

Support to Build-Up Exercise Launch phase

Support was provided to BUE-L through ensuring updated documentation was available in electronic form via the e-Library and in printed form via the field library. PTS staff also played roles on the information management team in the OSC, controlling and securing correspondence as well as providing the information security out briefing to the inspection team.

Work also began on printing field versions of newly developed or revised and approved QMS documents, and booklets for 21 QMS documents were received. The topic codes used in the OSI e-Library were revised to better reflect OSI documentation and equipment. A contractor was selected to produce a study on the QA/QC requirements of the OSI field laboratory and preparation and conduct of an OSI.

Quality Management System

The PTS issued 28 QMS documents in 2019, of which 24 were drafted and/or revised as part of the preparation for BUE-L. Updated field versions of the documents were also produced.

Improved On-Site Inspection e-Library

With the testing phase completed, the OSI e-Library was launched and training provided to OSI staff in May 2019. The training demonstrated the enhanced capabilities of the system, including better search functionality and the ability to create a replica of the OSI e-Library for export and interfacing with GIMO. The e-Library was demonstrated during SnT2019 and used extensively during BUE-L, where it performed as intended by efficiently providing documentation, interfacing well with GIMO and allowing for targeted replication to the OSC and servers for use in the field.

Documentation Storage Room at the TeST Centre

Upon completion of the TeST Centre's OSI documentation storage room, files were moved from temporary storage and staff offices to this central, purpose-built room and organized on movable library stack shelving. Files include items related to WGB, OSI technical reports and workshop reports, approval records for QMS documentation, additional printed copies of QMS documentation, and the deployable field library of current QMS documents.

Support to Working Group B

The PTS continued to provide substantive, technical and administrative assistance to WGB in its third round of elaboration on the draft OSI Operational Manual. The Model Text for the draft OSI Operational Manual (CTBT/WGB/TL-18/64) was issued on 4 July 2019. Field versions of the Model Text were also printed, for the purposes of the BUEs.



Documentation storage room at the TeST Centre.

A large conference room with people seated at long tables, overlaid with a red tint and a white text box. The room features wood-paneled walls with signs for 'DEUTSCH', 'ESPAÑOL', and 'PICCOLI'. A clock is visible on the wall. The text 'IMPROVING PERFORMANCE AND EFFICIENCY' is centered in a white box.

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

At all stages of the process of establishing the Treaty verification system, the Commission aims for effectiveness, efficiency, sustainability, client (i.e. States Signatories and NDCs) orientation and continual improvement. The implementation of the QMS is meant to ensure that work to establish the verification regime complies with the requirements of the Treaty, its Protocol and the relevant guidance of the Commission and enhances performance monitoring.

Establishing the QMS is a continual process towards the fulfilment of the goals and objectives set out in the Quality Policy of the Commission and, in particular, instilling a quality culture in the PTS.

QUALITY MANAGEMENT SYSTEM

To ensure continuous provision of high quality data, products and services, the Commission pursued further improvement of the QMS in 2019. The QMS is a living system that can be adjusted in line with the emphasis placed by the Commission on the needs of States Signatories and NDCs and on continual improvement.

Advances were made in promoting the QMS and staff awareness of the use of QMS products. With more than 2400 documents filed, the QMS documents management system provides the functionality to univocally locate the latest approved versions of documentation. A significant increase of 14% in the number of specifications, procedures, work instructions and quality plans was reflected in 2019 and, in particular, the number of work instructions increased by 34%.

In order to continue consolidating the reliability of data and products of the verification system, the Quality Management and Performance Monitoring (QMPM) Section is collaborating with the IMS, IDC and OSI Divisions to progressively align as appropriate the ongoing practices to ISO 17025 requirements.

The Quality Policy of the Commission emphasizes client orientation. Therefore the Commission continued to prioritize feedback from NDCs, which are the main users of its products and services, and to encourage them to actively contribute through the established channels to review the implementation of recommendations.

Work continues on customer satisfaction issues. Recording recommendations from NDC experts, as customers of the

PTS, to further improve the performance of the verification system, and tracking the status of implementation, is considered a high priority task. Links between NDCs' recommendations and results of the IDC experiments have been established and the QMPM Section is considering the use of these experiments to support closing NDC recommendations.

An internal audit has been initiated in close consultation with the QMPM Section as part of the effort to further develop synergies with the aim of embedding the focus of the PTS on quality and control in all of its activities, processes and procedures.

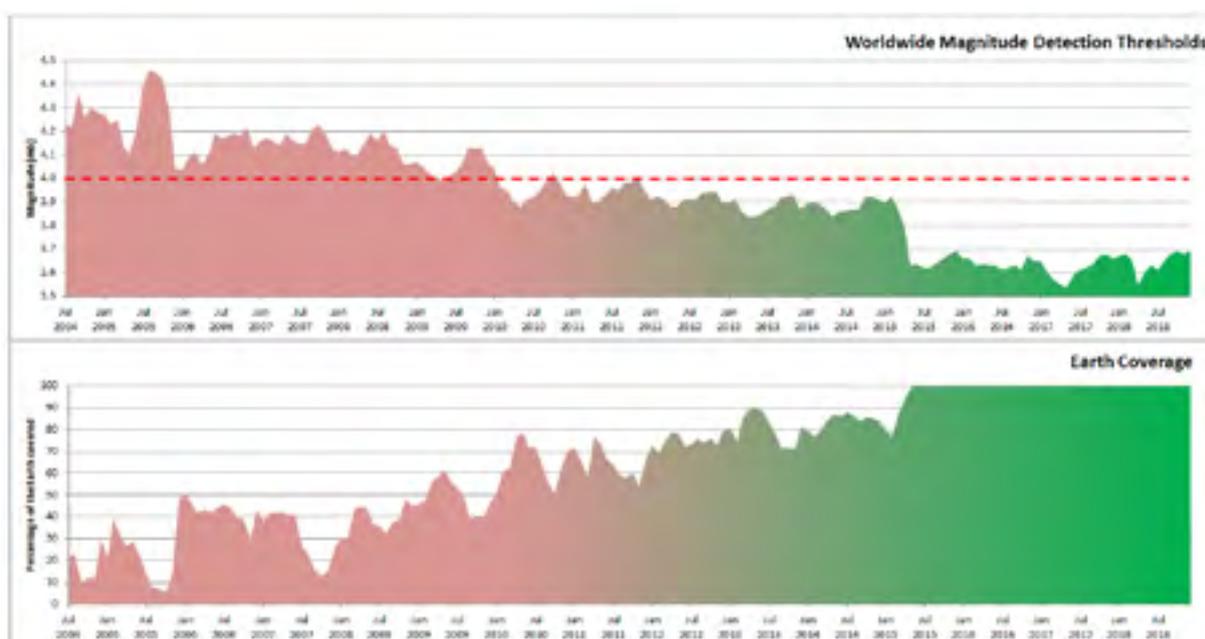
PERFORMANCE MONITORING

The PTS continued to enhance the performance reporting tool (PRTool) for 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 was initiated to ensure long term sustainability of PTS performance monitoring.

The QMPM Section improved the approach for monitoring the further development of OSI capability, including the implementation of the OSI action plan.

The Section also continued to follow up on the implementation of recommendations of past experiments of the IDC progressive commissioning, as part of the continual improvement process of the verification system.

2004-2018 CONTINUOUS ASSESSMENT OF GLOBAL SEISMIC DETECTION CAPACITY



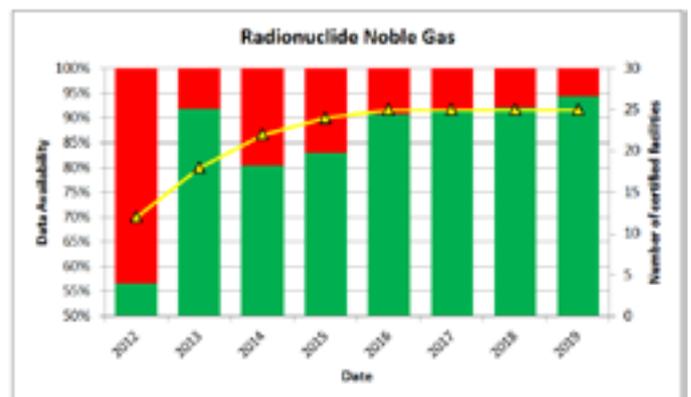
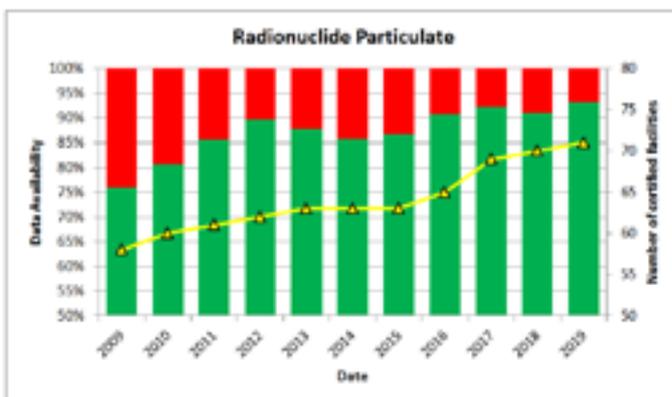
Top: time evolution of worldwide magnitude detection thresholds.

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



Evaluation of the on-site inspection build-up exercise launch phase.

DATA AVAILABILITY AND NUMBER OF RADIONUCLIDE TECHNOLOGY FACILITIES CERTIFIED



EVALUATION

As part of the final preparations for the evaluation of the next series of OSI BUEs, the QMPM Section completed the update of the functionality of the Evaluation Information Management System, which is being used by the evaluation team during the course of the exercises and afterwards to prepare the evaluation report.

The evaluation approach for OSI BUEs was finalized considering the lessons learned during the evaluation of the 2014 IFE, and took advantage of the experience gained with the consolidation of the evaluation approach developed for the experiments within the progressive commissioning of the IDC. The QMPM Section prepared the framework for the evaluation of the OSI BUE on the launch phase.

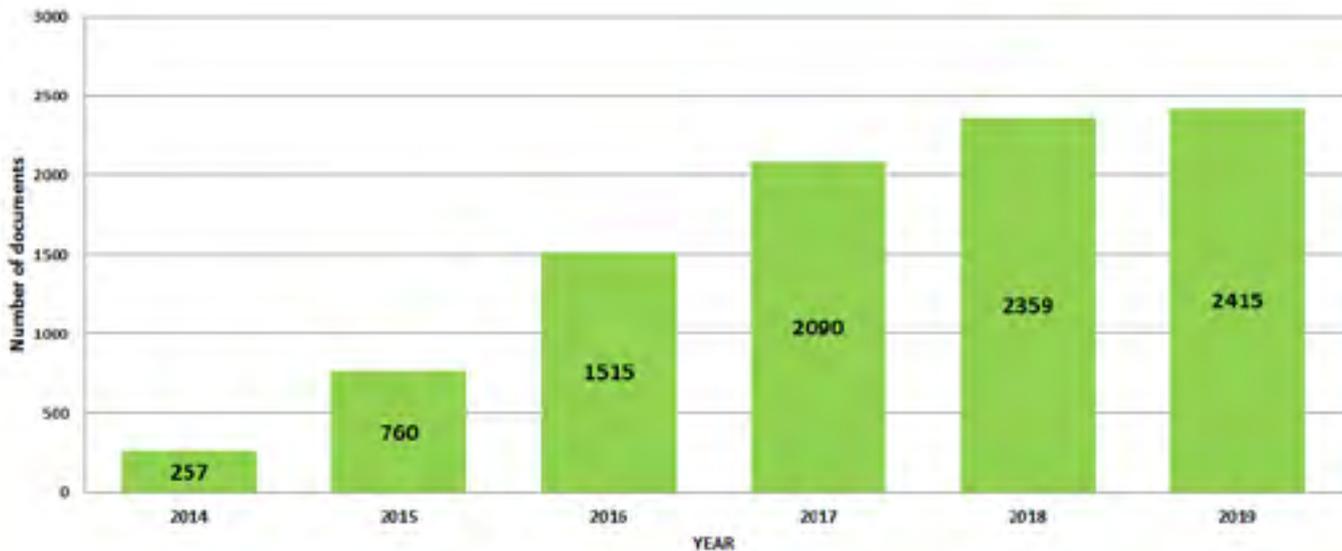
The QMPM Section conducted a training activity for the external evaluators who will participate in the evaluation of the series of OSI BUEs in 2019-2020. The training was conducted from 9 to 13 September 2019 at the VIC and the TeST Centre. The evaluation of BUE-L was conducted from 7 to 20 November

2019 by an evaluation team comprising five evaluators from States Signatories. The outcome of the evaluation of BUE-L will be used for the preparation of the next OSI BUEs, as appropriate, and for the elaboration of the comprehensive evaluation report on the series of OSI BUEs conducted in 2019-2020.

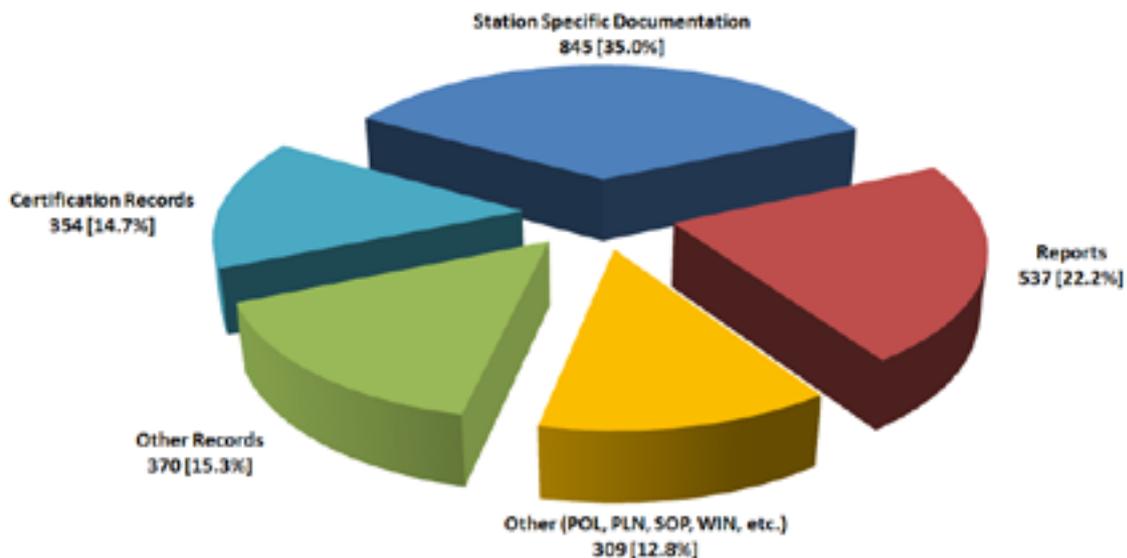
The evaluation report on Experiment 3 of the IDC Progressive Commissioning Plan was issued. Of the 17 validation tests performed during the experiment, 5 tests were successfully implemented. The remaining 12 tests were only partially implemented, resulting in 24 recommendations to improve system performance.

In preparation for Experiment 4 and taking into consideration the lessons learned from previous experiments, the QMPM Section prepared the evaluation framework for its comprehensive evaluation. Experiment 4 was conducted from 16 to 27 September 2019. The evaluation is being performed by an external evaluation team, comprising five evaluators from States Signatories, to assist the QMPM Section in a comprehensive evaluation of the experiment and in the elaboration of the final evaluation report.

NUMBER OF DOCUMENTS IN THE QUALITY MANAGEMENT SYSTEM REPOSITORY



DISTRIBUTION OF QUALITY MANAGEMENT SYSTEM DOCUMENTS





Evaluation team for the next series of on-site inspection build-up exercises.



Meeting of the on-site inspection build-up exercise launch phase at CTBTO headquarters in Vienna, Austria.



**INTEGRATED
CAPACITY
DEVELOPMENT**

CTBTO
TECHNOLOGY SUPPORT CENTRE (TSC)
TRAINING (TEST) C...

INAGURATED ON 19 JUNE 2019

Representatives
of States Signatories
to the CTBT

HIGHLIGHTS

Increased capacity development activities

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

Further development of e-learning

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

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

Training courses are held at the Commission headquarters in Vienna and at other locations, often with the assistance of hosting States. 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.

INTERNATIONAL DATA CENTRE AND NATIONAL DATA CENTRE TRAINING COURSES AND WORKSHOPS

Integrated capacity development and training activities in 2019 included nine NDC training events, nine station operator courses, three technical workshops, six technical meetings, two NDC workshops, SnT2019, as well as the participation of experts from developing countries in official technical meetings of the Commission. The first NDC training for French speaking NDCs took place in Antananarivo, Madagascar in April 2019.

The Radionuclide Laboratory Workshop 2019 was held from 18 to 21 June 2019 in Vienna. Forty-eight experts from 19 States Signatories and the PTS attended the workshop. The purpose of the workshop was to discuss and to address developments and issues pertaining to laboratory operations; to review and to plan PTEs for particulate samples and noble gas intercomparison exercises, certification, surveillance assessment and measurements; to discuss CTBT/PTS/INF.96/Rev.10; to share operational experiences and lessons learned towards quality improvement and to discuss advances in gamma spectrometry and noble gas measurements.

The International Hydroacoustics Workshop was held from 8 to 11 July 2019 in Vienna. A total of 30 participants from 11 States Signatories and the PTS contributed to this event. The objective of the workshop was to support the verification regime of the Commission by continuing the now established forum for scientific and technical knowledge exchange on three themes: (a) technological advancements in marine engineering pertinent to the sustainability and improvement of the hydroacoustic component of the IMS, (b) data analysis and signal processing methods for CTBT verification purposes and (c) three dimensional modelling for long range hydroacoustic signal propagation.

The Infrasound Technology Workshop 2019 was held from 10 to 14 November 2019 in Aqaba, Jordan. Eighty-six experts from 33 States Signatories and the PTS attended the workshop. The purpose of the workshop was to create an international forum for presenting and discussing recent advancements in infrasound research and the operational capabilities of global and regional networks. The workshop also reaffirmed the pivotal role of the PTS in the infrasound community and highlighted the usefulness of the technology for civil and scientific applications.

The NDC Capacity Building Workshop and Regional Seismic Travel Time in combination with Data Sharing and Integration Training took place in Chiang Mai, Thailand, from 28 October to 1 November 2019. Twenty-eight experts from 21 States Signatories and the PTS attended the workshop. The objectives for the NDC Capacity Building Workshop were to strengthen participants' knowledge of the CTBT and the work of the Preparatory Commission, to further build up the national and regional capacities in implementing the Treaty and participating in the verification regime and to promote the civil and scientific application of verification technologies.



The International Hydroacoustics Workshop was held from 8 to 11 July 2019 in Vienna. A total of 30 participants from 11 States Signatories and the PTS contributed to this event.

The International Noble Gas Experiment Workshop was held from 2 to 6 December 2019 in Freiburg, Germany, and attracted 111 experts from 24 States Signatories and the PTS. The purpose of the workshop was to present and evaluate the most recent advances in noble gas monitoring in support of the CTBT.

Activities under the EU Council Decision VII project for 2018-2019 continued supporting capacity building in Africa, South East Asia, the Pacific and the Far East and the Middle East and South Asia regions.

The PTS performed five follow-up maintenance visits during 2019 to assist the capacity of States Signatories to participate fully in the verification regime and to enhance their civil and scientific activities by obtaining, analysing and reporting on IMS data and IDC products. Planning was initiated for the installation of nine capacity building systems in 2020.

Approximately 120 participants subscribed to the NDC e-learning course on access to and application of IMS data and IDC products in 2019.

OSI TRAINING COURSES AND WORKSHOPS

The technique specific courses of the advanced block of the third training cycle concluded in October 2019. These courses focused on the application of inspection techniques as specified in the treaty protocol and targeted the various technical sub-teams of the third training cycle. The details of the courses conducted during 2019 are provided below.

The rapid deployment, sustainment and recovery course was conducted at the Austrian Armed Forces International Training Centre in Götzendorf, Austria, from 8 to 12 April 2019, with support from the Government of Austria. The objective of the course was to provide hands-on training on the OSI specific concepts, equipment and procedures related to rapid deployment, in-field sustainment and recovery of an OSI mission. The course covered all phases of an OSI, with emphasis on the inspection phase. The operations support sub-team of the third training cycle, comprising 19 experts from 17 States Signatory, attended the course.

The geophysical and seismic techniques course was conducted at the newly inaugurated TeST Centre and at nearby Austrian military training sites from 1 to 17 July 2019. The objective of the course was to provide hands-on equipment training on the use of geophysical inspection techniques (ground based magnetic field mapping, electrical conductivity measurements, ground penetrating radar, gravitational field mapping and seismic inspection techniques including seismic aftershock monitoring systems, active seismic techniques and resonance seismometry). The course, attended by 16 seismic experts from 14 Signatory States and 9 geophysical experts from 8 Signatory States, also covered the operation and maintenance of the equipment and the use of related data processing software and hardware.

The additional overflight techniques course was conducted from 23 September to 2 October 2019 in Ottawa, Canada, with support from Natural Resources Canada. The objective of the course was to train surrogate inspectors to install and operate airborne inspection technologies according to approved procedures on OSI-relevant airframes.

Participants were trained in airborne survey design, pre- and inflight airborne operations and the use of a common airborne position finding system and each of the permitted airborne technologies. The course was attended by 11 airborne survey experts from 11 Signatory States.

The radionuclide and noble gas techniques course was conducted from 13 to 25 October 2019 at the TeST Centre. The objective of the course was for trainees to acquire competencies required to perform activities related to paragraphs 69(c-d) of the Protocol and obtain practical knowledge and capabilities on all OSI equipment related to radionuclide and noble gas sampling, handling and analysis. The course was attended by 27 experts from 23 Signatory States.

The OSI training of trainers course was conducted from 17 to 21 June 2019 and was the first training event held at the new TeST Centre. The objective of this course was to expand the core group of OSI external facilitators to a number that can sustain consistent delivery of OSI training in the future, and to expand the geographical and gender balance of this instructor group that is representative of a typical OSI trainee group. The course was successfully attended by 30 experts with various OSI technical backgrounds from 27 Signatory States.

The integration of the OSI inspectorate database with the services, training and management system and the conference, training and workshop registration platform was completed in 2018. This new mechanism was used to support the processing of nominations and registrations for all OSI training events in 2019.

The development phase of the inspectorate call-up mechanism concluded in November 2019 with the validation of the call-up system during BUE-L. The call-up platform succeeded in reaching all test subjects in all geographical regions during the exercise. Prior to BUE-L, the call-up mechanism was tested during every technique specific course of the third training cycle.

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 2019. The integration of geospatial data simulation into this remote training platform allows for additional training scenarios with critical inspection team functionality concepts, such as the updating of search logic and the proposing and prioritizing of missions, and allows trainees to conduct virtual operational steps such as inspection team meetings and the narrowing of search zones. This remote GIMO training platform will be opened to the rostered surrogate inspectors of the first and second training cycles. The development and implementation of this training system, which simulates the daily operations cycle of an individual inspector and uses data simulation models to conduct virtual field missions, will be tested and validated during the BUEs scheduled for 2020.

The advanced course of the third training cycle was held at the Denel Overberg Test Range in South Africa in October 2018. Seventy candidates representing 44 States Signatories from all regions participated. The goal of the advanced course was to prepare trainees for OSI activities grounded in inspection team functionality and field team functionality concepts. A variety of training methodologies with a focus on practical learning, such as field training



Trainees and instructor at the Rapid Deployment, Sustainment and Recovery Course at the Austrian Armed Forces International Training Center.

exercises, were used. The trainees demonstrated competence in implementing information led search logic during the launch, pre-inspection and inspection phases of an OSI. The course also included soft skills training on negotiation techniques, cross-cultural communications, decision making mechanisms, leadership styles and team building. The course was hosted by the South African Council for the Non-Proliferation of Weapons of Mass Destruction and the South African Council for Geoscience.

The ground and airborne based visual observation course of the third training cycle was held at the same training site immediately after the advanced course. It was the first in a series of technique specific courses that will be delivered to the various technical sub-teams of the third training cycle. A total of 16 candidates from the visual observation sub-team, representing 15 States Signatories, participated. The objective of the course was to provide hands-on practice in identifying potentially relevant OSI observables acquired through both ground and airborne visual observation techniques. This included the planning, preparation and execution of helicopter overflight activities. This course was also hosted by the South African Council for the Non-Proliferation of Weapons of Mass Destruction and the South African Council for Geoscience. The host agencies also provided the use of a helicopter, its aircrew and fuel as a contribution in kind.

The integration of the OSI inspectorate database with the services, training and management system and the conference, training and workshop registration platform was completed in 2018. Legacy data from the previous inspectorate database was migrated to the services, training

and management system test environment to assess compatibility and to determine the requirements for further developments to support the functionality requirements of the OSI inspectorate database. This new mechanism was used to support the processing of nominations and registrations for all OSI training events in 2018.

An initial test of the OSI inspectorate call-up mechanism was conducted during the advanced course in South Africa. During the 24 hour test period, all participants in the third training cycle received automatically generated SMS and email messages instructing them to respond to a theoretical call-up for an OSI. The call-up platform succeeded in reaching all test subjects in all geographical regions.

A cloud based remote e-training system on inspection team functionality and the GIMO system was launched in September 2018 in support of the future activities of the third training cycle. The integration of geospatial data simulation into this remote training platform allows for additional training scenarios with critical inspection team functionality concepts such as the updating of search logic and the proposing and prioritizing of missions, and allows trainees to conduct virtual operational steps such as inspection team meetings and the narrowing of search zones. This secure platform also provides the possibility of developing various OSI scenarios with realistic geospatial data for classroom based training. The development and implementation of this training system, which simulates the daily operations cycle of an individual inspector and uses data simulation models to conduct virtual field missions, will be used for all training for the remainder of the third training cycle.

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 2019 (CTBT/PTS/INF.1515). In November 2018, the Commission extended the project for a further three years (2019-2021), subject to the availability of sufficient voluntary contributions.

In 2019, the project supported the participation of experts from 10 States: Argentina, Chile, Costa Rica, Malaysia, Morocco, Namibia, Nepal, Niger, the Sudan, and Tunisia. 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 49 experts from 38 States: 11 in Africa (Algeria, Burkina Faso, Ethiopia, Kenya, Madagascar, Morocco, Namibia, Niger, South Africa, the 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), 6 in the Middle East and South Asia (Iraq, Jordan, Kyrgyzstan, Nepal, Sri Lanka 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). Sixteen of the supported experts are women. Ten of these States are or were least developed countries.

Voluntary contributions from China, Germany, Kazakhstan, Turkey, the United Kingdom and the EU were used to finance the project in 2019, and a part of these funds was carried over to 2020. The Commission continues to seek additional voluntary contributions to ensure the financial sustainability of the project.



Experts from 10 developing countries took part in the Fifty-Second and Fifty-Third Sessions of Working Group B, including formal meetings and meetings of expert groups.



OUTREACH



HIGHLIGHTS

Growing high level engagement with States

Comprehensive public and media outreach strategy

Active involvement of youth in outreach activities of the organization

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 2019, 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 2019. 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 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.

Members of the Group of Eminent Persons restated their “unwavering commitment” to promoting the Treaty as a pillar of the global non-proliferation and disarmament architecture.



Group of Eminent Persons at their annual coordination meeting, 24 to 25 June, Vienna's Hofburg Palace.

At their annual coordination meeting, held on 24 to 25 June in Vienna's Hofburg Palace, on the margins of the SnT2019 conference, the Group of Eminent Persons agreed a declaration reaffirming their commitment to advancing a world free of nuclear testing and enhancing cooperation to promote the Treaty's entry into force.

The declaration recognizes that “the CTBT constitutes the most effective and practical non-proliferation and disarmament measure within grasp of the international community,” and calls on all countries to “continue their support in advancing the entry into force of the Treaty as the most practical step towards nuclear disarmament, notably during the upcoming 2020 NPT Review Conference”.

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 was launched in 2016. The objectives of the CTBTO Youth Group are to revitalize the discussion around the CTBT among decision makers, academia, students, expert society 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. Since its launch in 2016, the CTBTO Youth Group has grown to over 800 members. A considerable number of its members come from the Annex 2 States whose ratification is needed for the CTBT to enter into force.

In 2019, CTBTO Youth Group members participated in, among other events: the Paris Talks on 15 March; a Youth for Peace and Disarmament event co-hosted with the Ban Ki-moon Centre for Global Citizenship on 31 May in Seoul, Republic of Korea; SnT2019 from 22 to 28 June; a workshop on New Tools for Verifying Disarmament and Nonproliferation hosted by the James Martin Center for Nonproliferation Studies from 8 to 10 July in Monterey, United States of America; a Science Diplomacy Workshop from 12 to 13 September in Quito, Ecuador; the eleventh Article XIV Conference; the 2019 Annual Meeting of the Mexican Geophysical Union from 27 October to 1 November in Puerto Vallarta, Mexico; and the Moscow Nuclear Non-Proliferation Conference and young professionals seminar on CTBT: Treaty's Impact on the International Non-Proliferation Regime and Assessment of the Current State of Affairs from 7 to 12 November.

The group is open to all students and young graduates who wish to contribute to global peace and security and actively engage in promoting the CTBT and its verification regime.

On 31 May 2019, the Executive Secretary delivered a keynote speech at a youth event with former United Nations Secretary-General Ban Ki-moon and former Austrian President Heinz Fischer in Seoul, Republic of Korea, together with Korean members of the Group of Eminent Persons and CTBTO Youth Group.



Youth for Peace and Disarmament; an event co-hosted with the Ban Ki-moon Centre for Global Citizenship on 31 May in Seoul, Republic of Korea.

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 visits 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, including President Emmerson Mnangagwa of Zimbabwe, President Adama Barrow of the Gambia, President Kassym-Jomart Tokayev of Kazakhstan, President Roch Marc Christian Kaboré of Burkina Faso, former Prime Minister Enele Sosene Sopoaga of Tuvalu, the late Prime Minister Samiuela 'Akilisi Pōhiva of Tonga and Prime Minister Manasseh Damukana Sogavare of the Solomon Islands.

During his visits and in Vienna, the Executive Secretary also met with foreign ministers and other ministers of States Signatories and observers. They included foreign ministers of Australia, Austria, Belgium, Burkina Faso, China, Costa Rica, the Dominican Republic, Kazakhstan, Madagascar, Malta, Mongolia, Rwanda, Slovakia, Sweden and Zimbabwe.

Promoting parliamentary engagement, the Executive Secretary also met the Speaker of the Senate of the Parliament of Kazakhstan, the Speaker of the House of Representatives of Japan, the Parliamentary Vice-Minister for Foreign Affairs of Japan, a parliamentary member of the National Assembly of the Republic of Korea, and the chair of the National Defense Committee of the Republic of Korea.

A high level delegation of the Parliamentary Assembly of the Francophonie (APF) visited the Executive Secretary in Vienna on 19 February 2019. The delegation included the Parliamentary Secretary General of the APF, the President of the National Assembly of Madagascar and Vice-President of the APF, the Chairman of the APF Political Committee as well as several advisers.

The Executive Secretary addressed the forty-fifth plenary session of the APF, held from 7 to 8 July 2019 in Abidjan, Côte d'Ivoire, in the context of an international campaign for the entry into force of the CTBT initiated and launched by the APF in February 2019 in Vienna.

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 met with a number of heads and other senior officials of international and regional organizations.

On 23 January, the Executive Secretary participated in the panel discussion “Comprehensive Nuclear-Test-Ban Treaty: Possible Measures to Strengthen the Treaty’s Normative Standing”, hosted by the Vienna Center for Disarmament and Non-Proliferation.



Panel Discussion at the Vienna Center for Disarmament and Non-Proliferation.

On the margins of the Munich Security Conference in Germany from 15 to 17 February, the Executive Secretary met with the Minister of Foreign Affairs of Burkina Faso, the Vice Prime Minister and Minister of Foreign Affairs of Belgium, the Minister for the Armed Forces of France, the Deputy Foreign Minister of Foreign Affairs of the Russian Federation, the Speaker of the Senate of the Parliament of the Republic of Kazakhstan, the German Federal Government Commissioner for Disarmament and Arms Control, the Minister of Foreign Affairs of Rwanda and the Under Secretary of State for Arms Control and International Security of the United States of America.

While in the Dominican Republic from 27 February to 2 March, the Executive Secretary met with the Rector and senior faculty members of the Autonomous University of Santo Domingo and visited the NDC located at the National Seismic Institute of the university. The Executive Secretary also met with senior faculty members and students at the Santo Domingo Institute of Technology.

On 10 April, the Executive Secretary met with the Director of the Project on Nuclear Issues (PONI), at the Center for Strategic and International Studies, Washington, D.C., who was accompanied by the PONI Mid-Career Cadre of experts.

From 24 to 29 April, the Executive Secretary participated in a roundtable at the Council on Foreign Relations on the CTBT, met with leading academics and think tank experts, visited the

National Academy of Sciences of the United States of America, held a meeting with the President of the seventy-third Session of the United Nations General Assembly and met with the Parliamentary Vice-Minister of Japan and the Deputy Foreign Minister of Kazakhstan.

The Executive Secretary delivered a lecture on “Denuclearization of the Korean Peninsula and the role of CTBTO” at the National Assembly of the Republic of Korea on 29 May.

On 1 June, the Executive Secretary participated in the International Institute for Strategic Studies Shangri-La Dialogue in Singapore, and had several bilateral meetings with senior government officials.

From 13 to 14 June, the Executive Secretary visited Trieste, Italy, where he delivered an address to The World Academy of Sciences and held meetings with its President and other officials.

On 28 June, on the margins of the SnT2019 conference, the Executive Secretary again met with the Rector of the Autonomous University of Santo Domingo and a delegation from the Permanent Mission of the Dominican Republic.

During his visit to France from 2 to 6 July, the Executive Secretary addressed students from the Institute for Strategic Research at the Military School and delivered a keynote speech at the summer school of the Nuclear and New Generation Strategy Network, organized in partnership with the Foundation for Strategic Research.

On mission in the United States of America from 21 to 26 July, the Executive Secretary held meetings at the Nuclear Threat Initiative, the National Academy of Sciences and the United States Institute of Peace. Technical discussions were also held at the Air Force Technical Applications Center.

On 29 July, the Executive Secretary delivered an address at the Centennial Celebration of the International Union of Geodesy and Geophysics, hosted by the United Nations Educational, Scientific and Cultural Organization in Paris, France.

The Executive Secretary addressed the Conference on Disarmament in Geneva, Switzerland, on 30 July.

On 6 August, the Executive Secretary participated in the annual Hiroshima Peace Memorial Ceremony and had bilateral meetings with the mayor of Hiroshima, Mr Kazumi Matsui.



The Executive Secretary laid a wreath at the Hiroshima Peace Memorial Ceremony.

The Executive Secretary attended the 50th Pacific Islands Forum in Funafuti, Tuvalu, from 10 to 16 August, during which he addressed the Pacific Islands Forum Leaders Meeting on issues related to the CTBT and the contributions of the monitoring technologies to climate change and other civil and scientific applications.

On 22 August, in Vienna, the Executive Secretary met with the President of the United Nations General Assembly, and, together with representatives from other Vienna based organizations, attended a luncheon that was hosted in honour of the President.

The Executive Secretary participated in a ceremony in Nur-Sultan, Kazakhstan, from 28 to 29 August in commemoration of the International Day against Nuclear Tests. During the ceremony, the Executive Secretary and the late Director General of the International Atomic Energy Agency, Yukiya Amano, were named laureates of the Nazarbayev Prize for a Nuclear-Weapons-Free World and Global Security, acknowledging their contribution to global nuclear non-proliferation and disarmament.

The Executive Secretary delivered a keynote speech at the High-Level Plenary Meeting to Commemorate and Promote the International Day against Nuclear Tests, held in New York, United States of America, on 9 September.

The Executive Secretary participated in the panel entitled “Picking Up the Pieces in a Fractured World: Rebuilding Trust in Multilateralism for Peace and Security” held at the International Peace Institute in New York, United States of America, on 23 September.



The Executive Secretary, former President of the United Nations General Assembly, María Fernanda Espinosa Garcés and former Prime Minister of Australia, Kevin Rudd, at Picking Up the Pieces in a Fractured World: Rebuilding Trust in Multilateralism for Peace and Security.

The Executive Secretary attended the Rebranding Africa Forum held in Brussels, Belgium, from 4 to 6 October, where he received a Development Champion Award. He also held a keynote speech at the opening ceremony of the Forum.

The Executive Secretary delivered a speech at the Cuba Science Diplomacy Workshop Serie de Talleres Internacionales, held in Havana, Cuba, on 14 October.

The Executive Secretary visited the Dominican Republic to deliver an address to the Dominican Republic Science Diplomacy Workshop, held in Santo Domingo, on 15 October. During the

mission, the Executive Secretary was awarded an honorary professorship from the Autonomous University of Santo Domingo.

Upon an invitation from the Government, the Executive Secretary visited Switzerland from 4 to 5 November. The visit marked the twentieth anniversary of the ratification of the Treaty by Switzerland. During the visit, the Executive Secretary met with the Foreign Minister of Switzerland and gave a lecture at the university of ETH Zurich.

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 met with a number of prominent figures from academia, leading think tanks and other non-governmental entities.

PUBLIC INFORMATION

The Commission recorded a monthly average of more than 760,000 visits to the CTBTO public web site and social media channels YouTube, Twitter, Facebook and Flickr during 2019. This was roughly double the previous year's total, helped by coverage of important biennial events such as the SnT2019 conference and the Article XIV conference. As of December 2019, the CTBTO Twitter page had nearly 19 000 followers and the Facebook page had over 14 600 likes.

Multimedia production also rose, with 49 videos posted to the CTBTO YouTube channel in 2019, gaining almost 83 000 views. Social media channels further expanded their impact, generating 97 000 video views on the CTBTO's Twitter account and reposts on the United Nations account, and more than 12 000 views on the CTBTO Facebook page. The most viewed videos were “How to Find a Nuclear Test?”, which showcases the training of OSI inspectors, and “Early Monsoon Warning Using Beryllium-7” on how scientists have found a way to predict coming monsoons at least 30 days in advance by observing natural radioactivity in the air.

On Flickr, the most viewed images were from the SnT2019 conference, held from 24 to 28 June. There was also considerable interest in images from the joint Commission and Paz y Cooperación Global Scholar Art Campaign, launched in 2018 and concluded in 2019.

The Commission took full advantage of meetings, conferences and events throughout the year to extensively promote and explain its work. It provided extensive coverage of the SnT2019 conference through its web site and social media channels, and facilitated coverage by a range of media including journalists from France, India, Israel and Zimbabwe. Social media reach was greatly boosted through the innovation of a direct collaboration with a social media specialist from the United Nations Department of Public Information. CTBTO Youth Group members took part in a journalism project during the conference to hone their reporting, writing and social media skills, producing video and social media materials and publishing a daily update on the conference.

The International Day against Nuclear Tests was strongly highlighted. A joint message from the Executive Secretary and

the Foreign Minister of Kazakhstan was actively promoted through social media and the web site and formed a key pillar of an event commemorating the day at the CTBTO's Vienna Headquarters. The event also included a message from the United Nations Secretary-General and an exhibition of winning artworks from the Global Scholar Art Campaign. In Kazakhstan, the awarding of the Nazarbayev Prize for a Nuclear-Weapons-Free World and Global Security to the Executive Secretary and the late Director General of the International Atomic Energy Agency, Yukiya Amano, received widespread attention in the media and on social media. In total, approximately 270 media articles covered events related to the International Day against Nuclear Tests, including the United Nations high level plenary meeting that was subsequently held in New York on 9 September.

The Commission provided live streaming of the full Article XIV conference in New York on 25 September via United Nations Web TV, and also posted live tweets of key comments throughout the day. A two minute video on the conference and a series of shorter video pieces and interviews were rolled out through the following weeks and featured on CTBTO's social media channels, which highlighted the continued need for the entry into force of the CTBT.

GLOBAL MEDIA COVERAGE

The Treaty and its verification regime featured in more than 3950 global media articles during 2019, including interviews with the Executive Secretary by AFP, Al Jazeera America, Associated Press, The Astana Times, BBC, CNN, France 24, Hindu Businessline, Kuna, Kyodo, Nature, New Delhi TV, New Indian Express, NHK World, NK News, Reuters, RFI, Sky News, Sputnik International, Vesti, VOA Korea, Vox Africa, the Wall Street Journal and Xinhua News Agency.

Other coverage featuring the Treaty included articles and broadcast pieces by Al Jazeera, Arms Control Today, BBC, Business Recorder, Clarín, Colombo Gazette, the Conversation, Cuban News Agency, CNN, Der Standard, Die Welt, eldiario.es, El Mundo, Environmental News Network, Focus, Fox News, the Hindu, the Hindustan Times, IDN-InDepthNews, Kazakh TV, Manila Times, MENAFN, Mirage News, Nature, News.com.au, The New York Times, New Europe, the North Africa Post, ORF, Phys.org, Reuters, San Francisco Chronicle, Spiegel Online, Sputnik, TASS, UN News Centre, Vatican News, VOA Korea, Xinhua, The Wall Street Journal, The Washington Post, WIRED, Yonhap, 9 News and 38 North.

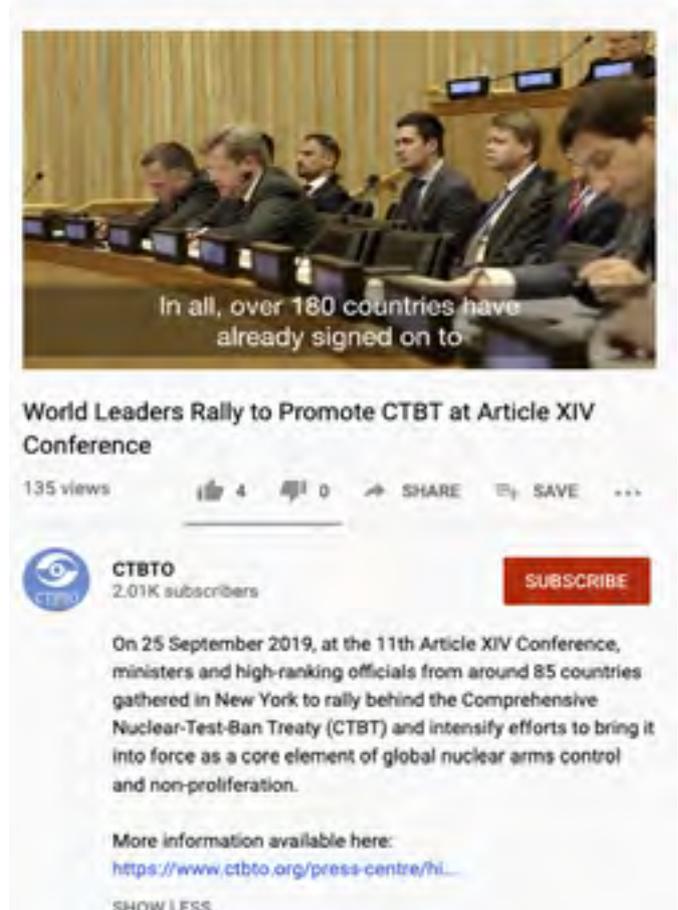
NATIONAL IMPLEMENTATION MEASURES

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.

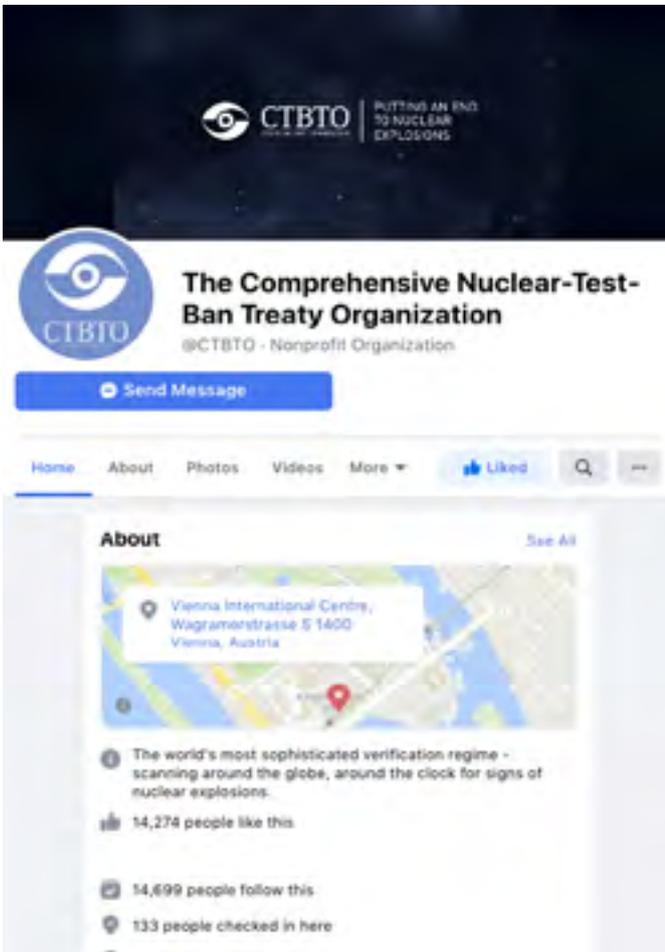
In 2019, the Commission continued to promote the exchange of information between States Signatories on national implementation measures. It also delivered presentations on aspects of national implementation at workshops, seminars, training courses, external events and academic lectures.



Twitter feed of the Commission.



YouTube page of the Commission.



Facebook page of the Commission.



SnT2019 Global Art Campaign Award Ceremony.



CTBTO visit for Indian journalists, May 2019.



**PROMOTING THE
ENTRY INTO FORCE
OF THE TREATY**

HIGHLIGHTS

Strong political support for the Treaty and the work of the Commission

Foreign Ministers of Algeria and Germany commencing their work as the new coordinators of the Article XIV process

Ratification of the Treaty by Zimbabwe

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

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

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

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 2019, 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 it.

NEW YORK, 2019

The eleventh Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty was held on 25 September 2019 on the margins of the opening of the seventy-fourth session of the United Nations General Assembly in New York.

The conference presented an opportunity to demonstrate the continued firm political commitment and support of the international community for the entry into force of the Treaty and its universality.

Around 85 States Signatories attended the conference. They reviewed the latest developments and discussed strategies to generate further support for the Treaty and its universality. A high number of foreign ministers and high level officials from ratifying, signatory and non-signatory States participated in the conference, including representatives from five States whose ratification is required for entry into force: China, Egypt, the Islamic Republic of Iran, Israel and the United States of America.

The President of the United Nations General Assembly, Mr Tijjani Muhammad-Bande (Nigeria), addressed the opening session. The High Representative of the Union for Foreign Affairs and Security Policy, Ms Federica Mogherini, also delivered a statement on behalf of the EU.

In addition to foreign ministers and high level State representatives, the conference was attended by members of the Group of Eminent Persons, including Ms Tarja Halonen (former President of Finland) as well as officials from international organizations, specialized agencies and non-governmental organizations. Ms Halonen presented the statement on behalf of the Group of Eminent Persons. A member of the CTBTO Youth Group was also given the floor to deliver a statement on behalf of the Group.

SHARED PRESIDENCY

The presidency of the conference was shared by the Foreign Minister of Algeria, Mr Sabri Boukadoum, and the Foreign Minister of Germany, Mr Heiko Maas.

EXPRESSIONS OF STRONG SUPPORT

The participants, including ministers and other senior officials, underlined the significance of the Treaty for nuclear disarmament and non-proliferation and the established norm against nuclear testing. They called on non-ratifying States, in particular the remaining Annex 2 States, to ratify the Treaty as soon as possible. They also expressed appreciation for the activities of the Commission and the effective performance of its verification regime.



2019 Comprehensive Nuclear-Test-Ban Treaty Article XIV Conference at United Nations Headquarters in New York, USA, September 2019.



Izumi Nakamitsu, Mohamed A. Alhakim, Bruno van der Pluijm, Llassina Zerbo and Bozorgmehr Ziaran during the 2019 Comprehensive Nuclear-Test-Ban Treaty Article XIV Conference at United Nations Headquarters in New York, USA, September 2019.

The Executive Secretary highlighted the importance of the Treaty for international peace and security. He noted that with 184 signatures and 168 ratifications the CTBT has reached near universality, although it is yet to enter into force. He invited focused outreach and open dialogue with the non-signatory and non-ratifying States to encourage them to consider ratification of the Treaty.

The conference unanimously adopted a Final Declaration that affirms that “a universal and effectively verifiable Treaty constitutes a fundamental instrument in the field of nuclear disarmament and non-proliferation.” It further reaffirms “the vital importance and urgency of the entry into force of the CTBT” and urges “all States to remain seized of the issue at the highest political level.”

The Final Declaration calls on the remaining States to sign and ratify the Treaty without delay and welcomes opportunities to engage with the non-signatory States, in particular Annex 2 States.

The Final Declaration also calls on all States “to refrain from nuclear weapon test explosions or any other nuclear explosions, the development and use of new nuclear weapon technologies and any action that would undermine the object and purpose and the implementation of the provisions of the CTBT and to maintain all existing moratoria on nuclear weapon test explosions, while stressing that these measures do not have the same permanent and legally binding effect to end nuclear weapon testing and all other nuclear explosions, which can only be achieved with the entry into force of the Treaty.”

It also proposes 15 practical measures to accelerate the ratification process and bring the Treaty into force. These include support for bilateral, regional and multilateral outreach initiatives, capacity building and training activities, and cooperation with civil society, international organizations and non-governmental organizations.

The Final Declaration stresses that participating States will continue to provide the political and tangible support required to enable the Commission to complete all of its tasks in the most efficient and cost effective way, in particular the further build-up of all the elements of the verification regime. It also expresses appreciation for the civil and scientific benefits of the monitoring technologies, including for tsunami warning.

In addition, the Final Declaration welcomes the range of mutually supportive ratification outreach activities, including the activities of the Group of Eminent Persons and the CTBTO Youth Group and the individual efforts of States Signatories.

NEW RATIFICATION AND SIGNATURE OF THE TREATY

Zimbabwe deposited its instrument of ratification on 13 February 2019. As of 31 December 2019, the number of ratifications of the Treaty stands at 168, and the number of signatures is 184. This new ratification makes the Treaty one of the most adhered to international instruments in the field of disarmament and drives it closer to the desired objective of universality.



The Article XIV Conference was held at the United Nations Headquarters in New York, USA.



POLICY MAKING

HIGHLIGHTS

Review of developments on the Korean Peninsula

Adoption of 2020-2021 biennial Programme and Budget Proposals

Appointment of the Chairperson of Working Group A

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-Second | 17-18 June | Ambassador Dong-ik Shin (Republic of Korea) |
| | Resumed Fifty-Second | 26 August | Ambassador Ganeson Sivagurunathan (Malaysia) |
| | Fifty-Third | 25-27 November and 4 December | Ambassador Ganeson Sivagurunathan (Malaysia) |
| Working Group A | Fifty-Fifth | 27-29 May | Ambassador Mitsuru Kitano (Japan) |
| | Fifty-Sixth | 28-30 October | Ambassador Nada Kruger (Namibia) |
| Working Group B | Fifty-Second | 25 March-5 April | Mr Joachim Schulze (Germany) |
| | Fifty-Third | 26 August-6 September | |
| Advisory Group | Fifty-Second | 13-15 May | Mr Michael Weston (United Kingdom) |
| | Fifty-Third | 7-8 October | |

MEETINGS IN 2019

The Commission and its subsidiary bodies each met in two regular sessions in 2019.

Among the major issues addressed by the Commission during 2019 were the promotion of the Treaty and advances towards its universality, including ratification of the CTBT by Zimbabwe and the intention of the government of Cuba to sign the CTBT; encouraging initiatives to further advance the Treaty; calling for signature and ratification of the Treaty by the remaining States, especially the Annex 2 States; welcoming the eleventh Conference on Facilitating the Entry into Force of the Treaty on 25 September 2019; the importance of the complete, verifiable and irreversible denuclearization of the Korean Peninsula; progress towards completion of the verification regime of the Treaty; and the activities of the organization.

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.

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.

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.

DEVELOPMENTS ON THE KOREAN PENINSULA

During the sessions of the Commission and its subsidiary bodies, States Signatories took note of the positive developments on the Korean Peninsula. They welcomed the diplomatic efforts, including through holding summits by all Parties involved in this process, and encouraged a continued dialogue to this end.

They took note with encouragement the statement by the People's Democratic Republic of Korea in April 2018 concerning a moratorium on nuclear tests, and efforts towards the dismantlement of the Punggye-ri nuclear test site.

State Signatories reiterated the importance of the full implementation of all relevant United Nations Security Council Resolutions and the complete, verifiable and irreversible denuclearization of the Korean Peninsula in a peaceful manner, including through Six-Party Talks.

They also called upon the People's Democratic Republic of Korea to sign and ratify the CTBT.

REVIEW OF THE FUNCTIONING OF THE ADVISORY GROUP

The Commission and WGA reviewed the functioning of the Advisory Group. They expressed satisfaction regarding the contribution of the Advisory Group and highlighted the importance of considering its functioning. To that end, it was decided to hold further consultations.

APPOINTMENT OF THE CHAIRPERSON OF WORKING GROUP A

The Commission appointed Ambassador Nada Kruger of Namibia as the Chairperson of WGA for a term expiring on 31 December 2021.



Sessions of the Commission and its subsidiary bodies in 2019.



MANAGEMENT

CREATIVE

BE
TEAMWO

WORK TOGETHER

MARK



HIGHLIGHTS

Improving human resources and procurement policies, procedures and processes

Allocation of 80% of the budget to verification related activities

Further strengthening of oversight

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 2019, 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 (audit), 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 2019, 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. Internal Audit also conducted one investigation and submitted the relevant report to the Executive Secretary for consideration. 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.

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.

Internal Audit continued to be actively engaged in forums, such as the Representatives of Internal Audit Services of the United Nations Organizations, whose goal is to share expertise amongst organizations dealing with similar matters and promote the implementation of leading practices.

FINANCE

2018-2019 Programme and Budget

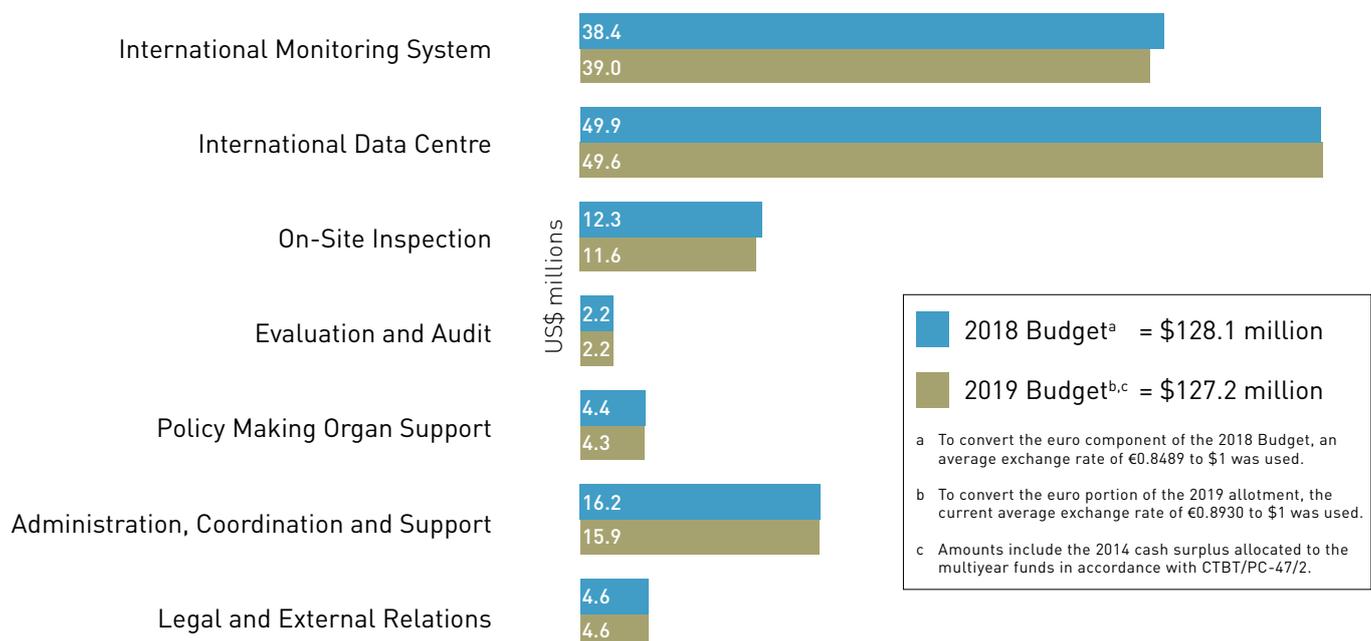
The Budget for 2018 amounted to US\$ 69 747 800 and €49 516 800, corresponding to slightly less than zero real growth. The Commission uses a split currency system to lessen its exposure to fluctuations in the value of the US dollar against the euro. At the budget exchange rate of €0.796 to \$1, the total US dollar equivalent of the 2018 Budget was \$131 955 500. This represented a nominal growth of 1.6% but was almost constant in real terms (a decrease of \$158 900).

On the basis of the actual average exchange rate in 2018 of €0.8489 to \$1, the final total US dollar equivalent of the 2018 Budget was \$128 078 345. Of the total Budget, 80% was originally allocated to verification related activities, including \$13 949 873 for the Capital Investment Fund, which is dedicated to the build-up and sustainment of the IMS, and \$10 721 437 for the multiyear funds that are dedicated to other long term verification related projects.

The Budget for 2019 totalled \$71 468 800 and €49 797 600, corresponding to slightly less than zero real growth. At the budget exchange rate of €0.796 to \$1, the total US dollar equivalent of the 2019 Budget was \$134 028 600. This represented a nominal growth of 1.7% but was almost constant in real terms (a decrease of \$106 600).

On the basis of the actual average exchange rate in 2019 of €0.8930 to \$1, the final total US dollar equivalent of the 2019 Budget was \$127 233 190. Of the total Budget, 80.6% was originally allocated to verification related activities, including \$15 104 402 for the Capital Investment Fund, which is dedicated to the build-up and sustainment of the IMS, and \$ 8 669 995 for the multiyear funds that are dedicated to other long term verification related projects.

DISTRIBUTION OF THE 2018-2019 BUDGET BY AREA OF ACTIVITY



Assessed Contributions

As of 31 December 2019, the collection rates of the assessed contributions from States Signatories for 2019 were 92.1% of the US dollar portion and 92.1% of the euro portion. The number of States that had paid their 2019 assessed contributions in full as of 31 December 2019 was 101.

Expenditure

The expenditure for the Programme and Budget in 2019 amounted to \$129 875 295, of which \$17 678 157 was from the Capital Investment Fund, \$8 825 924 was from the multiyear funds, and the remainder from the General Fund. For the General Fund, the unused budget was \$10 740 076.

GENERAL SERVICES

The PTS concluded the implementation of its major office space utilization optimization plan rolled out in 2017. It consolidated the cross-Divisional arrangement to optimize the use of available space and accommodate pressing archiving needs developed in 2018 to guarantee safe storage of the records and documentation of the Commission.

General Services continued to provide support in travel arrangements and in the processing of visas and accommodation for participants in workshops and meetings of the Commission, including SnT2019. It also continued to facilitate the works of the TeST Centre at Seibersdorf, Austria, and continued to service its needs.

Cooperation and dialogue with other Vienna based organizations was further strengthened, with the PTS actively participating in all common committees and joint advisory committees.

The modernization of the transport fleet of the PTS that was launched in 2018 continued in 2019.

PROCUREMENT

A new Procurement Manual was created which outlines the procurement related processes and procedures for internal use. Two of the projects started in 2018 to increase efficiencies and effectiveness and further promote transparency and accountability have been completed. These focused on offline efficiencies such as documentation, filing, client meetings, contract management training and internal procurement training for clients. The third project will officially begin in January 2020 and will be focused on online (Enterprise Resource Planning related) efficiencies.

The Commission obligated \$74 209 644 through 1063 procurements for high value purchases and \$1 102 406 through 679 contractual instruments for low value purchases.

As of 31 December 2019, 145 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.

VOLUNTARY SUPPORT FORUM

The Voluntary Support Forum was initiated in 2014 as a forum for interaction with the donor community and to ensure that voluntary contributions serve the strategic goals of the Commission. 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. Since 1999, the Commission has received approximately \$92 million in cash contributions and \$63 million in contributions in kind. The last meeting of the Voluntary Support Forum was in 2018, as the surrender of the cash surplus was subject to the deliberations of States Signatories in the second half of 2019. The forum will again be scheduled in 2020.

UNITED NATIONS JOINT STAFF PENSION FUND

On 1 January 2019, membership of the Commission in the United Nations Joint Staff Pension Fund (UNJSPF) became effective, in accordance with the Agreement signed between the Commission and the United Nations Joint Staff Pension Board as to the conditions governing the admission of the Commission to membership in the UNJSPF.

The liquidation of the preceding scheme, the Provident Fund, was successfully processed in 2019.

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 2019, there were 273 regular fixed term staff members of the PTS from 83 countries, compared with 278 staff members from 86 countries on 31 December 2018. In 2019, there were 181 staff members in the Professional and higher categories, while in 2018 there were 183.



Annual management retreat.

FIXED TERM STAFF MEMBERS BY FIELD OF WORK AS OF 31 DECEMBER 2019

| Field of Work | Professional | General Service | Total |
|---|---------------|-----------------|---------------|
| QMPM Section | 3 | 1 | 4 |
| IMS Division | 35 | 24 | 59 |
| IDC Division | 76 | 15 | 91 |
| OSI Division | 18 | 7 | 25 |
| Subtotal, verification related | 132 | 47 | 179 |
| Share, verification-related | 72.93% | 51.09% | 65.57% |
| Office of the Executive Secretary | 5 | 2 | 7 |
| Internal Audit | 3 | - | 3 |
| Human Resources Services | 4 | 6 | 10 |
| Division of Administration | 21 | 20 | 41 |
| Legal and External Relations Division | 16 | 17 | 33 |
| Subtotal, non verification related | 49 | 45 | 94 |
| Share, non-verification related | 27.07% | 48.91% | 34.43% |
| Total | 181 | 92 | 273 |

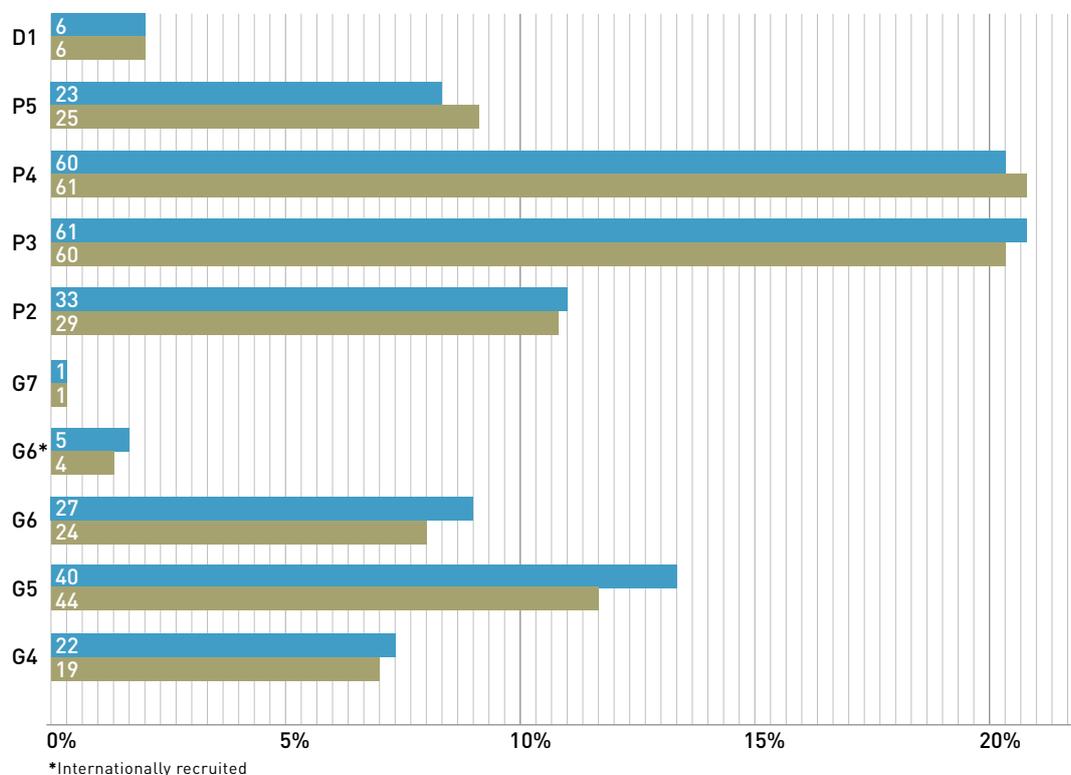
FIXED TERM STAFF MEMBERS BY GRADE, 2018 AND 2019

2018

183 Professional
95 General Service

2019

181 Professional
92 General Service

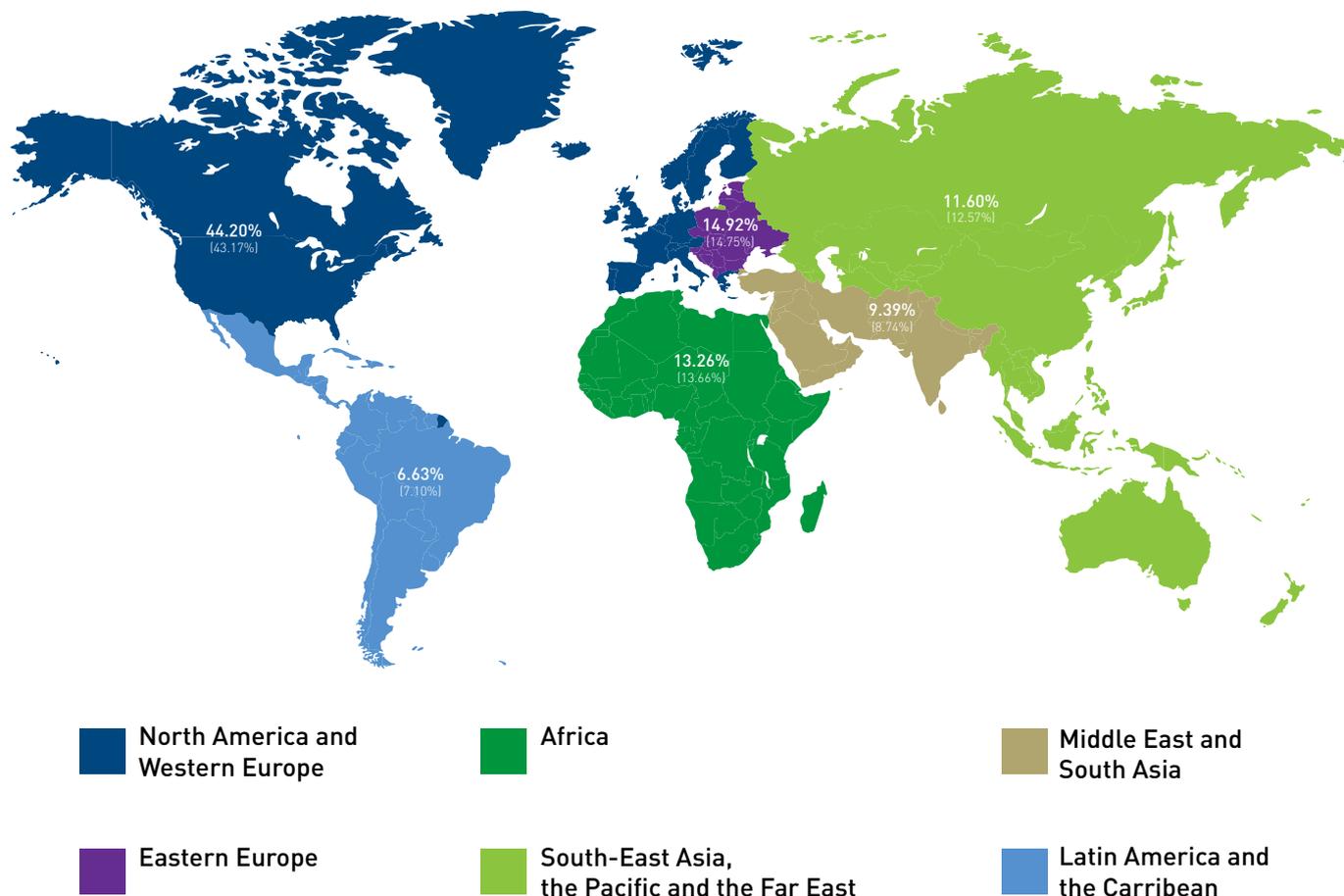


FIXED TERM STAFF MEMBERS BY GRADE AND GENDER, 2018 AND 2019

| Grade | Male | | | | Female | | | |
|--------------|------------|---------|------------|---------|------------|---------|------------|---------|
| | 2018 | | 2019 | | 2018 | | 2019 | |
| D1 | 3 | 1.79 % | 3 | 1.84 % | 3 | 2.73 % | 3 | 2.73 % |
| P5 | 18 | 10.71 % | 19 | 11.66 % | 5 | 4.55 % | 6 | 5.45 % |
| P4 | 47 | 27.98 % | 45 | 27.61 % | 13 | 11.82 % | 16 | 14.55 % |
| P3 | 45 | 26.79 % | 44 | 26.99 % | 16 | 14.55 % | 16 | 14.55 % |
| P2 | 15 | 8.93 % | 14 | 8.59 % | 18 | 16.36 % | 15 | 13.64 % |
| Subtotal | 128 | 76.19 % | 125 | 76.69 % | 55 | 55.45 % | 56 | 50.91 % |
| G7 | - | - | - | - | 1 | 0.91 % | 1 | 0.91 % |
| G6* | 5 | 2.98 % | 4 | 2.45 % | - | - | - | - |
| G6 | 18 | 10.71 % | 16 | 9.82 % | 9 | 8.18 % | 8 | 7.27 % |
| G5 | 12 | 7.14 % | 13 | 7.98 % | 28 | 25.45 % | 31 | 28.18 % |
| G4 | 5 | 2.98 % | 5 | 3.07 % | 17 | 15.45 % | 14 | 12.73 % |
| Subtotal | 40 | 23.81 % | 38 | 23.31 % | 55 | 46.36 % | 54 | 49.09 % |
| Total | 168 | | 163 | | 110 | | 110 | |

*Internationally recruited

FIXED TERM PROFESSIONAL STAFF BY GEOGRAPHICAL REGION AS OF 31 DECEMBER 2019 (Percentages as of 31 December 2018 are shown in brackets.)



SIGNATURE AND RATIFICATION

As of 31 December 2019

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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