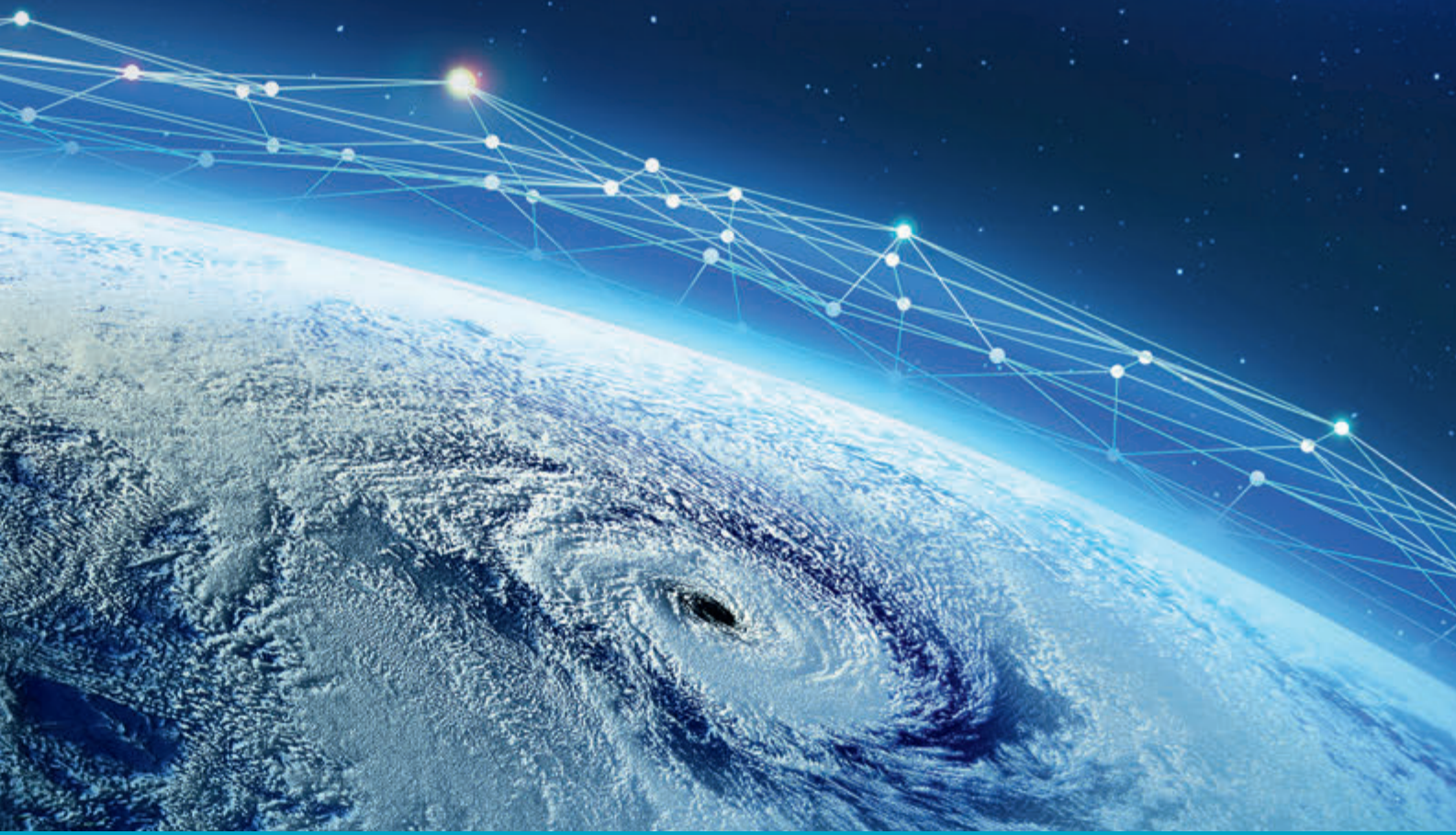
CTBTO
PREPARATORY COMMISSION

A GOAL WITHIN REACH

ANNUAL REPORT 2018



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The maps on pages 15–18 show the approximate locations of International Monitoring System facilities based on information in Annex 1 to the Protocol to the Treaty adjusted, as appropriate, in accordance with proposed alternative locations that have been approved by the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization for reporting to the initial session of the Conference of the States Parties following entry into force of the Treaty.

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Message

From the Executive Secretary

At a time of pressing political and security concerns, the Comprehensive Nuclear-Test-Ban Treaty (CTBT) has become a rallying point for unity and commitment to the goal of nuclear non-proliferation and disarmament. This was vividly manifested throughout 2018.

Our activities in 2018 were aligned with the strategic goals of the Medium Term Strategy: 2018-2021, which include acceptance of the verification system, global commitment to the CTBT and an efficient and sustainable Secretariat.

In pursuit of these goals, we aimed to build upon the momentum of support for the Treaty and to further its ratification and signature. We increased our high level engagement with States and promoted the roles of youth and women in the outreach activities of the organization. Sustainment and expansion of the International Monitoring System (IMS) and further development of our on-site inspection (OSI) regime enhanced the capabilities and robustness of our verification system.

The contribution of the Treaty to the global norm of nuclear non-proliferation and disarmament, its universality and the work of the organization continued to be on the agenda of the international community. World leaders, State officials and civil society representatives renewed the call for entry into force of the CTBT and supported our activities in many ways. Recognition of the expertise of the Commission and the potential for its involvement in the denuclearization process of the Korean Peninsula was of particular interest in 2018.

The CTBT featured as one of the pillars of the nuclear disarmament and non-proliferation regime at key events, including the high level week of the seventy-third session of the United Nations General Assembly in New York, the ninth Ministerial Meeting of the Friends of the CTBT and the 2018 Preparatory Committee for the 2020 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons.

Ministers and other high ranking officials attending the Ministerial Meeting of the Friends of the CTBT heralded the Treaty as one of the most concrete and practical measures towards the ultimate goal of nuclear disarmament and emphasized that its full ratification and entry into force is well overdue.

The Treaty was ratified by Thailand and signed by Tuvalu on 25 September, on the margins of the high level week of the United Nations General Assembly. This brought the number of signatures to 184 and the number of ratifications to 167.

The Inter-Korean Summits, the summit in Singapore between the United States President and the Chairman of the Democratic People's Republic of Korea and the announcements following these historic meetings suggested a positive trend. I was heartened by the announcement by the Democratic People's Republic of Korea of its commitment to the denuclearization of the Korean Peninsula. If successful, this can open a new chapter in efforts to promote regional peace and security. The Commission stands ready, if invited and with the approval of the States Signatories, to contribute within its mandate to the implementation of an agreement between the parties. Our expertise can support verification activities or confidence building measures aimed at confirming the permanent closure of the nuclear test sites in the Democratic People's Republic of Korea and verifying its commitment to the nuclear test ban.

I strongly believe that the final agreement between the parties must include signature and ratification of the CTBT by the Democratic People's Republic of Korea, thus advancing its entry into force.

On the eve of the Singapore Summit, I issued a joint appeal with the Coordinators of the Article XIV process, Mr Didier Reynders, Deputy Prime Minister and Minister of Foreign Affairs and European Affairs of Belgium, and Mr Ibrahim Al-Jafaari, Minister of Foreign Affairs of Iraq. The appeal expressed hope that these talks would provide a basis for progress on the verifiable denuclearization of the Korean Peninsula. It also highlighted the importance of a legally binding and irreversible end to the nuclear testing programme of the Democratic People's Republic of Korea through signature and ratification of the CTBT.

In 2018, I met with a number of Heads of State and Government, Foreign Ministers and other senior State officials, including those from Algeria, Australia, Austria, Bangladesh, Belgium, Burkina Faso, China, the Comoros, Côte d'Ivoire, Croatia, Cuba, Cyprus, Denmark, Ecuador, Ethiopia, Finland, France, Germany, Iceland, the Islamic Republic of Iran, Iraq, Israel, Italy, Japan, Jordan, Kazakhstan, Kuwait, Libya, Madagascar, Malaysia, the Netherlands, Niger, the Republic of Korea, the Russian Federation, Rwanda, Slovakia, Slovenia, South Africa, Spain, Thailand, Tunisia, Turkmenistan, Tuvalu, the United Kingdom of Great Britain and Northern Ireland, the United States of America and Zimbabwe, and the High Representative of the European Union for Foreign Affairs and Security Policy.

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 raise public awareness of the CTBT and the work of the organization, the 2nd CTBT Science Diplomacy Symposium was held in Vienna from 21 May to 1 June 2018. More than 120 policy makers, diplomats, academics, students and young professionals from around the globe attended this event, with an additional 200 participants following online. The symposium offered a series of in-depth, dynamic discussions on the legal, political and technical aspects of the Treaty. Participants were encouraged to think creatively and seek collective solutions to global peace and security issues. The session on 25 May was a highlight, with high level officials including the Austrian Federal Minister for Europe, Integration and Foreign Affairs; the Minister of Science, Technology and Environment of Cuba; and the United Nations High Representative for Disarmament Affairs addressing and interacting with participants.

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.

Establishment and sustainment of the 321 monitoring stations and 16 radionuclide laboratories of the IMS is essential to meeting the verification requirements of the Treaty as well as protecting the investment of the Commission. In early 2018, I visited China to celebrate the certification of four IMS stations, marking a significant step towards the completion of our monitoring network. These included two seismic and two radionuclide stations, bringing the total certified stations in China to five. In addition, we completed the installation of the radionuclide station in Niger and certified an infrasound station in Australia, a seismic station in Ethiopia and a radionuclide station in Thailand. With these certifications, our verification network now comprises 297 certified facilities, representing 88% of the network foreseen by the Treaty. This 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 2018, we continued to implement the OSI action plan for 2016-2019 and the OSI exercise plan for 2016-2020. Activities included training courses in the third OSI training cycle for future inspectors.

The establishment of a permanent Equipment Storage and Maintenance Facility is a major multiyear project of the Commission. With the design of the facility completed, construction started in January 2018. By the end of the year, we had entered the final phase of the project. The facility is slated to become operational in mid-2019. I am pleased to note that we have managed to stay on schedule and within budget.

Throughout the year and across the organization, we have sought to enhance synergy, streamline our activities and build on previous efforts to apply the best practices and procedures of other international organizations. Towards that end, the Commission decided to join the United Nations Joint Staff Pension Fund as of 1 January 2019. We also implemented a human resources management structure that is more flexible and closely aligned with our strategic goals and programmatic needs. A new talent acquisition programme will address the challenge of recruiting the most highly qualified and experienced staff while improving gender balance and geographical representation.

At the annual meeting of the American Association for the Advancement of Science in February 2018, I had the honour to receive the Science Diplomacy Award in recognition of the commitment to eliminating nuclear testing. The award ceremony highlighted the value of science diplomacy in resolving nuclear testing issues. I share this recognition with the States Signatories and the staff of the organization.

This is only a brief overview of some highlights from 2018. The following pages present a more detailed summary of the main activities of the Commission throughout the year.

I would like to take this opportunity to express my gratitude to the States Signatories for their unwavering support, which has enabled us to advance the Treaty and enhance the capabilities of its verification regime. I am also thankful to the staff of the organization, whose dedication and hard work make tangible our steadfast commitment to international peace and security.

The entry into force of the Treaty is a goal within reach. Let us continue building on our collective achievements and ensure a better future for humanity.

Lassina Zerbo
Executive Secretary
CTBTO Preparatory Commission
Vienna, April 2019

CONTENTS

ABBREVIATIONS

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

The Treaty

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

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

When the Treaty enters into force, the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) will be established in Vienna, Austria. The mandate of this international organization is to achieve the 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.

THE INTERNATIONAL MONITORING SYSTEM

HIGHLIGHTS IN 2018

Significant progress in the build-up of the IMS with 88% of its facilities certified

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

Innovative approach to the installation of radionuclide station RN48 (Niger) by training national technicians to fully manage and install the station

Nearshore cable inspection of hydroacoustic station HA1 (Australia).

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) i n 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 2018, following outreach to host States, the Commission made further progress with the installation and establishment of facilities in a number of States. Installation of radionuclide station RN48 (Niger) was completed. Three IMS stations were certified (auxiliary seismic station AS30 (Ethiopia), radionuclide station RN65 (Thailand) and infrasound station IS3 (Australia)), bringing the total number of certified IMS stations and laboratories to 297 (88% of the network foreseen by the Treaty), thus improving both the coverage and the 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 2018 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 2018. The noble gas proficiency test framework is reaching enough maturity to be considered to become official. PTEs are a key element of quality assurance and quality control (QA/QC) of IMS laboratories.

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

Pre-certification visit and training in France for station operators of radionuclide station RN48 (Niger).

Status of the Installation and Certification of International Monitoring System Stations as of 31 December 2018

284 INSTALLED& CERTIFIED | **10** INSTALLED | **5** UNDER CONSTRUCTION | **6** 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

51	Installed & Certified
1	Installed
1	Under Construction
2	Under Negotiation
5	Not Started

80 RADIONUCLIDE STATIONS

70	Installed & Certified
1	Installed
1	Under Construction
3	Under Negotiation
5	Not Started

40 NOBLE GAS SYSTEMS

25	Installed & Certified
31	Installed

16 RADIONUCLIDE LABORATORIES

13	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 2018, 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 2018 was US$19 099 414. This amount covers the costs related to PCAs for 177 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 2018, 129 out of 164 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 2018 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.

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

Logistics

The Commission further developed its capability for logistic support analysis in order to strive for the highest possible levels of data availability at optimal cost. With over 290 certified IMS facilities around the world, often in remote sites, maintaining the highest levels of data availability requires continuous analysis, refinement and validation of station life cycle costs and reliability variables. During 2018, the Commission continued its efforts to refine and validate models, with the aim of improving planning for the sustainment of the IMS network.

Effective configuration management strengthens overall confidence that IMS monitoring facilities meet technical specifications and other requirements for certification. It ensures that changes at stations are rigorously assessed to determine their effect and, when the changes are implemented, reduces costs, effort and unforeseen drops in data availability.

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 analyse and work towards optimizing the availability of IMS equipment and consumables at IMS stations, at its regional depots, at supplier depots and at the central depot in Vienna.

Maintenance

The PTS provides maintenance support and technical assistance at IMS facilities around the globe. During 2018, 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 manufacturers of IMS equipment 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 2018, 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.

Air flow measurement at radionuclide station RN33 (Germany).

Complete and updated station specific technical documentation can contribute to the efficient sustainment of IMS stations. Additional progress was made in 2018, with standard drawings completed for 51 IMS stations, 89% of required reports and records available, and station standard operating procedures (SOPs) reviewed and approved.

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 2018, 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 completed at certified IMS facilities in 2018, involving a substantial investment of human and financial resources. In seven cases, namely PS7 (Brazil), PS31 (Republic of Korea), PS45 (Ukraine), IS9 (Brazil), IS41 (Paraguay) and IS50 and IS52 (United Kingdom), recapitalization was followed by revalidation to ensure that the stations continued to meet technical requirements. Major upgrades of noble gas systems at one certified radionuclide station (RN44, Mexico) and one infrasound station (IS50, United Kingdom) were also completed.

Nearshore cable inspection of hydroacoustic station HA1 (Australia) was concluded in March 2018, resulting in a recommendation for temporary stabilization and long term sustainment. The recapitalization of the electronics at the onshore central recording facility of the station was concluded in July 2018 to improve data logging and state of health monitoring.

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.

Implementation of on-site calibration capability at infrasound station IS39 (Palau).

In 2018, 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 2018 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 2018, the Commission concentrated its engineering efforts on the following:

- Acceptance testing of new seismoacoustic equipment including high resolution digitizers and infrasound sensors.
- Definition of standard processes for type approval, acceptance testing, initial calibration and on-site calibration of seismoacoustic measurement systems with support from the scientific community and national metrology institutes.
- Collaboration with the International Bureau of Weights and Measures on measurement science for seismoacoustic monitoring technologies.
- Implementation of on-site calibration capability at four infrasound stations (IS3 (Australia), IS39 (Palau), IS41 (Paraguay) and IS52 (United Kingdom)).
- Further development of the standard station interface (SSI) in order to improve the software robustness and the provision of valuable state of health information to station operators and to support additional seismometer–digitizer combinations with the objective of streamlining calibration activities for station operators.
- Design of a set of standard power solutions for stations with the objective to test prototype systems in 2019.
- Update of grounding and lightning protection standards to the latest international standards.
- Development and deployment of digital meteorological stations at infrasound stations to improve the availability and quality of meteorological measurements.
- Assessment of next-generation hydroacoustic stations and potential temporary solutions.
- Expert study focusing on the remaining life of the hydrophone triplet(s) of hydroacoustic station HA8 (United Kingdom) to define corrective measures and cost effective solutions to improve long term sustainability. The north triplet has not transmitted data since March 2014 owing to cable damage.
- Establishment of a framework and acceptance document for the testing and integration of next-generation noble gas systems.
- Continued improvement of high purity germanium detectors, with the testing of a hardened detector design with improved vacuum.

In addition, four next-generation noble gas systems are currently under development or fully developed. The PTS continued to collaborate with the developers in preparation for system testing against IMS certification requirements. The systems must demonstrate operation at 95% data availability for one year prior to deployment in the IMS. Two of the four systems have already started the one year testing period.

Guidelines for power at radionuclide stations were drafted and will be used as a reference during the establishment of new stations and for power upgrading and refurbishment.

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.

Auxiliary Seismic Network

The Commission continued to monitor the operation and sustainment of auxiliary seismic stations in 2018. The data availability of auxiliary seismic stations was sustained during the year.

Installation of infrasound station IS3 (Australia).

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

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

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

Quality Assurance

In addition to improving performance at individual stations, the Commission accords great importance to ensuring the reliability of the IMS network as a whole. Hence, its engineering and development activities in 2018 continued to focus on measures for data surety and calibration.

The Commission further developed its calibration methodologies. In particular, in situ infrasound calibration capability was established at four infrasound stations during 2018. The Commission also continued the scheduled calibration of primary and auxiliary seismic 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.

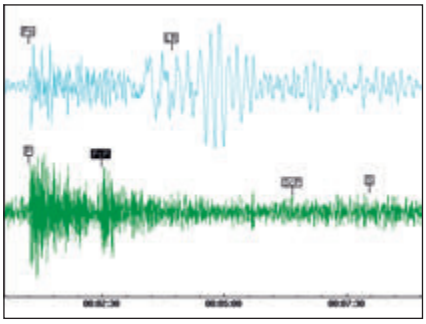
Under the QA/QC programme for radionuclide laboratories, the Commission assessed the 2017 PTE and conducted the 2018 PTE. The Commission also undertook a laboratory surveillance visit to radionuclide laboratory RL3 (Austria).

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.

Preparation of a noble gas sample for measurement at radionuclide laboratory RL3 (Austria).

Profiles of the Monitoring Technologies



Example of seismic waveform.

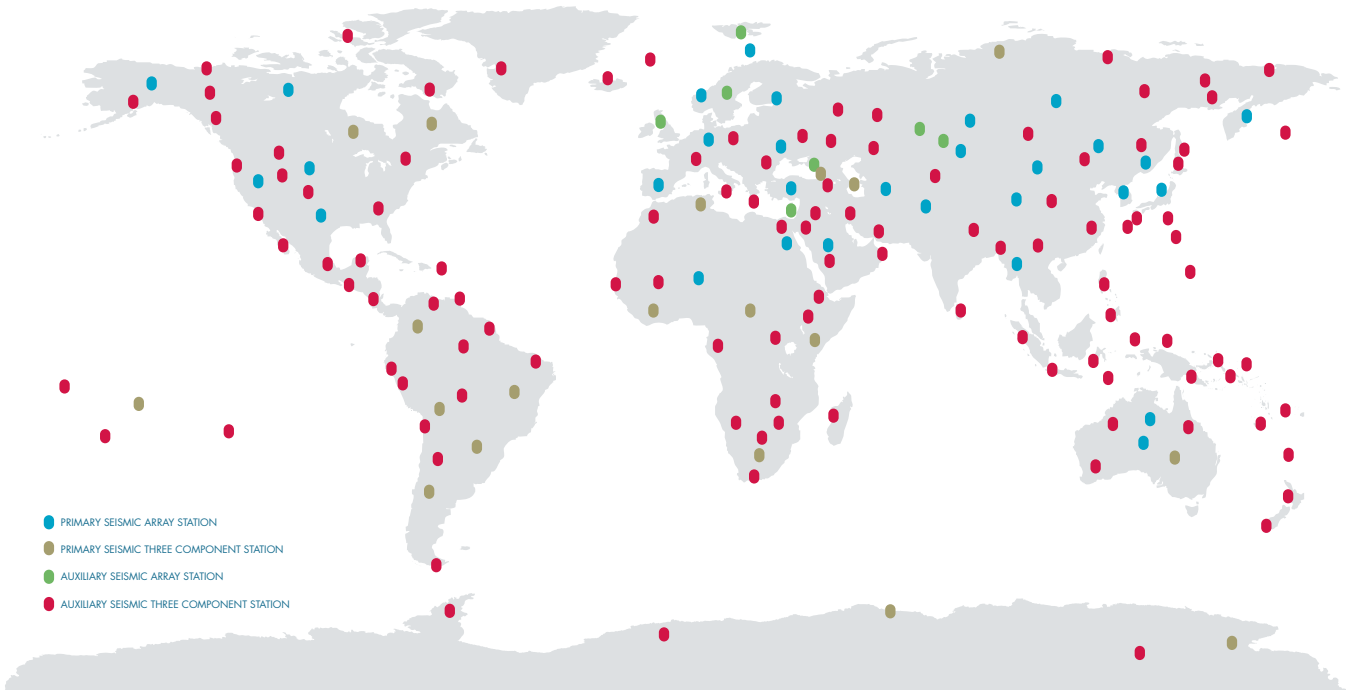
The objective of seismic monitoring is to detect and locate underground nuclear explosions. Earthquakes and other natural events as well as anthropogenic events generate two main types of seismic wave: body waves and surface waves. The faster body waves travel through the interior of the earth, while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



INFRASOUND

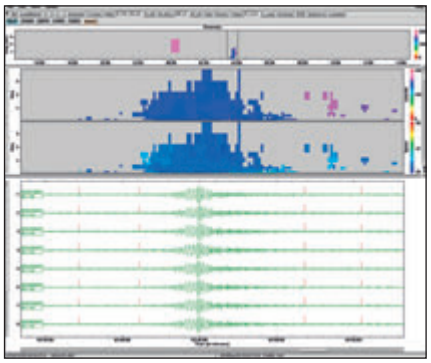
60 STATIONS **34** COUNTRIES

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

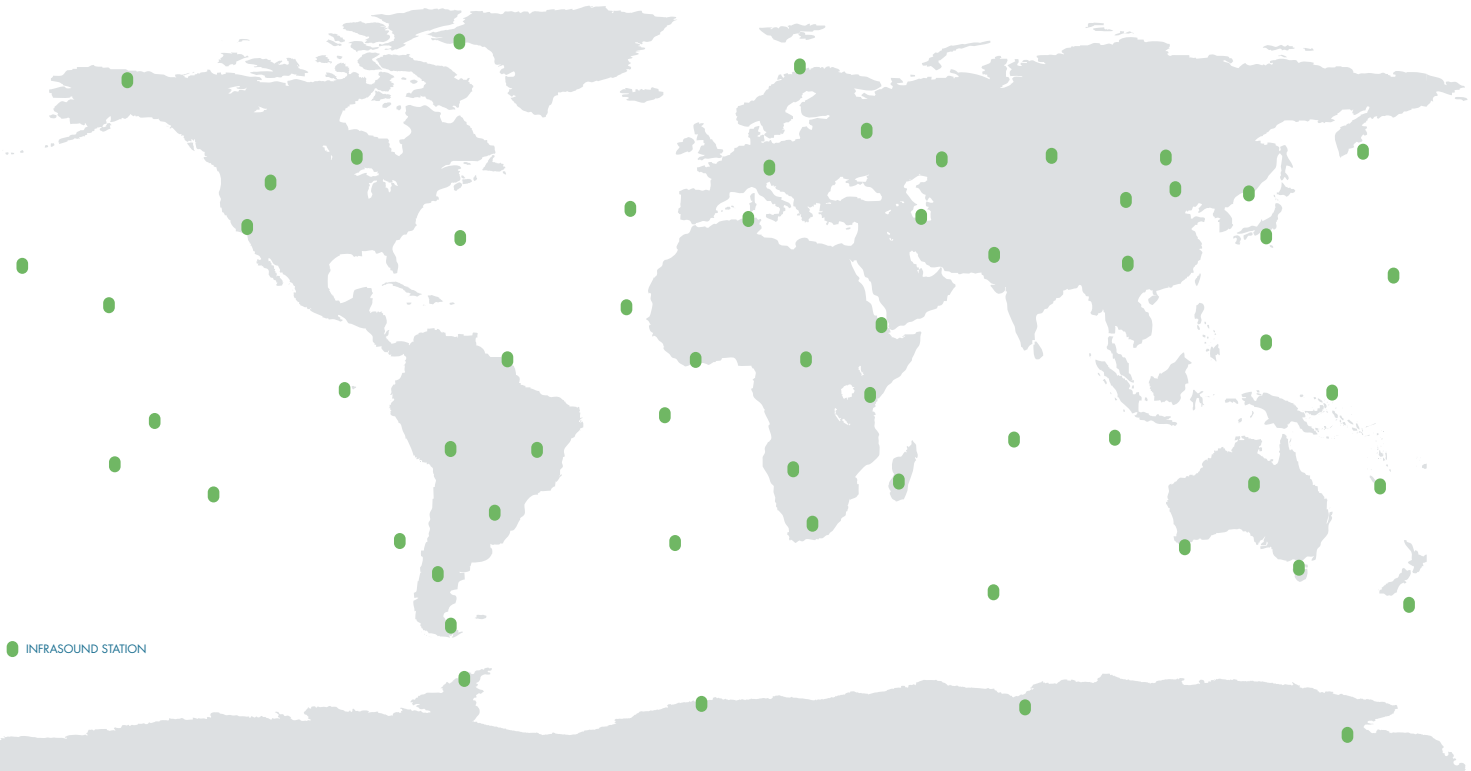
Infrasound waves cause minute changes in the atmospheric pressure that are measured by microbarometers. Infrasound has the ability to cover long distances with little dissipation, which is why infrasound monitoring is a useful technique for detecting and locating atmospheric nuclear explosions. In addition,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

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.

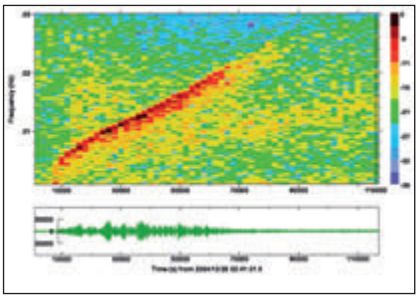


Example of infrasound waveform.



HYDROACOUSTIC

11 STATIONS **8** COUNTRIES



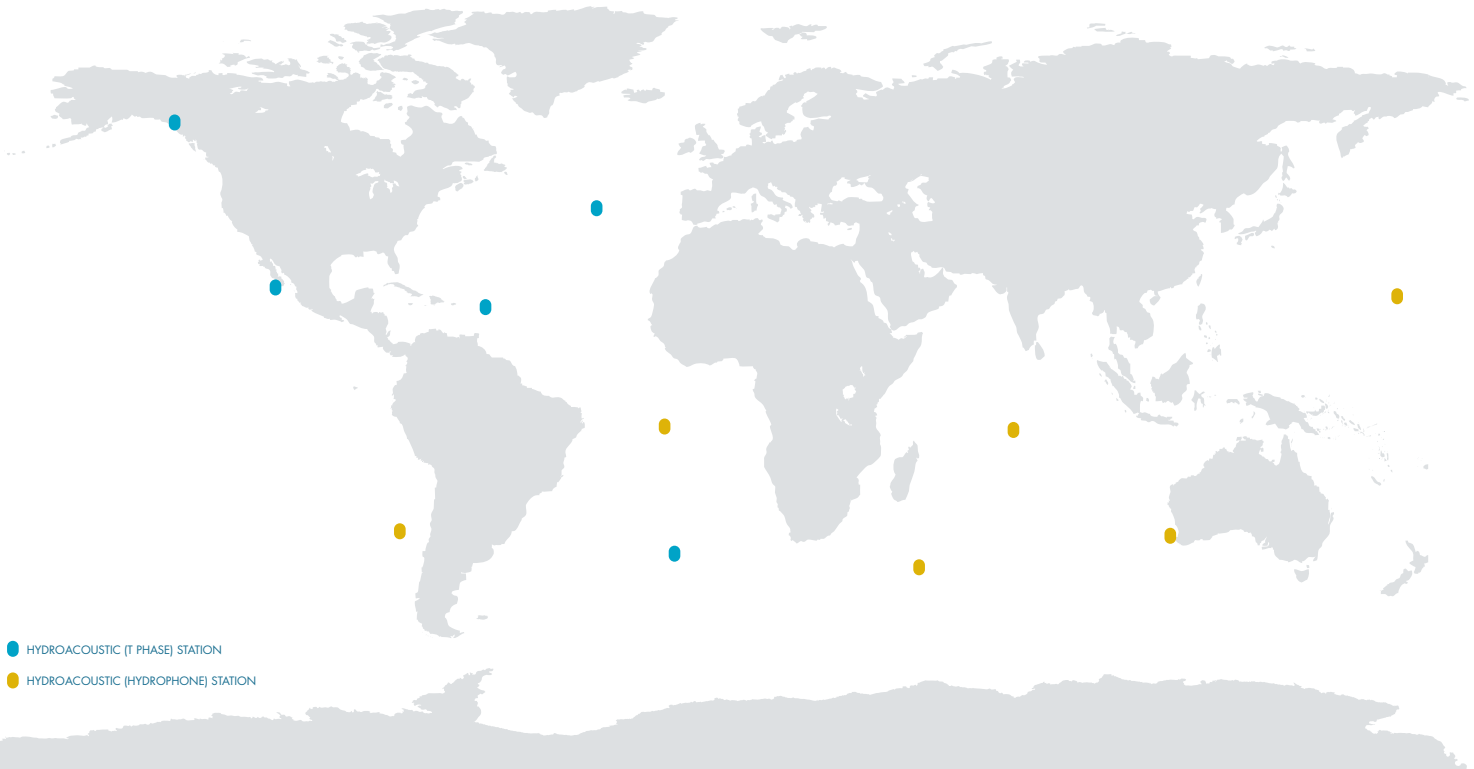
Example of hydroacoustic waveform.

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.



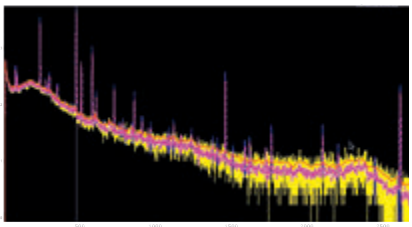
RADIONUCLIDE PARTICULATE

96 FACILITIES **41** COUNTRIES

80 STATIONS **16** LABORATORIES

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.

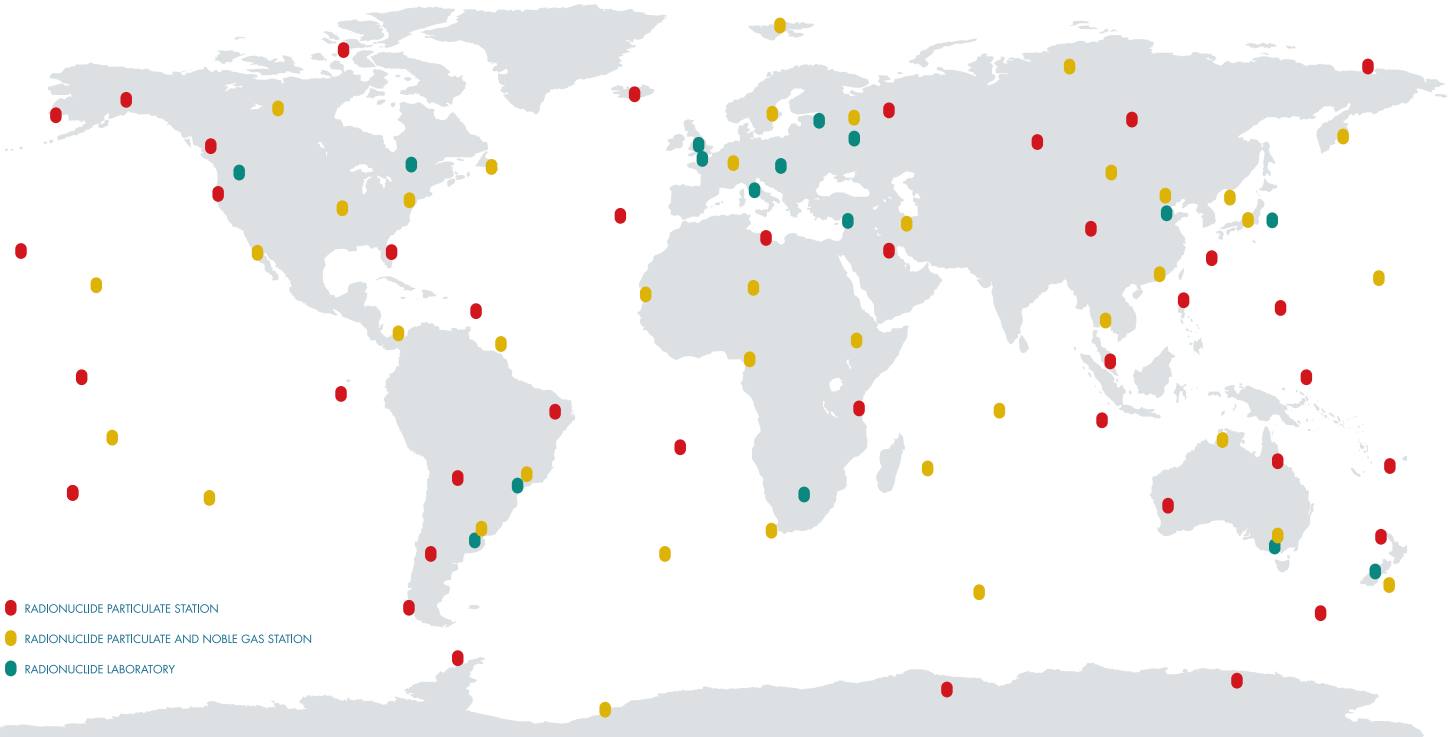


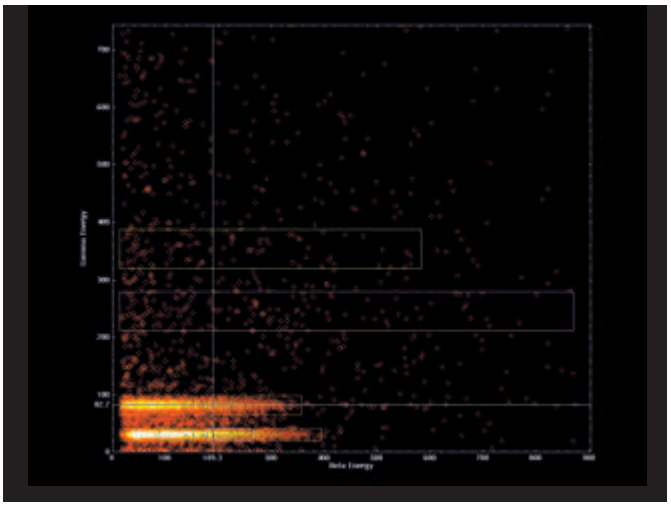
Example of gamma spectra.

Noble Gas Detection Systems

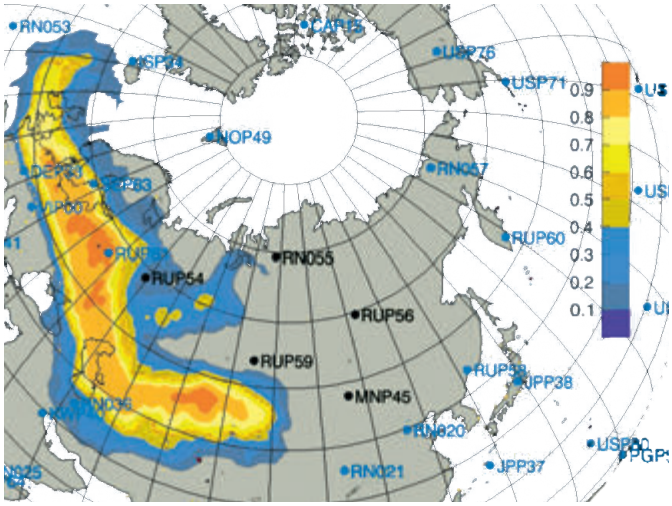
The Treaty requires that, by the time it enters into force, 40 of the 80 IMS radionuclide particulate stations also have the capability to detect radioactive forms of noble gases such as xenon and argon. Special detection systems have therefore been developed and are being deployed and tested in the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





Example of beta–gamma spectra.



Example of atmospheric transport modelling.

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

All of the noble gas detection systems in the IMS work in a similar way. 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.

THE GLOBAL COMMUNICATIONS INFRASTRUCTURE

HIGHLIGHTS IN 2018

High GCI availability maintained through migration to new infrastructure

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

Third generation of the GCI for 2018-2028 is operational

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

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 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.

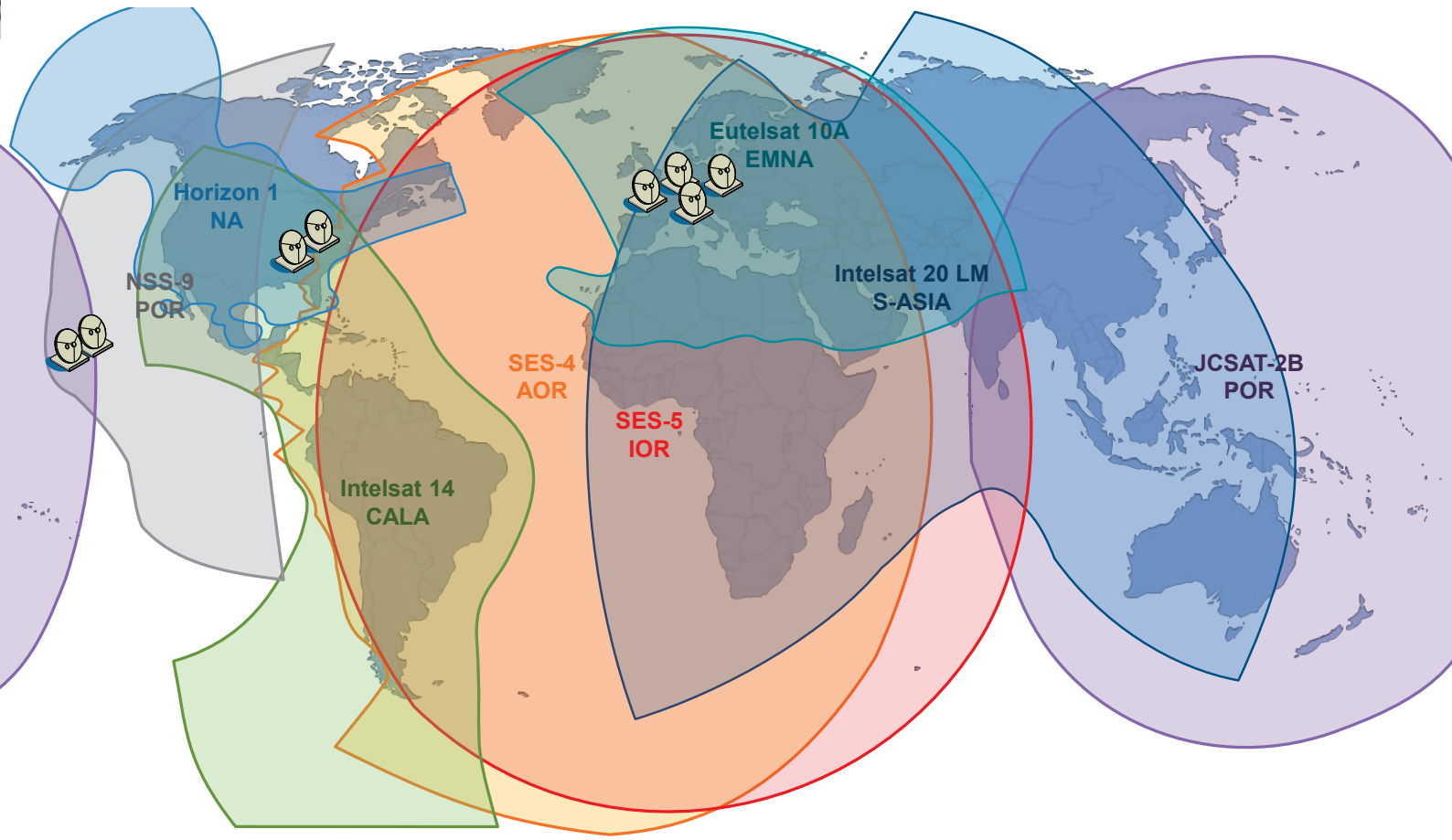
At the end of 2018, the GCI network included 266 redundant links. Of these, 206 are primary VSAT links backed up by 3G (110 links), BGAN (76 links), VPN (14 links) or VSAT (6 links). There are also 43 VPN links with VPN or 3G backup, 10 links with 3G primary and BGAN backup and 7 terrestrial multiprotocol label switching links. In addition, 71 independent subnetwork links and 6 Antarctic communication links were operated by 10 States Signatories to carry IMS data to a GCI connection point. In total, the combined networks have over 600 different communication links to transport data to and from the IDC.

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 adjusted availability figure. In 2017, this was 99.68%. Full statistics for the calendar year 2018 are not available owing to the migration process from GCI II to GCI III. The adjusted availability for GCI III in the first six months of the operational phase (July-December 2018) was 99.58%. No sites went offline on the 30 June migration deadline. To avoid interruptions in service, the GCI III contractor, at its own expense, re-contracted some of the GCI II VSAT links temporarily to allow the primary links of the remaining stations to be migrated without loss of data communications.

Over the year, data transported over the GCI from IMS facilities to the IDC and from the IDC to NDCs averaged 36 gigabytes per day. Data sent to NDCs that are directly connected to the IDC averaged 11.9 gigabytes per day. These figures are similar to those of 2017.

Satellite Coverage of Global Communications Infrastructure III



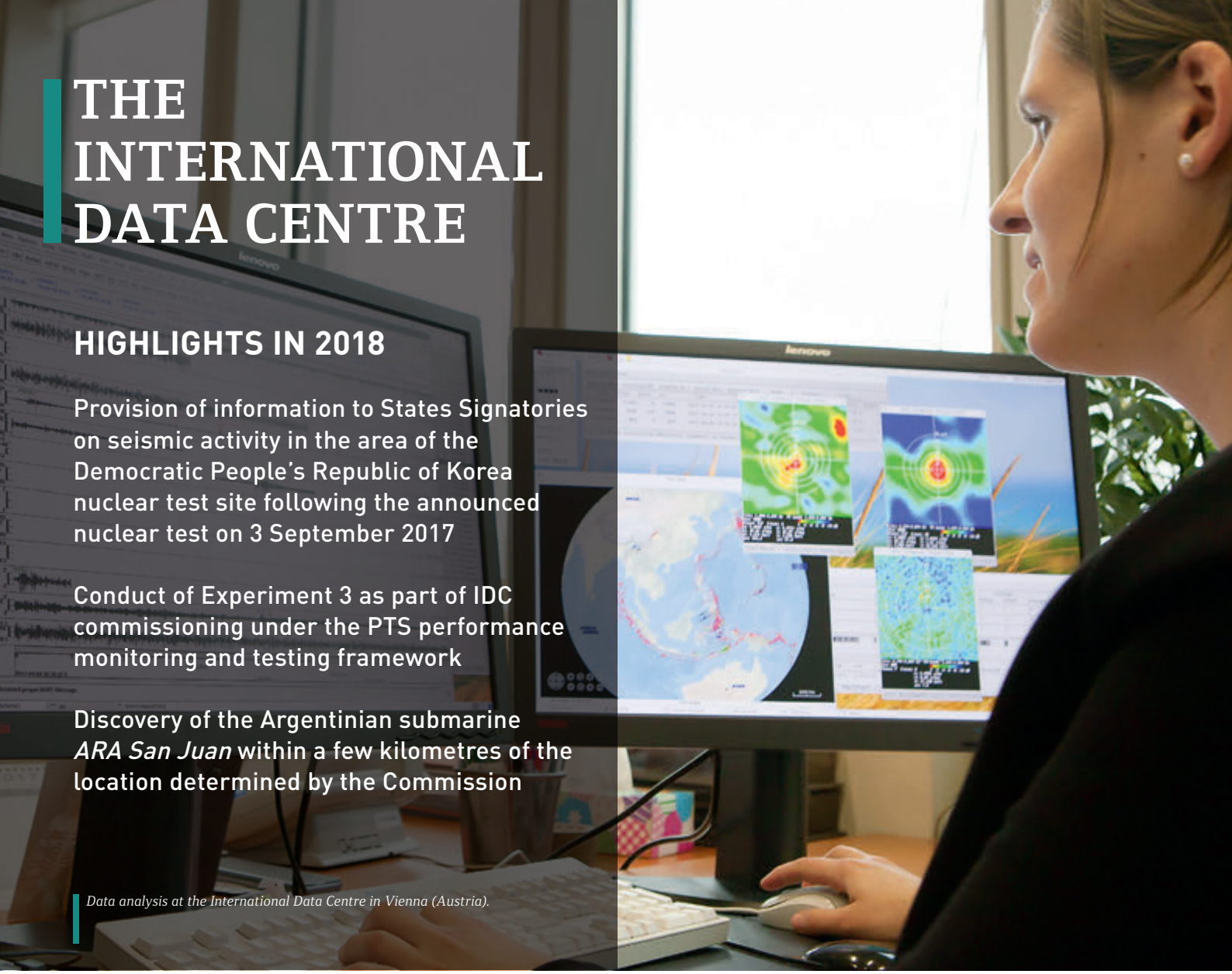
THE INTERNATIONAL DATA CENTRE

HIGHLIGHTS IN 2018

Provision of information to States Signatories on seismic activity in the area of the Democratic People's Republic of Korea nuclear test site following the announced nuclear test on 3 September 2017

Conduct of Experiment 3 as part of IDC commissioning under the PTS performance monitoring and testing framework

Discovery of the Argentinian submarine *ARA San Juan* within a few kilometres of the location determined by the Commission



Data analysis at the International Data Centre in Vienna (Austria).

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 2 days.

Radionuclide Measurements and Atmospheric Modelling

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

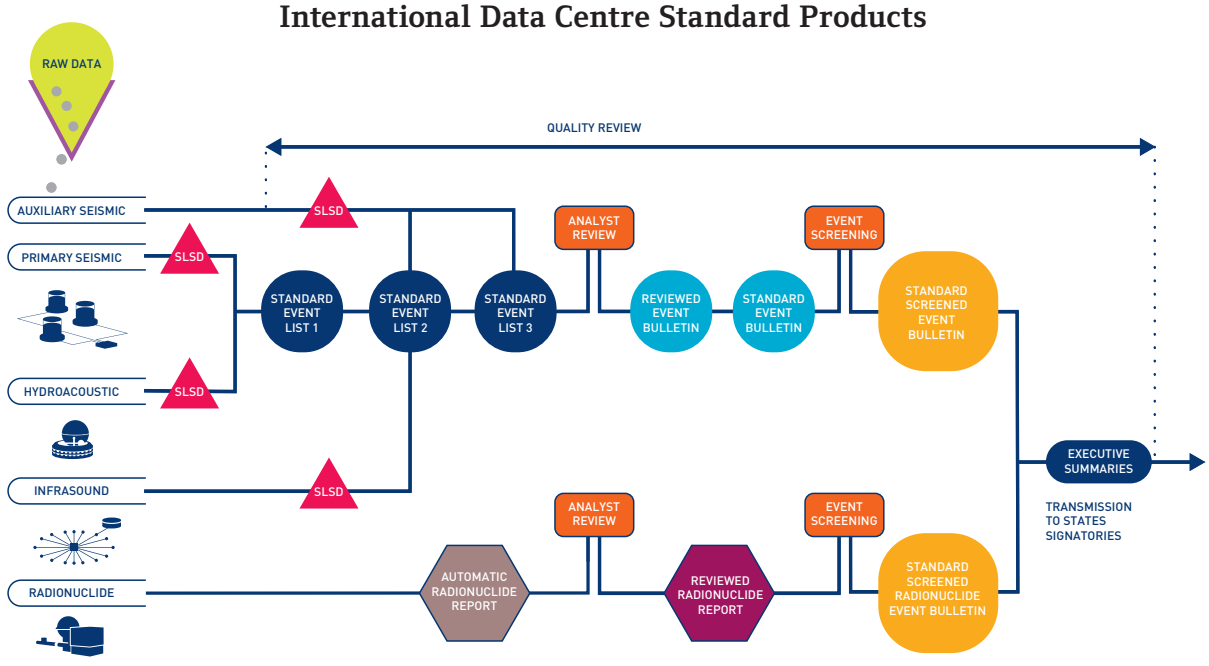
The Commission performs daily atmospheric backtracking calculations for each of the IMS radionuclide stations with near real time meteorological data obtained from the European Centre for Medium-Range Weather Forecasts (ECMWF) and from the National Centres for Environmental Prediction (NCEP). Images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

To corroborate the backtracking calculations, the Commission collaborates with the World Meteorological Organization (WMO) through a joint response system. This system enables the Commission to send requests for assistance in the case of suspicious radionuclide detections to 10 regional specialized meteorological centres or national meteorological centres of the WMO located around the world. In response, the centres aim to submit their computations to the Commission within 24 hours.

Distribution to States Signatories

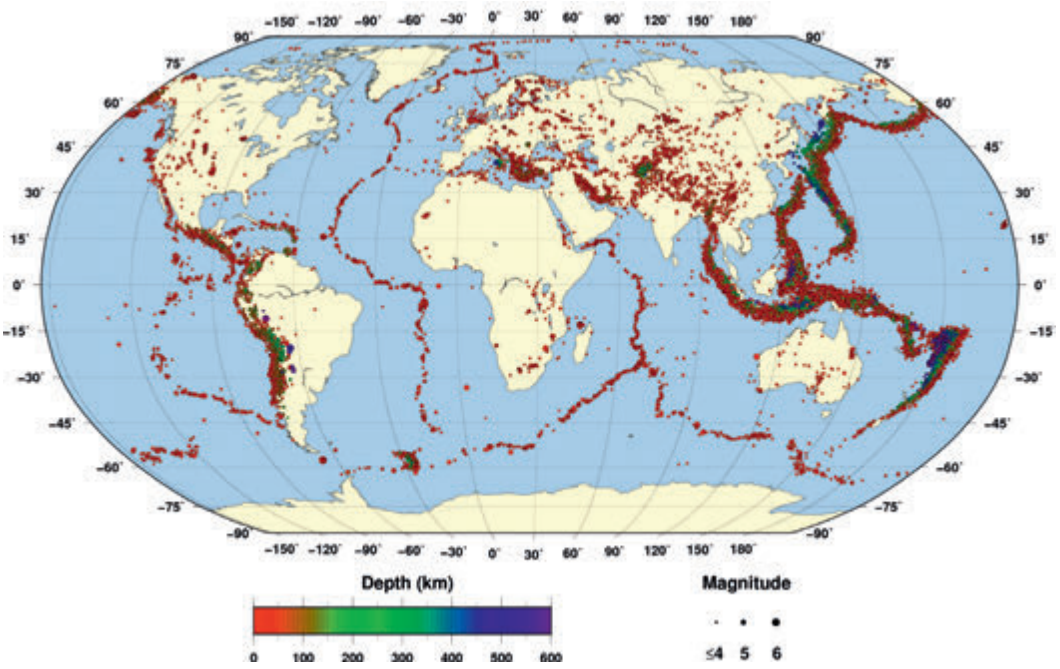
After these data products have been generated, they must be distributed in a timely way to States Signatories. The IDC provides subscription- and Internet-based access to a variety of products, ranging from near real time data streams to event bulletins and from gamma ray spectra to atmospheric dispersion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

International Data Centre Standard Products



SLSD: STANDARD LIST OF SIGNAL DETECTIONS

2018 Reviewed Event Bulletin
(36 267 Events)



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 2018, the PTS conducted Experiment 3, a two week test of various capabilities of the IDC. 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).

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

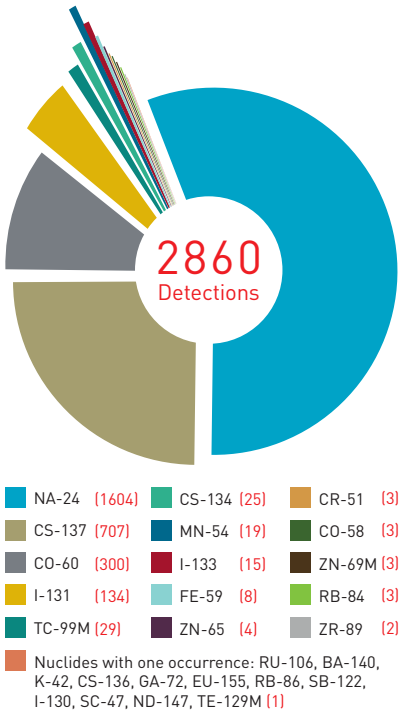
Within ongoing software modernization efforts, the IDC is developing a novel software application for the interactive analysis of radionuclide data. The new iNtegrated Software Platform for the Interactive Review (iNSPIRE) application is based on modern open source software development technologies. It is a single platform that will replace three tools that are currently used in IDC Operations and in the NDC in a box software package for radionuclide particulate and noble gas data. IDC analysts conducted the first round of

testing in early 2018. Recommended improvements were implemented and an updated version was installed in the IDC testbed for a second round of testing.

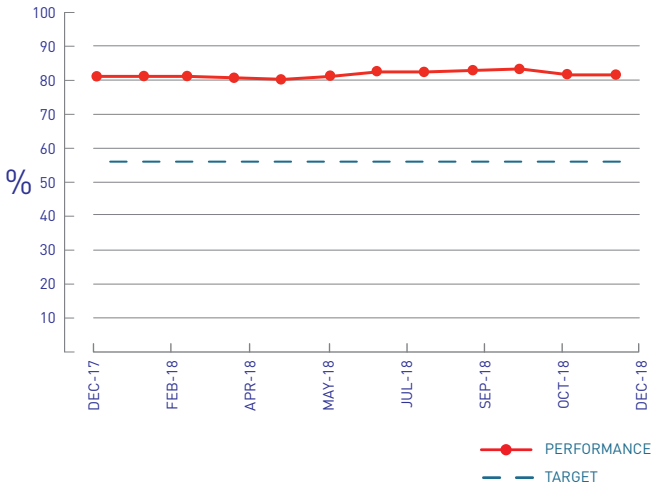
To ensure synergy between IDC software developments and the radionuclide applications of NDC in a box, an updated version of the radionuclide software modules that includes features implemented in IDC Operations in 2017 was incorporated into the new release of NDC in a box in May 2018. The improvements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

Within the acceptance testing process for next-generation noble gas systems, the SAUNA III system started sending data to the IDC testbed in February 2018, and the next-generation SPALAX system started sending data in October 2018. Both systems were configured in the IDC testbed, where the data are automatically processed on a daily basis.

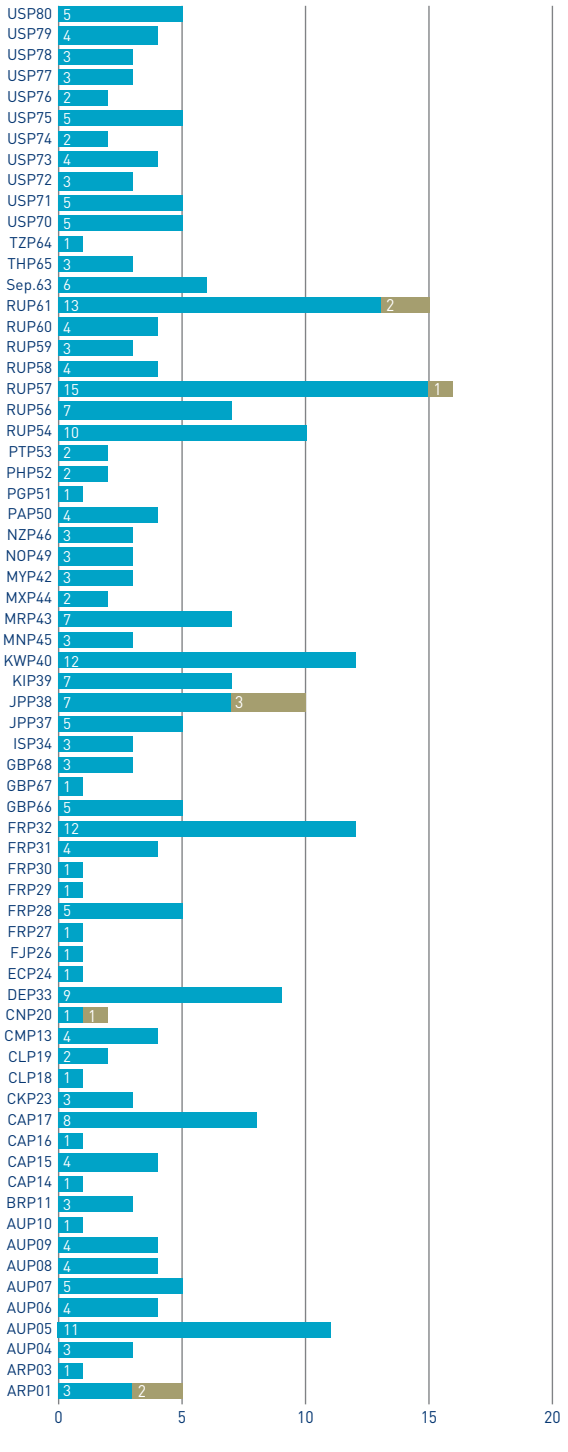
Treaty Relevant Radionuclides Detected in 2018



Correctly Categorized Automatically Processed Radionuclide Spectra



Radionuclide Events Recorded by IMS Stations in IDC Operations in 2018



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.

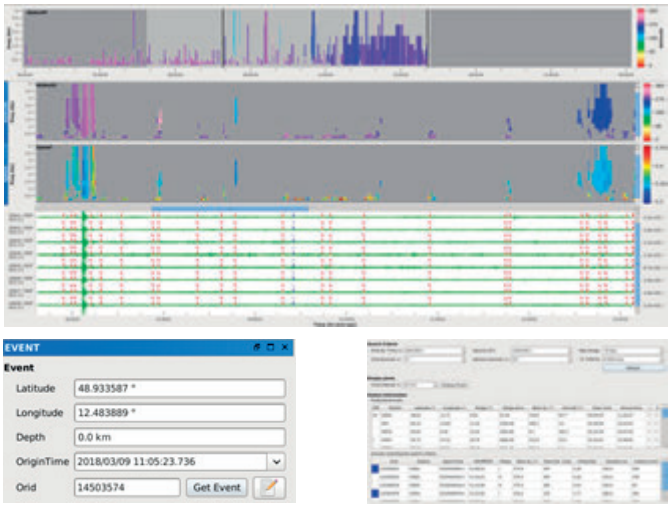
The IDC compiled assessment reports on the performance and data quality of both systems. After internal PTS review, the results were discussed with the system developers. The IDC also developed prototype software for high resolution beta–gamma data from the SPALAX system.

A major upgrade to the seismic, hydroacoustic and infrasound components of the NDC in a box software package was released in March 2018. This release provided upgrades to all waveform components of NDC in a box, as well as an update to configuration data. In addition, a preview version of the new GeotoolQt software which uses a more modern user interface package was included in the release to elicit early user feedback.

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 Commission continued to make progress in improving regional seismic travel time models. Several participants in the 2017 regional seismic travel time workshop in Africa presented papers on workshop results at a scientific session of the European Seismological Commission General Assembly meeting in Malta in September 2018.

The Commission also continued to develop new automatic and interactive software that uses state of the art machine learning and artificial intelligence. The enhanced NET-VISA software is now fully capable for the three waveform technologies and performs better than the existing operational event detection system in terms of both the number of false events it builds and the number of real events detected. In 2018, a major milestone was reached when NET-VISA results were routinely presented to analysts as a complement to the existing SEL3 automatic bulletin. It is possible to determine the provenance of the analyst-reviewed events added through this process. Offline tests conducted over the previous three years had shown that an improvement in terms of missed events (about 10% fewer) should be expected. Analysis of the operational results in 2018 confirmed this.



Redesigned interactive review software for waveform data: main window and event analysis tools (for event and scanning functionalities).

The redesigned detector and interactive review tools based on progressive multichannel correlation were further improved and evaluated in 2018. The software package processes infrasound data in real time for all IMS infrasound arrays in IDC development. Integration in the IDC testbed is nearing completion. Processing of data from hydrophone triplets is under evaluation 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. Phase 3 of IDC re-engineering included the delivery of an initial release of open source geophysical monitoring system software in December 2018. 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.

An updated atmospheric transport modelling (ATM) configuration with increased spatial resolution was implemented in IDC Operations in August 2018.

Following a security test of the WEB-GRAPE IBS (Internet based service) application in December 2017, the operational version of the application was made available to all authorized users. A new call-off contract was awarded for the enhancement of WEB-GRAPE IBS. Work on an online version resumed in October 2018.

The Commission participated in a meeting of the WMO expert team on emergency response activities and representatives of several regional specialized meteorological centres at the Vienna International Centre in October 2018. The meeting provided an opportunity for the Commission to express its appreciation to the WMO for its support and to discuss the emerging needs of the organization.

International Noble Gas Experiment and Atmospheric Radioxenon Background

The 31 noble gas systems that are in provisional operation at IMS radionuclide stations continued to send data to the IDC during 2018. The 25 certified systems sent data to IDC Operations, while data from the remaining 6 non-certified systems were processed in the IDC testbed. The Commission made significant efforts to ensure a high level of data availability for all systems through preventive and corrective maintenance and regular interaction with station operators and system manufacturers.

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

An initiative funded by the EU to improve understanding of the global radioxenon background, which started in December 2008, continued in 2018. 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 2018, the Commission started operating a mobile noble gas system in Mutsu, Japan. The Commission plans to use the results from

this campaign to characterize the radioxenon background in this area and thereby enable better understanding of the frequent radioxenon detections at radionuclide station RN38 in Takasaki, Japan. A second mobile noble gas system completed its campaign in Kuwait City, Kuwait, in February 2018 and was shipped to the manufacturer for refurbishment. The system will be deployed to a new site in 2019.

SAUNA TXL2 in operation at Mutsu, Japan.

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 2018, 15 such agreements or arrangements had been made with organizations in Australia, France, Greece, Indonesia, Japan, 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 2018, with the largest to date reported on 21 June 2018 over the western Russian Federation and detected as far away as the western United States of America, more than 8500 km away. 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 Infrasound Technology Workshop 2018.

On 18 December 2018, a large atmospheric event occurred over the Bering Sea at approximately 23:50 UTC. It was detected by 19 infrasound stations, ranging from infrasound station IS44 (Petropavlovsk-Kamchatskiy, Russian Federation), about 1200 km away, to infrasound station IS55 (Windless Bight, Antarctica, USA), more than 15 000 km away. This infrasound event is to date the second largest event recorded by the IMS network in terms of the number of stations that detected the event.

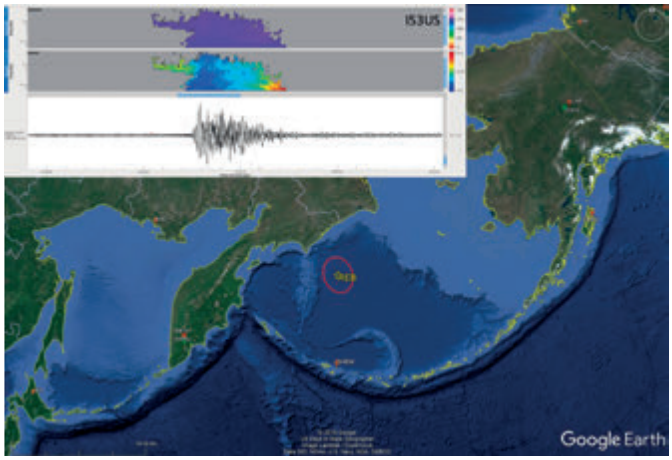
Real time detection of a volcanic eruption can help reduce the air traffic hazard of ash clouds clogging jet engines. Eruptions around the world are recorded by IMS infrasound stations and reported in IDC products. It is now established that information obtained by infrasound technology is also useful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

The Commission collaborated with the Volcanic Ash Advisory Centre in Toulouse, France, under the patronage of the WMO and the International Civil Aviation Organization and the Atmospheric dynamics Research InfraStructure in Europe (ARISE) project to develop an infrasound volcanic information system. The Commission served on the ARISE2 advisory board until the conclusion of the project in October 2018.

The deployment campaign of a mobile infrasound system installed in Romania and the processing of its results were completed in September 2018 after two years of operation. A second mobile infrasound system was installed in January 2018 in northern Côte d'Ivoire for a duration of one year. At the end of 2018, the Commission began its collaboration with the NDC of Costa Rica, leading to the installation of a third portable infrasound array at the La Selva Biological Station. The results of the campaigns in Romania and Côte d'Ivoire were presented at the final ARISE2 workshop, the African Regional Infrasound Workshop and Integrated Training, the 2018 NDC Workshop and the Infrasound Technology Workshop 2018.

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 2018, the Commission participated in international exercises including ConvEx-3.

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.

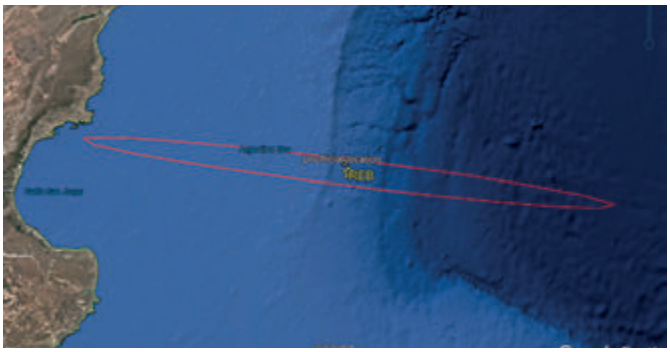


REB location of the infrasound event on 18 December 2018 at approximately 23:50 UTC (main image) and the associated detection at infrasound station IS53 (USA) (inset; visualization using specialized interactive review software).

The 6th Workshop on the Operation and Maintenance of the International Monitoring System (Vienna).

Search for the Argentinian Submarine *ARA San Juan*

The joint effort of the IDC and the IMS in support of the search for the Argentinian submarine *ARA San Juan* continued in 2018. Data analysis was refined and 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. Technical advice and data in support of the search were provided to the authorities of Argentina upon their request. Fruitful scientific interaction, exchange of expertise and collaboration with experts of the Argentinian Navy was established. The scientific findings obtained from the data analysis and computations were presented on numerous occasions to both scientific and non-expert audiences. On 16 November 2018, the *ARA San Juan* was found resting on the sea floor at a depth of approximately 900 m. The reported location of the submarine was in the vicinity of the unusual signal recorded by the IMS on 15 November 2017 and reported in the REB.



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.*

The 6th Workshop on the Operation and Maintenance of the International Monitoring System

O&M workshops are designed to address different issues in the progressive build-up of a sustainable network of IMS stations. The overall aim is to discuss and implement best practices in O&M related activities that are required for delivery of an IMS that fully meets entry into force specifications.

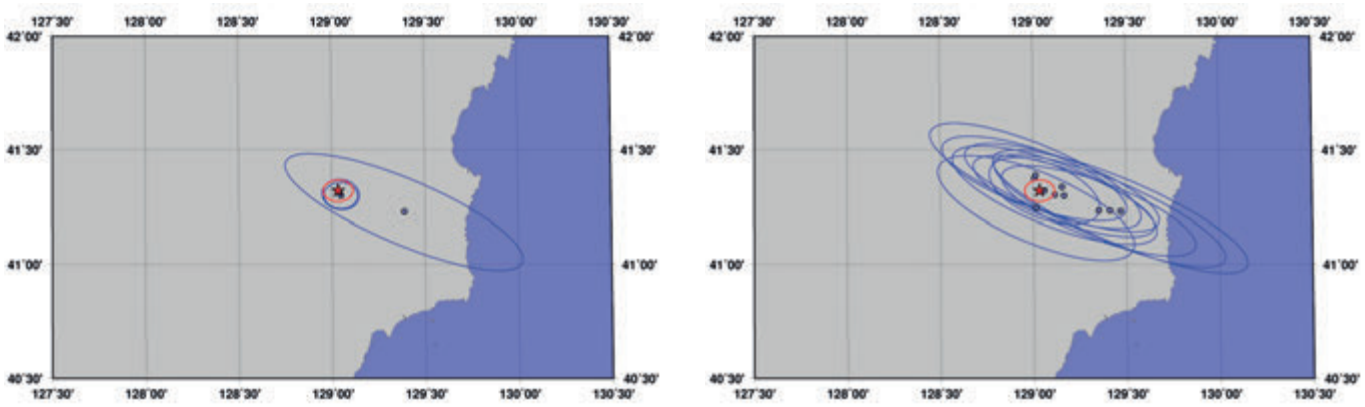
Data availability is a key performance indicator for IMS stations. Station operators are considered the most important resource for the successful O&M of IMS facilities. Communication, reliable equipment, the sharing of knowledge and experience between the PTS and station operators and the effective management of all IMS stations, including preventive and predictive station maintenance, are essential for reaching high levels of data availability in all four technologies.

The 6th Workshop on the Operation and Maintenance of the IMS was held in Vienna in November 2018. Approximately 150 participants, including station operators and managers from 54 States Signatories, PTS staff and equipment suppliers, attended. Fourteen women were among the station operators and managers present. The programme included 62 oral presentations and 20 posters. The workshop also featured two panel discussions, six discussion groups and a demonstration of several station assessment and performance management tools, followed by hands-on practice.

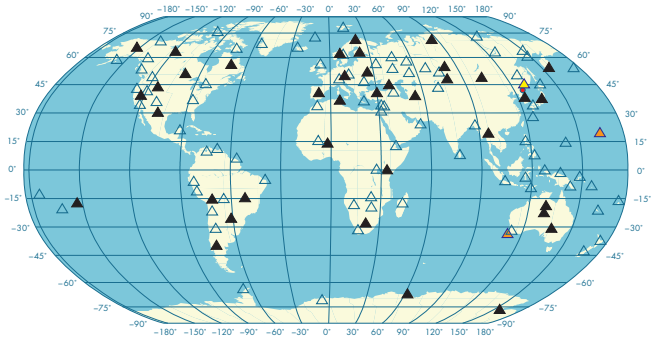
Aftershocks Following the Announced Nuclear Test by the Democratic People's Republic of Korea in 2017

With a body wave magnitude of 6.1, the announced nuclear test by the Democratic People's Republic of Korea on 3 September 2017 was significantly larger than all previous tests. Several aftershocks were recorded, the largest of which occurred 8.5 minutes after the announced test and had a body wave magnitude of 4.1.

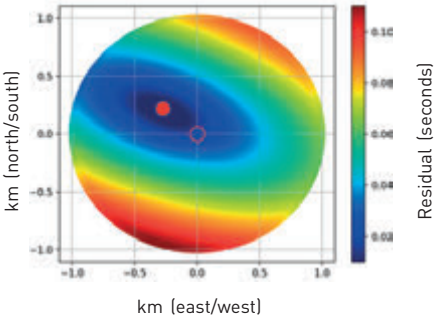
Seismic activity in the area of the nuclear test continued well into 2018 and was higher than the activity observed after previous tests by the Democratic People's Republic of Korea. The figure below shows the location of the events from the analyst reviewed Late Event Bulletin, with error ellipses that include the location of the test site and the increase in activity after the test.



Late Event Bulletin event error ellipses at the site of the announced nuclear test by the Democratic People's Republic of Korea on 3 September 2017. Left: Error ellipses from January 2016 up to the announced nuclear test. Right: Error ellipses after the test. The red star indicates the location of the test.



IMS stations that detected the seismic event on 3 September 2017. Black triangles represent primary seismic stations. Empty triangles represent auxiliary seismic stations. Orange triangles represent hydroacoustic stations. Yellow triangles represent infrasound stations. The red dot shows the location of the event.



Estimate of the relative locations of the announced test (open circle in centre of figure) and the aftershock that occurred 8.5 minutes afterwards (red circle, north-west of the main event).

ON-SITE INSPECTION

HIGHLIGHTS IN 2018

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

Design and construction of a permanent Equipment Storage and Maintenance Facility

Advanced training course of the third training cycle (South Africa).

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 2018 focused on implementation of the OSI action plan for 2016-2019 and the initial 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.

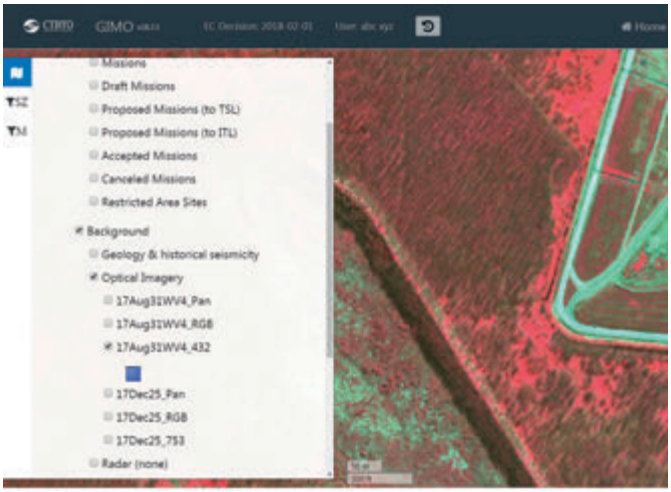
The OSI action plan for 2016-2019 comprises 43 projects categorized into five categories: policy development, methodology and documentation, operations and operations support, techniques and equipment development, and inspectorate development and infrastructure development.

During 2018, 17 projects were completed and 26 were under implementation, 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 2018 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 five individual projects that were under implementation.

Three policy documents, on physical security, information security and health and safety during OSIs, were formally approved. The inspection team functionality manual and the SOP on field team functionality were updated and reviewed and entered the formal approval process. Substantial recommendations were provided to the study aimed at investigating the effects of extreme environmental conditions on OSI operations during OSI Workshop-24.



Phase II of the Geospatial Information Management for OSI (GIMO) system.

Phase II of the Geospatial Information Management for OSI (GIMO) system was further developed on the basis of recommendations and lessons from the 2014 IFE, a dedicated expert meeting and a tabletop exercise on inspection team functionality, field team functionality and search logic. An advanced version of GIMO comprising full inspection planning capabilities and integration of equipment, personnel and tasks to conduct selected missions was successfully tested during the advanced course of the third training cycle. The OSI databank was updated and integrated in other OSI databases and the GIMO system.

OSI communications equipment underwent maintenance and updating, and some of it was used in training and testing activities.

Capability gaps in the health and safety equipment portfolio were filled on the basis of recommendations from OSI Workshop-23. Medical equipment upgrades comprising a portable blood gas meter and a heart rate monitor for the field were procured and brought into service.

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.

An expert meeting on the concept for future BUEs was conducted in January 2018. It involved 40 experts including 21 external participants from 15 States Signatories and representatives of international organizations and the PTS. The programme included discussions of the BUE concept, exercise design, planning and preparations and resulted in technical and policy recommendations on the draft exercise and evaluation concepts. The output of the meeting was a concept for the preparation and conduct of future BUEs that was made available to States Signatories in an Information Paper prior to the Fiftieth Session of Working Group B.

Following a WGB recommendation and interest shown by neighboring countries to host the exercises, the BUE project management team started a process to identify suitable field exercise locations within 300 km of the Vienna International Centre. The PTS conducted reconnaissance visits to three sites to assess their suitability as field exercise locations. Potential host countries were invited to submit a financial offer to host field exercises. Following technical and financial evaluations, the PTS accepted the offer of Slovakia.

As reiterated by participants at the expert meeting on the concept for future BUEs, OSI exercises require a realistic and credible scenario. On this basis, a scenario task force was established, comprising 17 technical experts from 12 States Signatories including the host country and PTS staff. The task force held three meetings during 2018 aimed at developing a contiguous scenario for the three BUEs to be conducted in 2019-2020. The resulting scenario is technically realistic, rationally coherent, temporally logical and intellectually motivating so that OSI processes, procedures and techniques can be adequately tested.

Equipment, Procedures and Specifications

The implementation of OSI action plan projects related to inspection techniques and capabilities progressed further. Upon project completion, revised or proposed equipment specifications will be submitted to WGB for possible inclusion in the draft list of equipment for use during OSIs. These projects will also result in improved procedures for the application of the inspection techniques that will ultimately be reflected in new or updated Quality Management System (QMS) documents.

The year 2018 also saw the launch of the last OSI action plan project related to inspection techniques, i.e. drilling. The objective is to better understand the complexities of drilling and its potential applications during an inspection. The first two project phases, comprising the compilation of background information on the basis of previous documents, meetings and conferences and the conduct of an expert meeting in Vienna were implemented. The final project phase, to be undertaken in 2019, will encompass the execution of action points agreed during the meeting and any other follow-up activities.

Regular operational activities in support of the programme of the Equipment and Implementation Section of the OSI Division were undertaken throughout the year and significant input was provided to the third OSI training cycle through planning and preparation of relevant technical modules of the advanced training course.

With the construction of a permanent Equipment Storage and Maintenance Facility under way in 2018, the Commission continued to cooperate closely with the Austrian authorities to alleviate resource and operational constraints at the temporary storage area. This cooperation allowed the PTS to use the facilities and resources of the Austrian Ministry of Defence for the development and testing of OSI techniques, notably in the fields of OSI airborne systems and geophysical inspection techniques for shallow applications.

Contributions were made in 2018 to the General Assembly of the European Geophysical Union and the Long Night of Research, both in Vienna.

Construction of a permanent Equipment Storage and Maintenance Facility (Austria).

Airborne Techniques and Visual Observation

A validation test of the airborne multispectral system was performed in cooperation with the Austrian Armed Forces in Linz, Austria, in June 2018. Seven experts from seven States Signatories participated. They were familiarized with the operation of the system and given an opportunity to operate the system in-flight on board a Bell 212 helicopter. A demonstration of airborne mission planning and data processing software was also provided. The week culminated with the experts helping to uninstall the system, followed by a review of system performance measured against the specifications set out in the draft equipment list developed at OSI Workshop-23.

Validation test of the airborne multispectral system (Austria).

Work has commenced to develop an airborne physical simulator to support the testing of airborne systems as well as the training of inspectors in the application of airborne techniques. The simulator is designed to provide a realistic environment to test the installation of hardware components and the procedures for the operation of different systems, thus reducing the need for actual helicopter airtime. It will be used prior to actual airtime to train inspectors in the application of airborne techniques and health and safety procedures when working around and on an airframe. This arrangement will allow facilitators to expose trainee inspectors to equipment faults and issues that may arise in-flight and provide instruction on corrective actions.

Airborne video and narration systems were upgraded and tested in Vienna on board an AS 350 helicopter prior to being used for inspector training in South Africa in October 2018. The procedures for ground testing the equipment and operating the systems in-flight were updated and validated during these test flights.

A desk study on the potential of air and ground based remotely controlled autonomous systems for data gathering and in-field support activities within the context of an OSI was concluded. The findings of the study were reported to the Fifty-First Session of WGB. Proposals for future studies and the use of such platforms within the context of an OSI were also presented to WGB.

Geophysical Inspection Techniques

An expert meeting on resonance seismometry was held in Vienna in May 2018. The purpose of the meeting was to provide guidance on numerical modelling and data processing, to draft input for a concept of operations and to confirm and/or amend the equipment specifications documented in the report of OSI Workshop-23. Twenty-two experts from 13 States Signatories reviewed the results of numerical and experimental studies and discussed relevant observables, resulting in the updating of the technology evaluation matrix for resonance seismometry and relevant documentation, including in relation to integrating resonance seismometry with other OSI techniques.

A field test of OSI geophysical techniques for shallow applications was carried out at an Austrian military training ground near Vienna in September 2018. Nine experts from seven States Signatories participated in the field test, which was designed following a market survey and performance testing of selected non-seismic geophysical equipment. The performance testing considered particular OSI requirements and addressed technical specifications and operational procedures. As a result, equipment for electrical conductivity measurements, magnetic field surveys and ground penetrating radar was identified as being in compliance with OSI requirements and subsequently tested. The field test assessed functionality and operational use of all equipment and resulted in amendments to the technical specifications for geophysical equipment as documented in the report OSI Workshop-23. Relevant SOPs and work instructions (WINs) will be updated once new equipment is obtained. The test also served as a basis for procuring equipment for use during future training activities.

Measurements of Radioactivity and Radionuclide Particulate Related Inspection Techniques

A feasibility study on weather support and ATM activities that would be required for different phases of an OSI was conducted. The report of this study provided key findings and recommendations for the actual development of ATM capabilities in support of an OSI.

The certification of airborne gamma radiation survey equipment on board a Bell 212 helicopter was prepared with the support of the Austrian Armed Forces during two technical meetings held in March and June 2018 in Linz, Austria. The meetings focused on practical integration of PTS equipment with the aircraft and on procedures to prepare the relevant documentation for airworthiness according to Austrian standards. Specific supporting equipment to mount the global navigation satellite system antenna was manufactured at the Linz military workshop, and an interface to the helicopter power was built with air certified parts to operate the airborne gamma survey equipment in a safer configuration and avoid the need for on-board batteries.

Five portable gamma radiation monitoring (GRM) scanners were delivered and brought into OSI operational status. The scanners have new capabilities that were recommended by the expert meeting on radionuclides and noble gases held in 2015. An upgraded acquisition sub-system allows summing signals from up to three sensors and doubles the detection sensitivity of the previous range of GRM scanners, thereby providing increased flexibility during field missions. In addition, the new software operated on a tablet sized screen

Ground and airborne based visual observation course (South Africa).

provides the operator with real time mapping capability of survey mission raw data.

Specifications for two car borne GRM survey sensors were issued. The sensors have a similar acquisition module as the portable GRM scanners and may be used as individual systems or in a single unit with doubled detection efficiency and software assisted directional detection capability. Acceptance tests will be carried out in early 2019.

A field application for the acquisition of raw GRM data, including data from high resolution in situ systems was designed and developed. The application was developed in synergy with the development of the GIMO system for full integration of data flow and processes.

The transportable 20 foot container that currently provides the infrastructure for the OSI field laboratory was maintained at the temporary storage area in order to host training modules in 2019. The second phase of a detailed design proposal for intermodal rapid deployment containers with modularized and extendable options is drawing to a close.

Noble Gas Related Inspection Techniques

Work to adapt mobile xenon and argon measurement devices for flight pods and to improve these systems progressed steadily. In parallel, the OSI SAUNA system for xenon detection was further developed with financial support provided by the EU under Council Decision VII.

Deployable atmospheric air sampler.

One newly designed deployable atmospheric air sampler was brought into service to increase noble gas sampling capacity, and work on new subsurface gas samplers commenced. A comprehensive literature review and testing carried out as part of efforts to improve gas separation in the field for smaller and more easily transportable samples resulted in two reports on the materials that are best suited to this purpose. A design plan for a separation setup for xenon was drafted and additional work on further noble gas detection capabilities commenced.

Operations and Operations Support

OSI action plan projects related to operations and operations support were extended until the end of 2019 due to their interrelationship with ongoing projects related to OSI methodology, techniques and equipment development.

The design of a comprehensive security system for the base of operations was finalized in 2018, with the delivery of a customized, integrated, deployable security and surveillance system foreseen in 2019. The engineering design for improved units that can be transported and deployed by air and customized for command post and field laboratory applications is nearly complete, with manufacture and testing of a prototype unit scheduled for the second half of 2019.

A comprehensive review of potential options and arrangements to ensure guaranteed access to strategic airlift capability for OSI purposes was completed in 2018. Recommendations from this review will be followed by testing of brokered air charter services and considered in further development projects upon full implementation of the OSI action plan.

A needs analysis was carried out as part of a study of the potential use of third party contracts and standing arrangements in support of an OSI, taking into consideration the provisions of the Treaty and its Protocol, the draft OSI Operational Manual as well as the demands of launching and supporting field operations.

Upgrades for the base of operations infrastructure focused on modernized and ruggedized softshell modules, field electrical distribution and air conditioning systems. A study on hybrid power generation capabilities for the base of operations and for in-field operations was launched.

Operations support activities included scheduled maintenance, calibration and certification of all major auxiliary OSI equipment components (e.g. generator sets, uninterruptible power supplies). This also comprised continuous servicing and replacement of infrastructure to extend the life cycle of current equipment modules.

The temporary storage area provided infrastructure and logistics support to OSI programmatic activities, including a testing environment to simulate the working and receiving areas of a base of operations for an OSI. Staff of the OSI Division continued to serve as core members of the PTS-wide project team that manages the temporary storage area and provides logistics support services.

On-Site Inspection Documentation

Activities during 2018 involved providing support to WGB and implementing action plan projects, including further development and revision of OSI QMS documents and the conduct of OSI Workshop-24, entitled "OSI in Different Environments and Events Other Than Underground".

OSI Workshop-24 (United Kingdom).

Reporting

A report on the expert review of the progress inspection report and preliminary findings document generated during the 2014 IFE was issued in January 2018. Drafting of headquarters procedures for preparing and handling of the draft inspection report and revised WINs for inspection team reporting incorporating new GIMO functionality also commenced.

Quality Management System

Many OSI QMS documents underwent revision, came under review, or were approved. Policies on physical security during an OSI and on information security related to OSIs were approved and issued, as was the OSI health and safety policy. The rolling list of QMS documents was updated and the WIN on preparing and updating the rolling list was revised. The SOPs on launch and support for OSI, organization and activities of the Operations Support Centre (OSC), protection of information during an OSI and the inspection team functionality manual as well as the WIN on guidelines for classification of OSI related information and data entered the QMS review process.

Work also began on printing field versions of newly developed or revised and approved QMS documents, and sample booklets for five 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.

On-Site Inspection Administration and Document Control

Documents used in the 2014 IFE were updated and new documents related to inspection team and OSC administration and documentation control related procedures were drafted. Several WINs on activities, tasks and responsibilities of the OSC were drafted.

Improved On-Site Inspection e-Library

With the testing phase nearly completed, significant progress has been made with respect to the functionality and user friendliness of the improved OSI e-Library. In particular, this included determining and testing the most effective way to create a replica of the OSI e-Library that can be exported to and interfaced with the GIMO system. Links were added to the OSI e-Library, interfacing it with the PTS QMS site and the knowledge and training portal. Such interfacing is crucial for the overall aim of building up OSI capability and ensuring all software is operational and reliable.

Work continues on creating new metadata across the OSI e-Library, reflecting the revised and most up to date coding system. Furthermore, a means of generating a list of all or specific documents in the repository of the e-Library was developed and improved. The user manual for the e-Library was also developed, and plans for a staff training course are under way.

Support to Working Group B

The PTS continued to provide substantive, technical and administrative assistance to WGB in its third round of elaboration of the draft OSI Operational Manual.

Training

Advanced Course of the Third Training Cycle

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 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.

Advanced training course of the third training cycle (South Africa).

Ground and airborne based visual observation course (South Africa).

Ground and Airborne Based Visual Observation Course

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.

Training Event Registration Mechanism, On-Site Inspection Inspectorate Database and Call-Up Mechanism

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.

On-Site Inspection e-Training System

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.

IMPROVING PERFORMANCE AND EFFICIENCY

HIGHLIGHTS IN 2018

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

2018 National Data Centre Workshop (Algeria).

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 Quality Management System (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 2018. 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. The procedure for controlling and coding QMS documents was consolidated, and use of the document management system significantly increased. With more than 2300 documents filed, the QMS provides the functionality to univocally locate the latest approved versions of documentation.

The Commission provided States Signatories with the first compilation of terms that supplement the glossary of verification terms. The compilation contains more than 1000 terms gathered from internal documents that contain a glossary. Work on a supplement to the glossary of verification terms aims to manage and share a common vocabulary as an aid for ensuring the consistency and quality of products and services. This fosters PTS cross-functional alignment and helps all members of the organization to better understand the context and usage of terms. It intends to serve as a basis for strengthening the quality of the work done at the PTS.

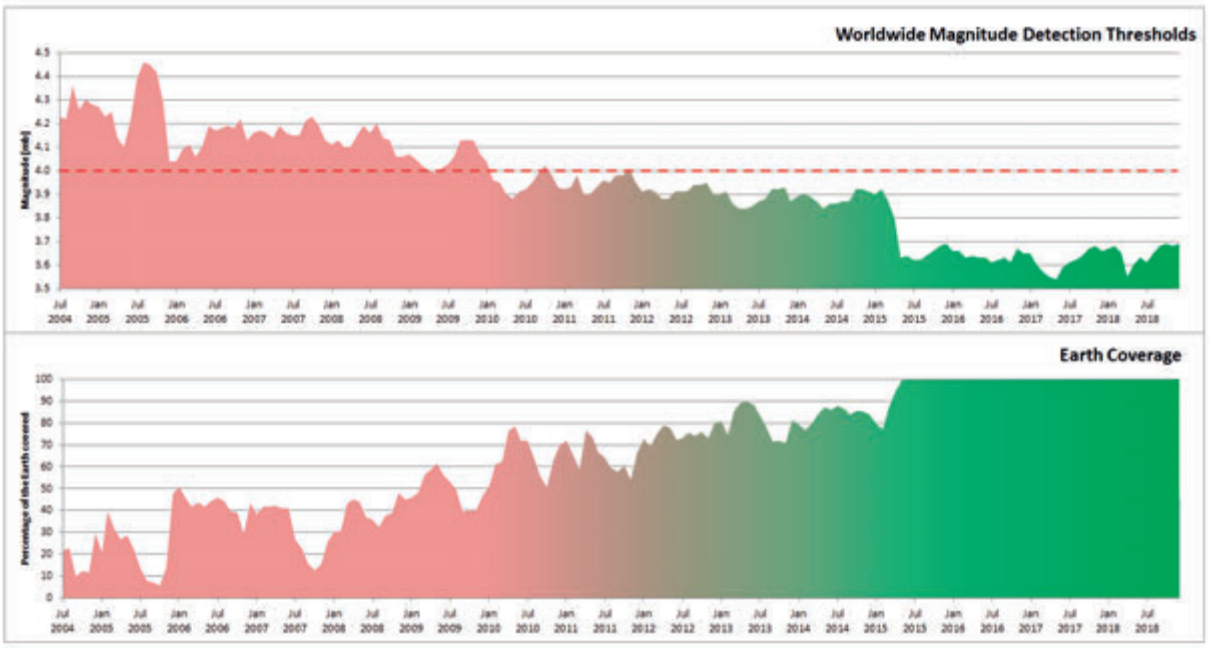
The Quality Policy of the Commission emphasizes client orientation. Therefore the Commission continued to prioritize feedback from NDCs, which are the main users of its products and services, and to encourage them to actively contribute through the established channels to review the implementation of recommendations. The 2018 NDC Workshop in Algeria provided an opportunity for the PTS and NDCs to report on and discuss progress achieved.

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 major version of PRTool with significantly improved functionality was released in 2018, followed by two additional releases that included new metrics, on threshold monitoring of the seismic network and on the minimum detectable concentration per station of 133Xe as measured at IMS stations. Documentation accompanying the new releases includes revisions of the associated Process Metrics Manual to ensure full consistency between the definitions of the metrics and the reported information.

The figure below shows the continuous assessment of the global detection capability of the primary seismic network from 2004 to 2018. The top graph displays the worldwide averaged median body wave magnitude (mb) able to be detected at 90% confidence level. The bottom graph represents the percentage of the total surface of the earth for which events of magnitude mb=4.0 can be detected at 90% confidence level. The value of mb=4.0 (dashed line) roughly corresponds to a 1 kilotonne underground nuclear test.

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 mb=4.0 can be detected at 90% confidence level.

2018 National Data Centre Workshop (Algeria).

The Quality Management and Performance Monitoring (QMPM) Section continued to use the OSI recommendation tracking module of the Evaluation Information Management System (EIMS) and its link to the CTBTO Organizational Management Programme Achievement Status System (COMPASS) project management tool for the purposes of monitoring the further development of OSI capability through the implementation of the OSI action plan.

Evaluation

As part of its preliminary preparations for the evaluation of the next series of BUEs, the QMPM Section continued to improve the functionality of the EIMS, which is intended to be used by the evaluation team during the BUEs and afterwards to generate the evaluation reports.

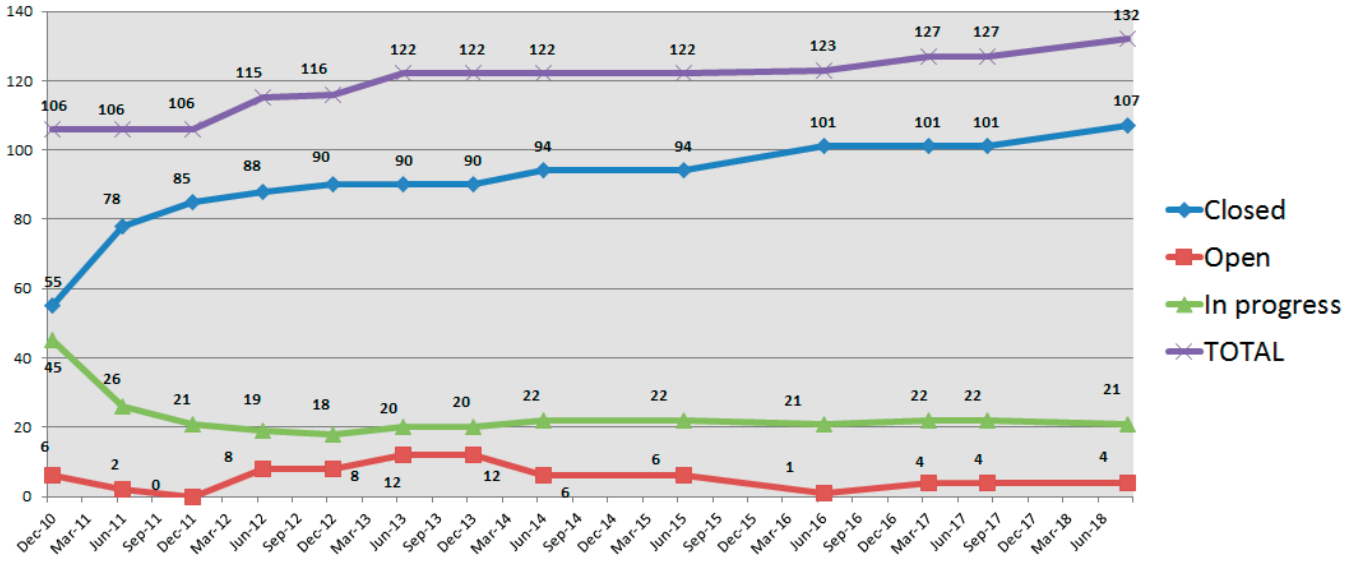
In preparation for the forthcoming evaluation of the next series of three BUEs, the QMPM Section developed a strategic level evaluation concept blueprint covering the period 2018-2021.

The technical evaluation report on Experiment 2 of the IDC Progressive Commissioning Plan was issued. Of the 31 validation tests performed during the experiment, 20 tests were successfully implemented. The remaining 11 tests were only partially implemented, resulting in 25 recommendations to improve system performance.

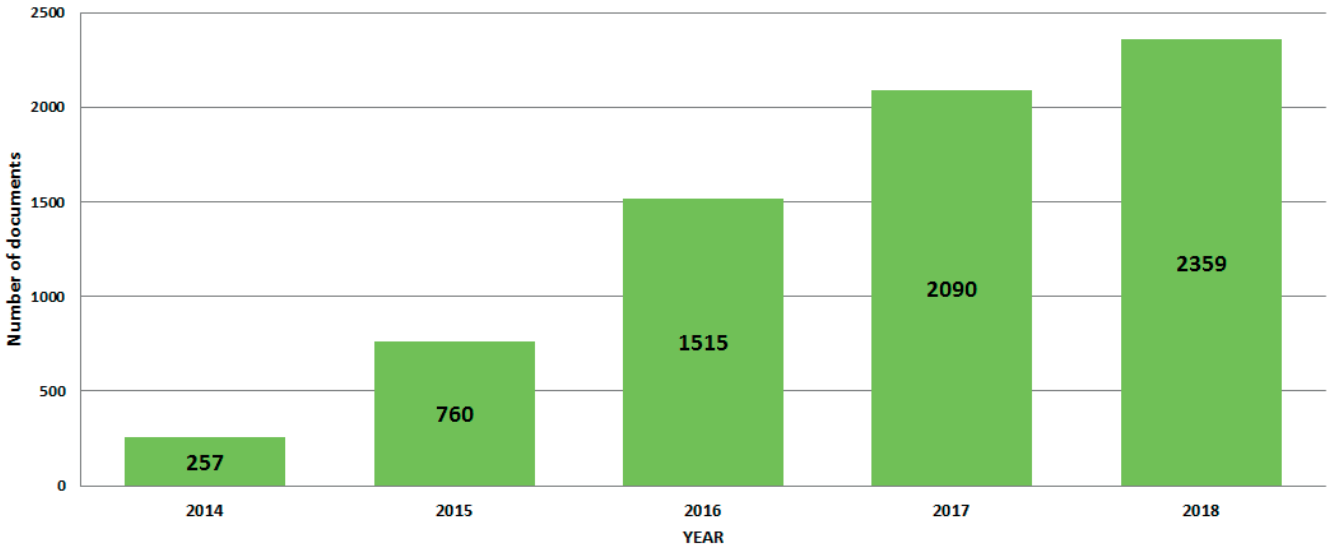
In preparation for Experiment 3 and taking into consideration the lessons learned from previous experiments, the QMPM Section developed an evaluation framework for a comprehensive evaluation of the conduct and outcome of future experiments.

This approach was initiated during the implementation of Experiment 3 from 23 September to 6 October 2018. An external evaluation team, comprising four evaluators from States Signatories, assisted the QMPM Section in a comprehensive evaluation of the experiment and in the elaboration of the final evaluation report.

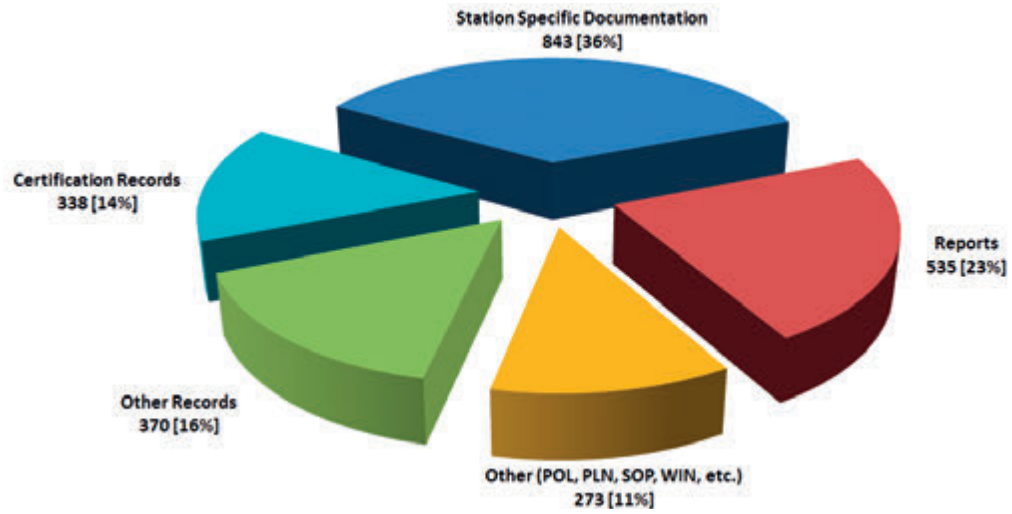
Recommendations from National Data Centre Workshops



Number of Documents in the Quality Management System Repository



Distribution of Quality Management System Documents



INTEGRATED CAPACITY DEVELOPMENT

HIGHLIGHTS IN 2018

Increased capacity development activities

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

Further development of e-learning

2nd CTBT Science and Diplomacy Symposium (Vienna).

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.

2nd CTBT Science and Diplomacy Symposium (Vienna).

Activities

2nd CTBT Science and Diplomacy Symposium

The 2nd CTBT Science and Diplomacy Symposium was held from 21 May to 1 June 2018 at the Vienna International Centre. More than 120 policy makers, diplomats, academics, students and young professionals attended, with an additional 200 participants following online. Participants came from all over the world, including from many countries that have not yet ratified the CTBT. The symposium aimed to raise public awareness of the contribution of the Treaty to international peace and security and to inspire cooperative and collaborative research and innovation on nuclear test monitoring science and technology. Participants were encouraged to think creatively about political, legal and diplomatic solutions to the challenges facing the Treaty.

There was special emphasis on youth engagement, with over 40 members of the CTBTO Youth Group taking part in the discussions as panelists or contributing to the dialogue from the audience. Members of the Group of Eminent Persons also participated and lent their expertise to discussions.

The two week event consisted of a wide range of thematic discussion sessions, hands-on simulation exercises and a field trip to the Atominstitut at the Vienna University of Technology. A high level session on 25 May featured keynote speeches by an all-female panel, including Ms Karin Kneissl, Federal Minister for Europe, Integration and Foreign Affairs of the Republic of Austria; Ms Elba Rosa Pérez Montoya, Minister of Science, Technology and Environment of Cuba; and Ms Izumi Nakamitsu, United Nations High Representative for Disarmament Affairs. There was also an expert dialogue, entitled "Assessing the Current Global Security Context: Successes, Challenges, and Possible Ways Forward", with Mr Desmond Browne, Vice-Chairman of the Nuclear Threat Initiative and former Secretary of State for Defence of the United Kingdom, and Ms Michelle Ndiaye, Director of the Africa Peace and Security Programme, Institute for Peace and Security Studies, and Head of Secretariat, Tana High-Level Forum on Security in Africa.

An information visit for government representatives from non-ratifying States was held in conjunction with the symposium. Nearly 40 government nominees from 22 non-ratifying States participated. In addition to taking part in the entirety of the symposium programme, they met with the Executive Secretary and exchanged views on issues related to possible ratification of the CTBT.

On-Site Inspection Workshop-24

OSI Workshop-24, entitled "OSI in Different Environments and Events Other Than Underground", was held at the National Oceanography Centre in Southampton, United Kingdom. Discussions centred on the scientific and legal aspects of OSIs in different climates or geophysical environments, events other than underground nuclear explosions and in areas beyond the jurisdiction or control of any state, and practical and organizational challenges of mounting an OSI on the high seas.

On-Site Inspection Regional Introductory Course-23 (Argentina).

Seventy-four participants from 29 States Signatories and the PTS attended the workshop. Discussions were held in two parallel expert groups, one focusing on OSIs on or above the high seas and the other focusing on OSIs in challenging environments. This resulted in numerous valuable recommendations, particularly with regard to the elaboration of the Model Text for the draft OSI Operational Manual, taking into account topics such as concept of operations, logistics, search logic, inspection team functionality, equipment, technology, inspector training and health and safety.

On-Site Inspection Regional Introductory Course for Latin America and Caribbean States

OSI Regional Introductory Course-23 took place in April 2018 at the Escuela de las Armas, Campo de Mayo, in Buenos Aires, Argentina. Forty-five participants representing 19 States Signatories from the Latin America and the Caribbean region attended. The participants included geologists, seismologists, geophysicists, radionuclide and radiation monitoring experts, experts in field deployment support, as well as experts in airborne position finding or visual observation.

The course was the twenty-third regional introductory course hosted by the Commission. The programme involved brief lectures, hands-on training, equipment demonstrations, tabletop exercises and a two day field exercise. It provided a comprehensive introduction to OSI related concepts, technologies and operations as well as field exercise activities.

The key objectives were to acquaint national technical experts and personnel from the Latin America and the Caribbean region with the OSI verification regime, to broaden the pool of experts from the geographical region for participation in OSI related activities and to identify potential candidates for the roster of inspectors.

On-Site Inspection E-Learning Development

The knowledge and training portal continued to support the activities of the third training cycle through the development of individual course homepages and the OSI e-learning library. The platform contains assessment materials, e-learning modules, background documents, logistical documents related to specific courses and an evaluation mechanism and enables users to track progress on learning activities.

Four new course web pages were developed in 2018, containing several modules on inspection team functionality, OSI techniques and activities, ground and airborne based visual observation as well as an interactive module on the GIMO system. These resources were used as preparatory learning material for the third training cycle. A web page for OSI Regional Introductory Course-23 was also developed, providing introductory modules on the OSI verification regime.

A course web page in support of a remote refresher training programme for the roster of inspectors from the first and second training cycles was also developed. The course page contained all of the modules delivered during the introductory block of the third training cycle from 2016-2018 and will serve as a platform for knowledge refreshment.

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

In 2018, the project supported the participation of experts from 12 States: Argentina, Chile, Ecuador, Ethiopia, Iraq, Malaysia, Morocco, Myanmar, Namibia, Niger, the Sudan and Tunisia. These experts took part in the Fiftieth and Fifty-First Sessions of WGB, including formal meetings and meetings of the 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 48 experts from 37 States, including 15 women. Ten of these States are or were least developed countries. The participants came from 11 States in Africa (Algeria, Burkina Faso, Ethiopia, Kenya, Madagascar, Morocco, Namibia, Niger, South Africa, the Sudan and Tunisia), 1 in Eastern Europe (Albania), 9 in Latin America and the Caribbean (Argentina, Bolivia, Brazil, Chile, 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).

Voluntary contributions from China, Germany, Kazakhstan, Turkey and the United Kingdom were used to finance the project in 2018, and part of these funds was carried over to 2019. The Commission continues to seek additional voluntary contributions to ensure the financial sustainability of the project.

National Data Centre capacity building course (Vienna).

OUTREACH

HIGHLIGHTS IN 2018

Growing high level engagement with States

Comprehensive public and media outreach strategy

Active involvement of youth in outreach activities of the organization

Visit to the radionuclide station on the roof of the Vienna International Centre.

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 2018, 184 States had signed and 167 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 2018. 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

To ensure an integrated and proactive approach to advancing ratification of the CTBT by the remaining Annex 2 States, a group comprised of eminent personalities and internationally recognized experts was launched by the Executive Secretary in 2013. Through the expertise, experience and personal networks of its members, the Group of Eminent Persons has supported and complemented efforts to raise the profile of the Treaty. The CTBTO Youth Group was launched in February 2016 to transfer knowledge of the CTBT to the next generation of leaders and, in turn, revitalize the discussion on the Treaty amongst civil society. The CTBTO Youth Group has become a robust platform to build peer-to-peer relationships and foster much needed dialogue, facilitating an understanding of the CTBT, its verification regime and the invaluable benefits it provides to the planet and its citizens. The group, which started out with fewer than a dozen members, now has approximately 650 members, representing more than 90 countries. The CTBTO Youth Group is open to all students and young graduates who are directing their careers to contribute to global peace and security and who wish to actively engage in promoting the CTBT and its verification regime.

These two outreach bodies aim to support and complement the work of the Commission towards the further universalization and entry into force of the Treaty. As a result of their political standing and influential network, members of the Group of Eminent Persons can help place the CTBT at the top of the global security agenda by outlining strategic priorities

Ms Federica Mogherini, High Representative of the European Union for Foreign Affairs and Security and member of the Group of Eminent Persons, at the ninth Ministerial Meeting of the Friends of the CTBT (New York).

necessary for entry into force. Members of the CTBTO Youth Group, with their energy and ability to quickly mobilize, can help execute activities to support the strategic priorities of the Commission.

Revitalizing the discussion around the CTBT, members of the Group of Eminent Persons and the CTBTO Youth Group participated in a number of events around the world, including the 2nd CTBT Science Diplomacy Symposium, the ninth Ministerial Meeting of the Friends of the CTBT and the Paris Peace Forum. They also organized two side events in connection with the Second Preparatory Committee for the 2020 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), on the mutually reinforcing relationship between the CTBT and the NPT and on the role of the CTBT as a potential blueprint for a nuclear-weapon-free zone on the Korean Peninsula.

Together with members of the Group of Eminent Persons, CTBTO Youth Group members have worked on developing global and regional strategies to promote universalization and entry into force of the Treaty, notably during a joint international conference in Kazakhstan in August 2018.

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. He participated in several bilateral meetings and other high level events at which he met several Heads of State and Government. These included the Presidents of Burkina Faso, Croatia, Cyprus, Finland, Iceland, Kazakhstan and the Russian Federation and the Emir of Kuwait. The Executive Secretary also met with the Prime Ministers of Madagascar and the Republic of Korea, as well as the Vice-President of the Islamic Republic of Iran.

Joint international conference of the Group of Eminent Persons and the CTBTO Youth Group (Kazakhstan).

During his visits and in Vienna, the Executive Secretary met with Foreign Ministers and other ministers of States Signatories and observers. They included the Foreign Ministers of Austria, Algeria, Bangladesh, Burkina Faso, China, the Comoros, Japan, Kazakhstan, Libya, Niger, Norway, the Republic of Korea, the Russian Federation, Rwanda and Spain. He also met the Minister of Energy of Algeria; the Minister for Science and Technology of Ethiopia; the State Secretary, Ministry of Foreign Affairs, of Slovenia; the Minister of Defence of Côte d'Ivoire; the Minister for Science, Technology and the Environment of Cuba; the Chief Scientific Adviser, Foreign and Commonwealth Office, of the United Kingdom; the Deputy Foreign Minister of Turkmenistan; the Vice Minister of Energy of Ecuador; the Minister of Higher Education and Scientific Research of Iraq; the Vice Minister for Foreign Affairs and International Cooperation of Italy; the Deputy Minister of Energy, Science, Technology, Environment and Climate Change of Malaysia; the Minister of Mines and Energy of Namibia; the Minister of Defense of Tunisia, the Minister of Trade and Industry of South Africa; and the Deputy Minister of Energy of South Africa.

The Executive Secretary also met other senior government representatives from the following States Signatories and observers: Belgium, Denmark, France, Jordan, the Netherlands, the United Kingdom of Great Britain and Northern Ireland and the United States of America.

Promoting parliamentary engagement, the Executive Secretary met the speakers of the Parliament of Kazakhstan, as well as parliamentarians from Austria, the Comoros, France, Germany, Kazakhstan, Madagascar and the European Parliament.

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

The Commission continued to take advantage of global, regional and subregional conferences and other gatherings to enhance understanding of the Treaty and to advance its entry into force and the build-up of the verification regime. The Commission was represented at meetings of the International Atomic Energy Agency, the Inter-Parliamentary Union, the Second Session of the Preparatory Committee for the 2020 Review Conference of the Parties to the NPT, the Organisation for the Prohibition of Chemical Weapons, the African Union, the African Commission on Nuclear Energy, the North Atlantic Treaty Organization, the United Nations Industrial Development Organization, the United Nations General Assembly and its First Committee, the United Nations Office on Drugs and Crime, the Parliamentary Assembly of the Francophonie and the Tokyo International Conference on African Development.

During these meetings and conferences, the Executive Secretary met with a number of heads and other senior officials of international and regional organizations including the Secretary-General of the United Nations, the Secretary General of the International Civil Aviation Organization, the Secretary General of the Inter-Parliamentary Union, the Secretary General of the League of Arab States, the Director-General of the Organisation for the Prohibition of Chemical Weapons, the Chair of the African Union Commission, the

Executive Secretary Lassina Zerbo delivering a keynote speech at the United Nations General Assembly to commemorate the International Day against Nuclear Tests.

Chairperson of the African Commission on Nuclear Energy, the Secretary-General of the Organisation for Security and Co-operation in Europe (OSCE), the Director General of the United Nations Educational, Scientific and Cultural Organization, the Director General of the United Nations Industrial Development Organization, the High Representative for Disarmament Affairs of the United Nations, the Chair of the Political Committee of the Parliamentary Assembly of the Francophonie and the United Nations Acting Special Representative for the Central African Republic.

The Executive Secretary addressed the seventy-third session of the United Nations, the United Nations Conference on Disarmament, the ninth Friends of the CTBT Ministerial Meeting, and several international gatherings, including the Forum for Security Co-operation of the OSCE, the OSCE Parliamentary Assembly Winter Meeting, the Fourth Conference of the States Parties to the Treaty of Pelindaba, the second session of the Preparatory Committee for the 2020 Review Conference of the Parties to the NPT, the Academy of Science South Africa–World Academy of Sciences–American Association for the Advancement of Science Regional Workshop on Science Diplomacy, the Annual Meeting of the African Aeronautics and Space Organisation and the Political Affairs Committee of the Francophonie Parliamentary Assembly. He also attended the Paris Peace Forum and the Valdai Discussion Club.

On the occasion of the International Day against Nuclear Tests, the Executive Secretary participated in an international conference hosted by Kazakhstan in Astana and attended by the Group of Eminent Persons and the CTBTO Youth Group. He also delivered a keynote speech at the high level meeting of the United Nations General Assembly to commemorate and promote the International Day against Nuclear Tests.

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

From left: Ms Fatou Haidara, Managing Director, Directorate of Corporate Management and Operations, United Nations Industrial Development Organization; Executive Secretary Lassina Zerbo; Mr Lee Nak-yon, Prime Minister of the Republic of Korea; Mr Yukiya Amano, Director General of the International Atomic Energy Agency; Mr Dennis Thatchaichawalit, Deputy Director General of the United Nations Office at Vienna.

Public Information

The CTBTO public web site and social media channels averaged more than 381 000 visits per month in 2018. The Commission continued to expand its presence on YouTube, Facebook, Twitter and Flickr. As of December 2018, the CTBTO Twitter page had approximately 16 000 followers and the CTBTO Facebook page had over 14 000 likes.

Twenty-one new videos were added to the CTBTO YouTube channel in 2018. There were 64 000 video views over the course of the year. Videos from the 2nd CTBT Science Diplomacy Symposium and the video "Putting an End to Nuclear Explosions", in which a data analyst describes what it was like to work at the PTS on the day the Democratic People's Republic of Korea announced it had conducted a nuclear test, were the most viewed.

On Flickr, images from the 2nd CTBT Science Diplomacy Symposium were the most viewed. The inaugural issue of "Newsroom", the magazine of the CTBTO Youth Group, also generated significant interest.

The International Day against Nuclear Tests was another highlight. As part of the commemorations, an international conference was hosted by Kazakhstan and attended by members of the Group of Eminent Persons and the CTBTO Youth Group. In addition, a global art campaign was jointly launched by the Commission and Paz y Cooperación, a Spanish non-governmental organization. There were 75 media articles covering events related to the International Day against Nuclear Tests, with more than 20 articles covering the international conference in Kazakhstan.

Exhibits on the work of the Commission were posted at a wide range of external meetings, conferences and similar events, such as the international conference in Kazakhstan; the Paris Peace Forum; the International Convention on Science, Technology and Innovation in Cuba; and the Ministerial Meeting of the Friends of the CTBT, where the video "Putting an End to Nuclear Explosions" was shown.

Global Media Coverage

Global media coverage of the Treaty and its verification regime remained high, with more than 3900 articles and citations in online media. These included interviews with the Executive Secretary by AFP, AP, The Astana Times, BBC, CNN, France 24, Nature, NHK World, Reuters, Sky News, Vesti, the Wall Street Journal and Xinhua News Agency.

Other significant articles on the Treaty and its verification regime were published by Al Jazeera, Arms Control Today, BBC, Clarín, CNN, Der Standard, Die Welt, El Mundo, Focus, Fox News, IDN-InDepthNews, Kazakh TV, Nature, News.com.au, ORF, Phys.org, Reuters, Spiegel Online, TASS, The Conversation, UN News Centre, The Washington Post, WIRED, 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 2018, 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.

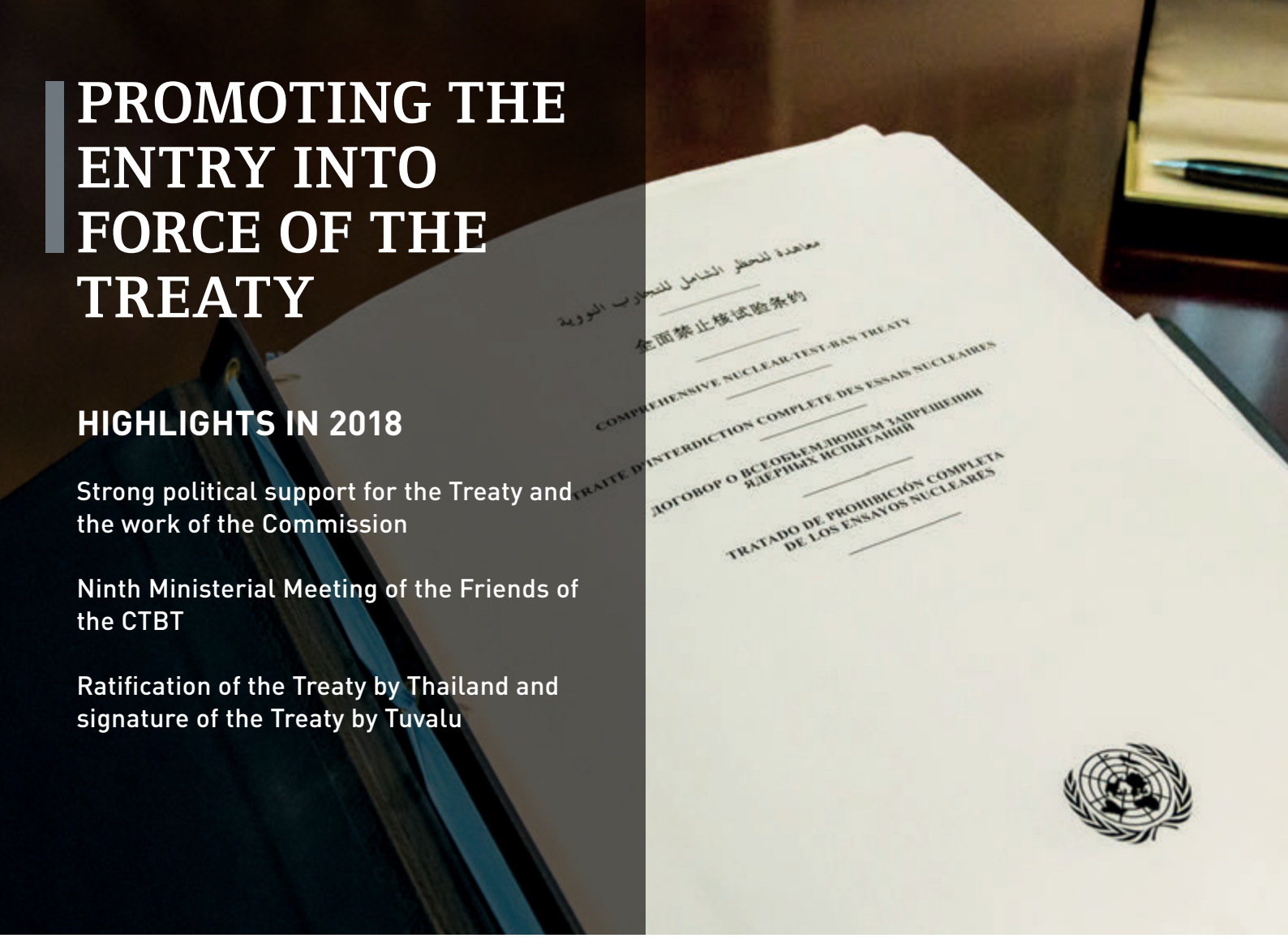
Exhibition on the work of the Commission at the Vienna International Centre.

Poster announcing the global art campaign for the International Day against Nuclear Tests.

Inaugural issue of "Newsroom", the magazine of the CTBTO Youth Group.

Twitter feed of the Commission.

PROMOTING THE ENTRY INTO FORCE OF THE TREATY



HIGHLIGHTS IN 2018

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

Ninth Ministerial Meeting of the Friends of the CTBT

Ratification of the Treaty by Thailand and signature of the Treaty by Tuvalu

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

Conditions for Entry into Force

The entry into force of the Treaty requires ratification by all 44 States listed in its Annex 2. These so-called Annex 2 States are States that formally participated in the final stage of the negotiation of the Treaty in the Conference of Disarmament in 1996 and possessed nuclear power reactors or nuclear research reactors at that time. As of 31 December 2018, 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, 2018

The ninth Ministerial Meeting of the Friends of the CTBT was held on 27 September 2018 in New York. It was organized by the Foreign Ministers of Australia, Canada, Finland, Germany, Japan and the Netherlands, in cooperation with the Article XIV Co-Presidents, the Foreign Ministers of Belgium and Iraq. A high number of ministers and other senior officials from States Signatories attended the meeting. A member of the CTBTO Youth Group was invited to address the meeting.

In a joint ministerial statement, the ministers emphasized that the CTBT stands as a core element of the international nuclear disarmament and non-proliferation regime and contributes to a world without nuclear weapons. They welcomed ratification of the Treaty by Thailand and signature of the Treaty by Tuvalu and urged all States that have not yet done so to sign and ratify the Treaty, in particular the remaining eight Annex 2 States. Noting that the Treaty is approaching universality, they reaffirmed their resolute determination to pursue the entry into force of the Treaty.

The ministers expressed their commitment to achieving the complete, verifiable and irreversible denuclearization of the Democratic People's Republic of Korea and welcomed the Inter-Korean Summits, the summit between the United States of America and the Democratic People's Republic of Korea and ongoing diplomatic efforts. They urged the Democratic People's Republic of Korea to sign and ratify the CTBT as a matter of priority.

They further noted that the conduct of nuclear weapon test explosions is in clear violation of United Nations Security Council resolutions and therefore irresponsible and unacceptable.

The ministers welcomed advances achieved in ensuring the robustness of the verification regime of the Treaty and its scientific and civil applications.

The seventy-third session of the United Nations General Assembly was another occasion for States to renew their commitment to and support for the Treaty. The General Assembly adopted a resolution on the CTBT (A/RES/73/86), with 183 States voting in favour. The resolution urges all States that have not yet signed or ratified the Treaty or that have signed but not yet ratified the Treaty, in particular those whose ratification is needed for its entry into force, to sign and ratify it as soon as possible and to accelerate their ratification processes. It welcomes the ratification of the Treaty by Thailand and its signature by Tuvalu, and urges all States to remain seized of the issue at the highest political level and to promote adherence to the Treaty through bilateral and joint outreach, seminars and other means. In addition, the resolution underlines the need to maintain momentum towards the completion of all elements of the verification regime.

New Ratification and Signature of the Treaty

On 25 September 2018 Thailand deposited its instrument of ratification. Tuvalu signed the Treaty on the same day. As of 31 December 2018, the number of ratifications of the Treaty stands at 167, and the number of signatures is 184. These new developments make the Treaty one of the most adhered to international instruments in the field of disarmament and drive us closer to the desired objective of universality.

The Deputy Minister of Foreign Affairs of the Kingdom of Thailand at the ratification of the Treaty by Thailand in September 2018.

The Prime Minister of Tuvalu at the signing of the Treaty by Tuvalu in September 2018.

POLICY MAKING

HIGHLIGHTS IN 2018

Developments on the Korean Peninsula

Decision to join the United Nations Joint Staff Pension Fund

Review of the functioning of the Advisory Group

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

Working Group A (WGA) deals with budgetary and administrative matters, while Working Group B (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 2018

Body	Session	Dates	Chairperson
Preparatory Commission	Fiftieth Fifty-First	2-3 July 7-9 November	Ambassador Maria Accili Sabbatini (Italy)
Working Group A	Fifty-Third Fifty-Fourth	11-13 June 17 October	Ambassador Maria Accili Sabbatini (Italy) Ambassador Lotfi Bouchaara (Morocco)
Working Group B	Fiftieth Fifty-First	12-23 March 27 August-7 September	Mr Joachim Schulze (Germany)
Advisory Group	Fiftieth Fifty-First	14-18 May 25-27 September	Mr Michael Weston (United Kingdom)

Meetings in 2018

The Commission and its subsidiary bodies each met in two regular sessions in 2018.

Among the major issues addressed by the Commission during 2018 were the promotion of the Treaty and advances towards its universality, including ratification of the CTBT by Thailand and signature of the Treaty by Tuvalu; calling for signature and ratification of the Treaty by the remaining States, especially the Annex 2 States; the situation on the Korean Peninsula and latest positive developments; 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.

Sessions of the Commission and it subsidiary bodies in 2018.

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 Inter-Korean Summits, the Panmunjom Declaration, the joint statement by United States President Donald J. Trump and Chairman Kim Jong-un of the Democratic People's Republic of Korea at the Singapore Summit as well as the summits between China and the Democratic People's Republic of Korea.

They urged the Democratic People's Republic of Korea to take concrete steps towards complete, verifiable and irreversible denuclearization and to maintain its declared suspension of nuclear weapons testing. The parties were encouraged to engage seriously in the follow-on negotiations.

States Signatories highlighted the importance of verifiable closure and dismantlement of the nuclear test sites of the country and the potential role of CTBT expertise and capabilities, subject to the approval of the Commission. They also urged the Democratic People's Republic of Korea to sign and ratify the Treaty.

Transition from the Provident Fund to the United Nations Joint Staff Pension Fund

At its Forty-Ninth Session, the Commission mandated the PTS to file an application and enter into negotiations for membership in the United Nations Joint Staff Pension Fund (UNJSPF).

At its Fiftieth Session, the Commission approved joining the UNJSPF as of 1 January 2019. It also approved the draft agreement between the United Nations Joint Staff Pension Board and the Commission as to the conditions governing the admission of the Commisesion to the UNJSPF.
With the approval of the United Nations General Assembly at its seventy-third session, the Commission became a UNJSPF member organization as of 1 January 2019.

Fifty-First Session of the Preparatory Commission.

Review of the Functioning of the Advisory Group

The Commission and Working Group A 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 and Vice-Chairpersons of Working Group A

The Commission appointed Ambassador Lotfi Bouchaara of Morocco as the Chairperson and Ambassador Brendon Charles Hammer of Australia and Ambassador Károly Dán of Hungary as the Vice-Chairpersons of Working Group A for a term expiring on 31 December 2020.

MANAGEMENT

HIGHLIGHTS IN 2018

Improving human resources policies, procedures and processes

Allocation of 80% of the budget to verification related activities

Further strengthening of oversight

Annual management retreat.

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 and legal services.

The PTS also provides a wide variety of general services, from arrangements concerning shipments, customs formalities, visas, identity cards, laissez-passer and low value purchases to insurance, tax, travel and telecommunication services, as well as standard office and information technology support and asset 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 Vienna International Centre over planning of office and storage space, maintenance of the premises, common services and security.

Throughout 2018, 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 audit, investigation and advisory 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 2018, Internal Audit concluded and issued seven 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. Internal Audit provided several recommendations to management. Internal Audit also performed and reported on three special assignments as directed by the Executive Secretary. 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 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 best practices.

Finance

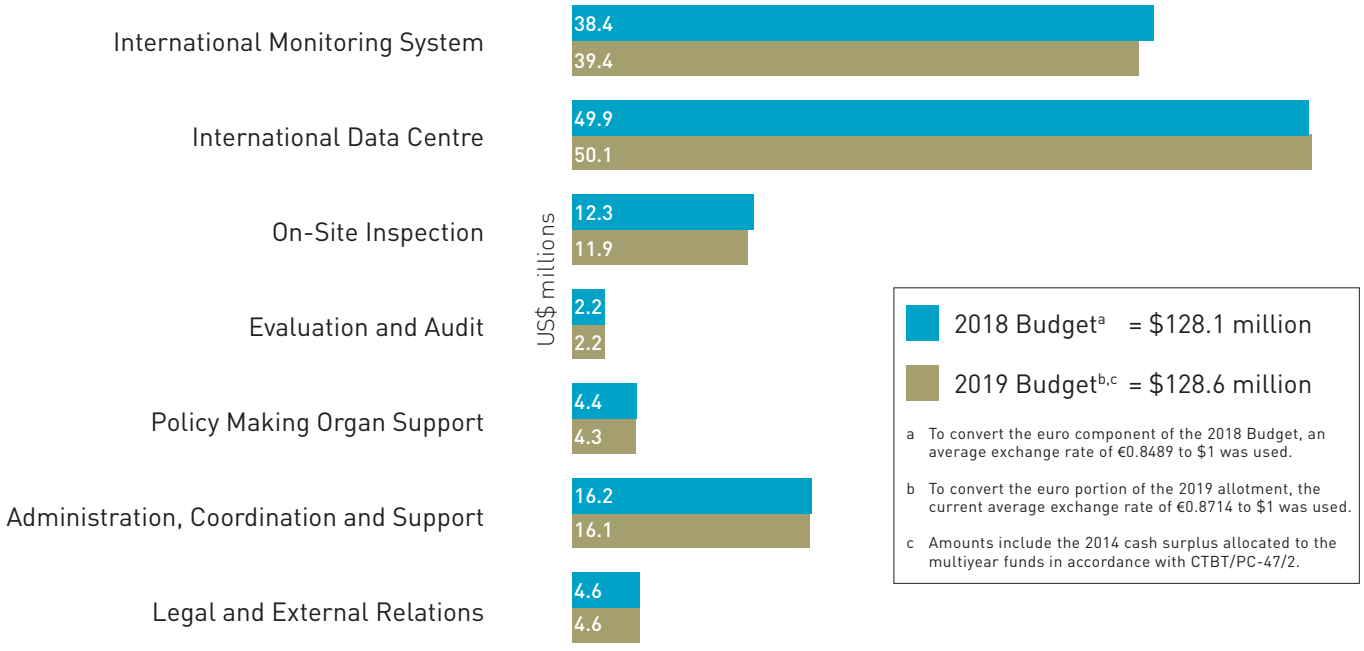
2018-2019 Programme and Budget

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 $128 076 055. 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).

Distribution of the 2018-2019 Budget by Area of Activity



Annual management retreat.

Assessed Contributions

As of 31 December 2018, the collection rates of the assessed contributions from States Signatories for 2018 were 92.0% of the US dollar portion and 92.2% of the euro portion. The number of States that had paid their 2018 assessed contributions in full as of 31 December 2018 was 104.

Expenditure

The expenditure for the Programme and Budget in 2018 amounted to $115 198 727, of which $9 584 667 was from the Capital Investment Fund, $10 449 304 was from the multiyear funds, and the remainder from the General Fund. For the General Fund, the unused budget was $8 459 799.

General Services

The PTS continued to implement its major office space utilization optimization plan rolled out in 2017. An important cross-Divisional arrangement to optimize the use of available space and accommodate pressing archiving needs was 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 the 2nd CTBT Science Diplomacy Symposium and the 2018 NDC Workshop. It also serviced the needs of the temporary storage area at Seibersdorf, Austria, and facilitated works for the establishment of a new Equipment Storage and Maintenance Facility.

Cooperation and dialogue with other Vienna based organizations was strengthened, with the PTS actively participating in all joint and common committees. Close cooperation with other organizations in Vienna helped identify new ways to improve and streamline internal processes such as hotel procurement and travel and invoice certification processes, as well as more robust oversight of work related to building management at the Vienna International Centre.

The transport fleet of the PTS was modernized, in part to provide better support to daily operations, and bidding for improved specialized transport for offsite work was initiated.

Procurement

The Administrative Directive related to procurement was promulgated in 2018 to include the best practices of the Procurement Section as well as those of other international organizations. Three projects were initiated to further streamline procurement processes for efficiency and effectiveness while ensuring transparency and accountability.

The Commission obligated $59 860 199 through 885 procurements for high value purchases and $847 662 through 551 contractual instruments for low value purchases.

As of 31 December 2018, 140 IMS stations, 28 noble gas systems, 12 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 $81 million in cash contributions and $58 million in contributions in kind.

The Voluntary Support Forum held one meeting, in November 2018. All States Signatories and observers were invited. During the meeting the PTS presented several projects for which it sought voluntary contributions in 2019 as outlined partly in Appendix II of the 2018-2019 Programme and Budget. The projects covered two planned regional outreach and capacity building events in anglophone and francophone Africa amounting to $0.5 million, the urgent funding needs for the project to facilitate the participation of experts from developing countries in official technical meetings of the Commission in the amount of $120 000 per year, and the general additional resource requirements for phase 3 of IDC re-engineering.

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 2018, there were 278 regular fixed term staff members of the PTS from 86 countries, compared with 277 staff members from 86 countries on 31 December 2017. In 2018, there were 183 staff members in the Professional and higher categories, while in 2017 there were 189.

Headquarters of the Provisional Technical Secretariat in Vienna.

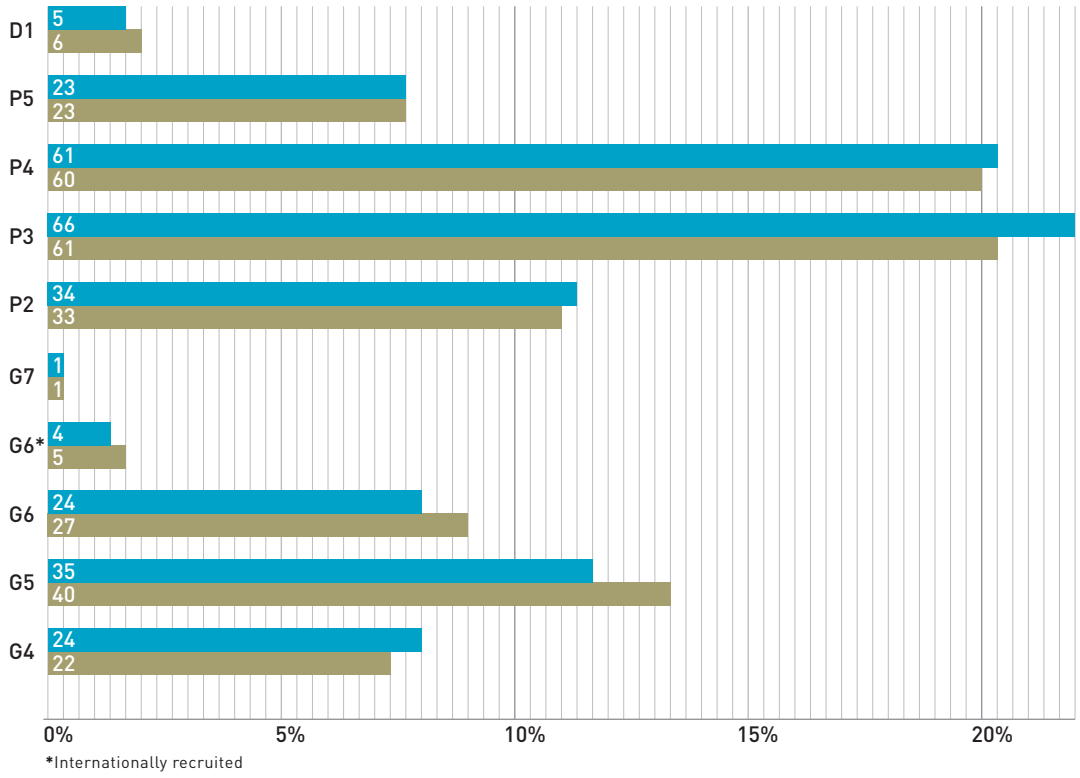
Fixed Term Staff Members by Field of Work as of 31 December 2018

Field of Work	Professional	General Service	Total
QMPM Section	3	1	4
IMS Division	39	23	62
IDC Division	77	14	91
OSI Division	19	7	26
Subtotal, verification related	*138*	*45*	*183*
Share, verification-related	*73.54%*	*48.86%*	*65.70%*
Office of the Executive Secretary	8	10	18
Internal Audit	4	-	4
Division of Administration	19	22	41
Legal and External Relations Division	14	18	32
Subtotal, non verification related	*45*	*50*	*95*
Share, non-verification related	*26.46%*	*51.14%*	*34.30%*
Total	**183**	**95**	**278**

Fixed Term Staff Members by Grade, 2017 and 2018

2017
189 Professional
88 General Service

2018
183 Professional
95 General Service



*Internationally recruited

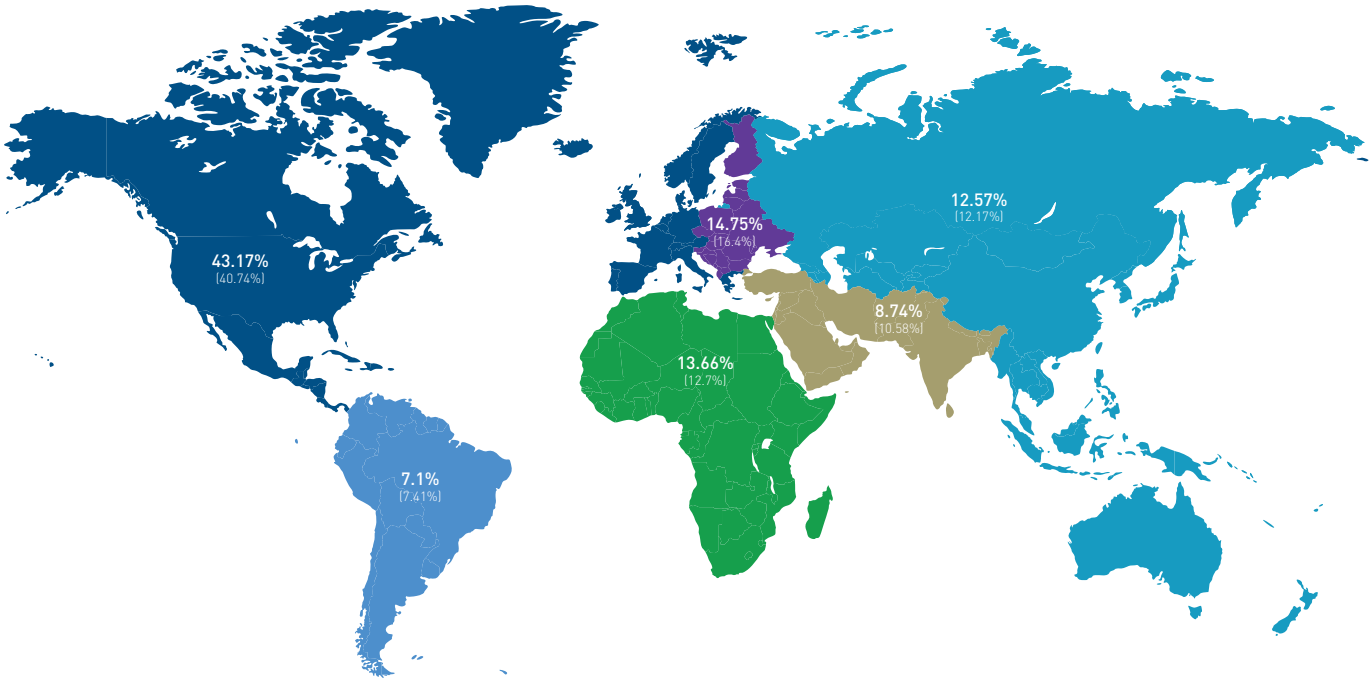
Fixed Term Staff Members by Grade and Gender, 2017 and 2018

Grade	Male				Female			
	2017		2018		2017		2018	
D1	3	2.48 %	3	1.79 %	2	1.79 %	3	2.73 %
P5	16	8.08 %	18	10.71 %	7	6.25 %	5	4.55 %
P4	45	29.19 %	47	27.98 %	16	14.29 %	13	11.82 %
P3	48	27.95 %	45	26.79 %	18	16.08 %	16	14.55 %
P2	16	9.32 %	15	8.93 %	18	16.08 %	18	16.36 %
Subtotal	*128*	*77.02 %*	*128*	*76.19 %*	*61*	*54.46 %*	*55*	*55.45 %*
G7	-	-	-	-	1	0.89 %	1	0.91 %
G6*	4	2.48 %	5	2.98 %	-	-	-	-
G6	16	9.94 %	18	10.71 %	8	7.15 %	9	8.18 %
G5	12	8.08 %	12	7.14 %	23	20.54 %	28	25.45 %
G4	5	2.48 %	5	2.98 %	19	16.96 %	17	15.45 %
Subtotal	*37*	*22.98 %*	*40*	*23.81%*	*51*	*45.54 %*	*55*	*46.36 %*
Total	165		168		112		110	

*Internationally recruited

Fixed Term Professional Staff by Geographical Region as of 31 December 2018

(Percentages as of 31 December 2017 are shown in brackets.)



SIGNATURE AND RATIFICATION

As of 31 December 2018

184 States Signatories
167 Ratified / 17 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
45 Ratified / 6 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	

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
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
The former Yugoslav Republic of Macedonia	29 Oct. 1998	14 Mar. 2000
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

CTBTO
PREPARATORY COMMISSION


CTBTO
PREPARATORY COMMISSION
PUTTING AN
END TO NUCLEAR
EXPLOSIONS