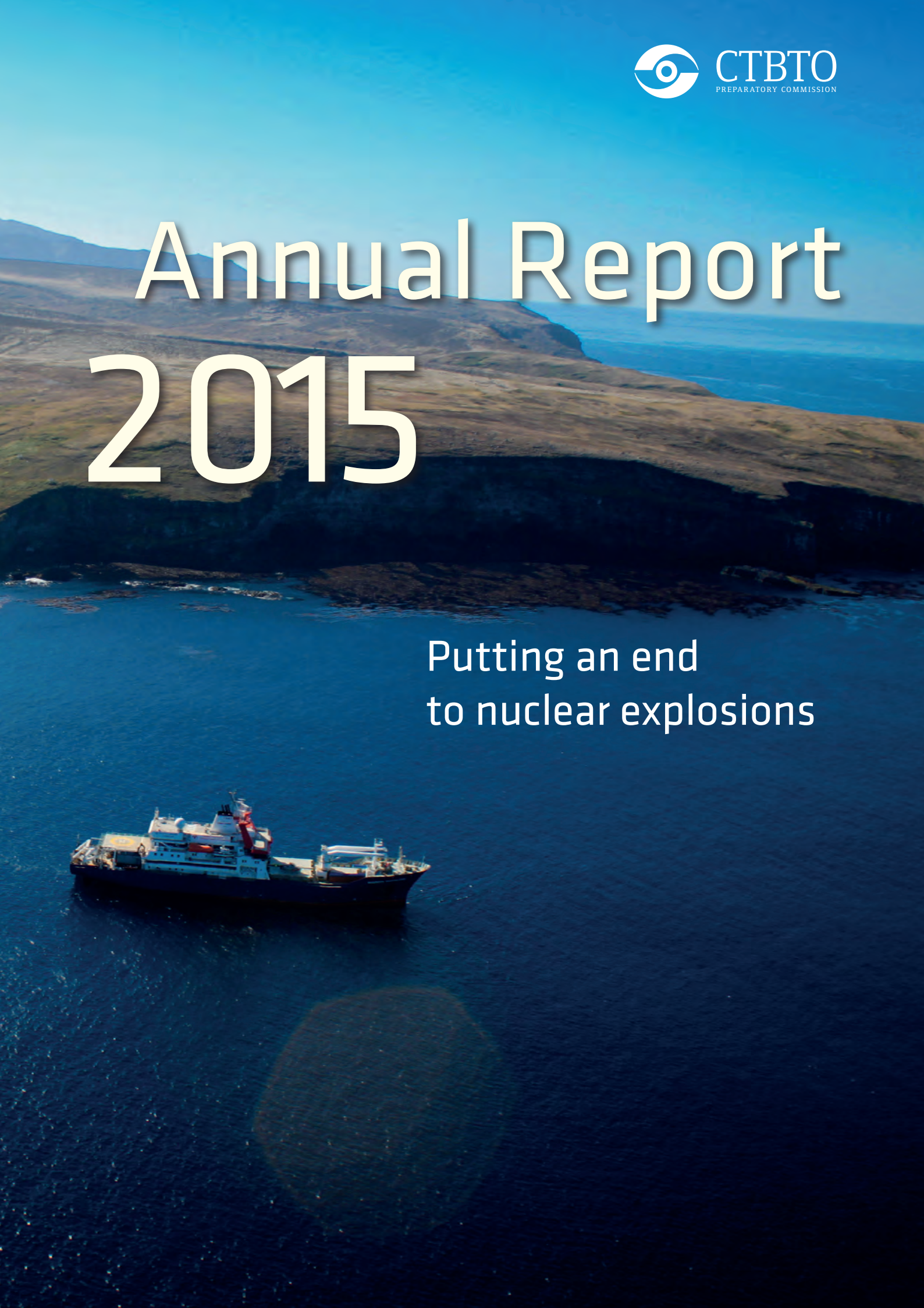
CTBTO
PREPARATORY COMMISSION

Annual Report 2015

Putting an end to nuclear explosions



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 weapon. 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, 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.

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

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

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Message
from the Executive Secretary

In 2015 States and civil society continued to manifest their strong support for the Comprehensive Nuclear-Test-Ban Treaty (CTBT) and the work of the Commission.

The ninth Conference on Facilitating the Entry into Force of the CTBT, on 29 September 2015, served as a platform for States Signatories to reaffirm their commitment to the Treaty and their desire for its universality. The conference was opened by the United Nations Secretary-General and chaired by the Foreign Ministers of Japan and Kazakhstan. Over 90 States Signatories attended the conference, many at the level of foreign minister or other senior levels. The participants included delegates from five of the Annex 2 States whose ratification is required for entry into force: China, Egypt, the Islamic Republic of Iran, Israel and the United States of America. The conference reviewed the progress towards bringing the Treaty into force and discussed strategies and efforts to achieve this. Its Final Declaration contains 14 practical measures to accelerate the ratification process and achieve entry into force.

The seventieth session of the United Nations General Assembly was another opportunity for States to highlight the important role of the Treaty in the international nuclear non-proliferation and disarmament regime.

Throughout the year, we increased our high level engagement with States. I met with President Michel Kafando of Burkina Faso, Pope Francis of the Holy See, President Hassan Rouhani of the Islamic Republic of Iran, President Mahamadou Issoufou of Niger, President Vladimir Putin of the Russian Federation, President Maithripala Sirisena of Sri Lanka, King Mswati III of Swaziland, President Gurbanguly Berdimuhamedov of Turkmenistan, and President Barack Obama of the United States of America.

I held talks with foreign ministers and other national cabinet ministers of States Signatories. They included Angola, Belgium, Costa Rica, Ethiopia, Finland, Gambia, the Holy See, Israel, Japan, Kazakhstan, Morocco, Myanmar, Niger, Romania, South Africa, Swaziland, Sweden and Turkmenistan. I also met with the High Representative for Foreign Affairs and Security Policy of the European Union. The powerful message of support that I received on all these occasions was very reassuring.

The senior statesmen, active and former politicians, and internationally recognized experts who make up the Group of Eminent Persons (GEM) continued their efforts to promote the Treaty. The group met twice in 2015, in Seoul, Republic of Korea, and in Hiroshima, Japan. During its meetings, GEM identified ways to advance the Treaty's entry into force, including through a multilateral approach to engage the leadership of the remaining eight Annex 2 States with the aim of facilitating their ratification processes.

The Commission made further progress in strengthening its verification capabilities. Following successful outreach with host States, the Commission reached political agreements for the establishment of stations of the International Monitoring System (IMS) in a number of States in Africa and South America where there had been slow progress in the past. The organization also took major steps to complete some IMS facilities that were under construction. With additional certifications in 2015, the total number of certified IMS facilities reached 282, improving both the coverage and the resilience of the network. This figure represents 84% of the network foreseen by the Treaty.

The organization continued to provide States Signatories with near real time data from the IMS facilities and data products from the International Data Centre (IDC). It also took additional steps in commissioning the IDC. In this context, it developed a detailed road map for Phase 5b of the IDC Progressive Commissioning Plan and a new version of the validation and acceptance test plan.

The Commission's activities in the area of on-site inspection (OSI) focused on evaluation of the 2014 Integrated Field Exercise. This helped in the preparation of a new OSI action plan for 2016–2019. Based on a review of its previous OSI training activities and inspection techniques, the organization also devised plans for the next OSI training cycle and for development of the inspection techniques.

CTBT: Science and Technology 2015, the fifth conference in the series, offered yet another occasion for the Commission to build on its partnership with the scientific community. By benefiting from cutting edge research, it can further improve the verification regime of the Treaty. Over 850 participants from 99 States – from the scientific and technology communities, academia, civil society and governments – attended the conference and engaged in its deliberations. Particular effort was made to ensure participation of young scientists through initiatives such as the citizen science panel, the young scientists evening and Academic Forum sessions.

Hundreds of nationals of States Signatories, in particular from developing countries, continued to benefit from our capacity building activities, workshops and educational programmes. We see this as an investment whose aim is to help States Signatories to better fulfil their Treaty obligations and to use the data and products of the verification system more efficiently.

States Signatories made a number of decisions that contributed to the further organizational development of the Commission and allow for better long term planning and budgeting. They decided to introduce biennial budgeting for the activities of the organization and to establish a multiyear funding modality. They also agreed on the procedures for the appointment of the Chairpersons and Vice-Chairpersons of the subsidiary bodies of the Commission.

These are just a few of our achievements in 2015. The following report provides more details on the many activities of the organization.

To close, I want to take this opportunity to thank States Signatories for their unconditional commitment to advancing the work of the organization.

Lassina Zerbo
Executive Secretary
CTBTO Preparatory Commission
Vienna, March 2016

Highlights of Activities

International Monitoring System Division

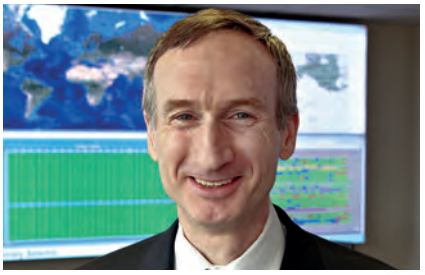
Nurcan Meral Özel, Director

Preparations for the installation of new IMS stations

Ability of radionuclide laboratories to analyse noble gas data

International Data Centre Division

Randy Bell, Director



Further work in the progressive commissioning of the IDC

Holding the CTBT: Science and Technology 2015 conference

On-Site Inspection Division

Oleg Rozhkov, Director

Evaluation of the 2014 Integrated Field Exercise

Development of a new OSI action plan

Legal and External Relations Division

Genxin Li, Director

More high level engagement with States

Promoting the nuclear test ban norm

Administration Division

Thierry Dubourg, Director

Further improvement of the financial and budgetary arrangements of the organization

Establishment of four multiyear funds

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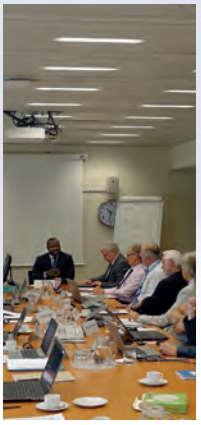


Abbreviations

3-C	three component
ARAS	alternative radionuclide analysis system
ARISE	Atmospheric dynamics Research InfraStructure in Europe
ATM	atmospheric transport modelling
AU	African Union
CIF	Capital Investment Fund
CNS	James Martin Center for Nonproliferation Studies
CTBT	Comprehensive Nuclear-Test-Ban Treaty
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
DOTS	Database of the Technical Secretariat
ECS	Experts Communication System
ESMF	Equipment Storage and Maintenance Facility
EU	European Union
FIMS	Field Information Management System
GCI	Global Communications Infrastructure
GEM	Group of Eminent Persons
IAEA	International Atomic Energy Agency
IDC	International Data Centre
IFE	Integrated Field Exercise
IIMS	Integrated Information Management System
INGE	International Noble Gas Experiment
IMS	International Monitoring System
ISTHAR	Information System with Hyperlinks on Tasks Assigned by the Resolution Establishing the Preparatory Commission
IT	information technology
ITF	inspection team functionality
MPLS	multiprotocol label switching
NDC	National Data Centre
NGO	non-governmental organization
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NTI	Nuclear Threat Initiative
O&M	operation and maintenance
OPCW	Organisation for the Prohibition of Chemical Weapons
OSC	Operations Support Centre
OSI	on-site inspection
PCA	post-certification activity
PRTool	performance reporting tool
PTE	Proficiency Test Exercise
QA/QC	quality assurance and quality control
QMS	Quality Management System
REB	Reviewed Event Bulletin
RRR	Reviewed Radionuclide Report
SEL	Standard Event List
SSD	station specific documentation
UNIDO	United Nations Industrial Development Organization
VCDNP	Vienna Center for Disarmament and Non-Proliferation
VDMS	verification data messaging system
VIC	Vienna International Centre
VPN	virtual private network
VSAT	very small aperture terminal
VSF	Voluntary Support Forum
WGA	Working Group A
WGB	Working Group B
WMO	World Meteorological Organization

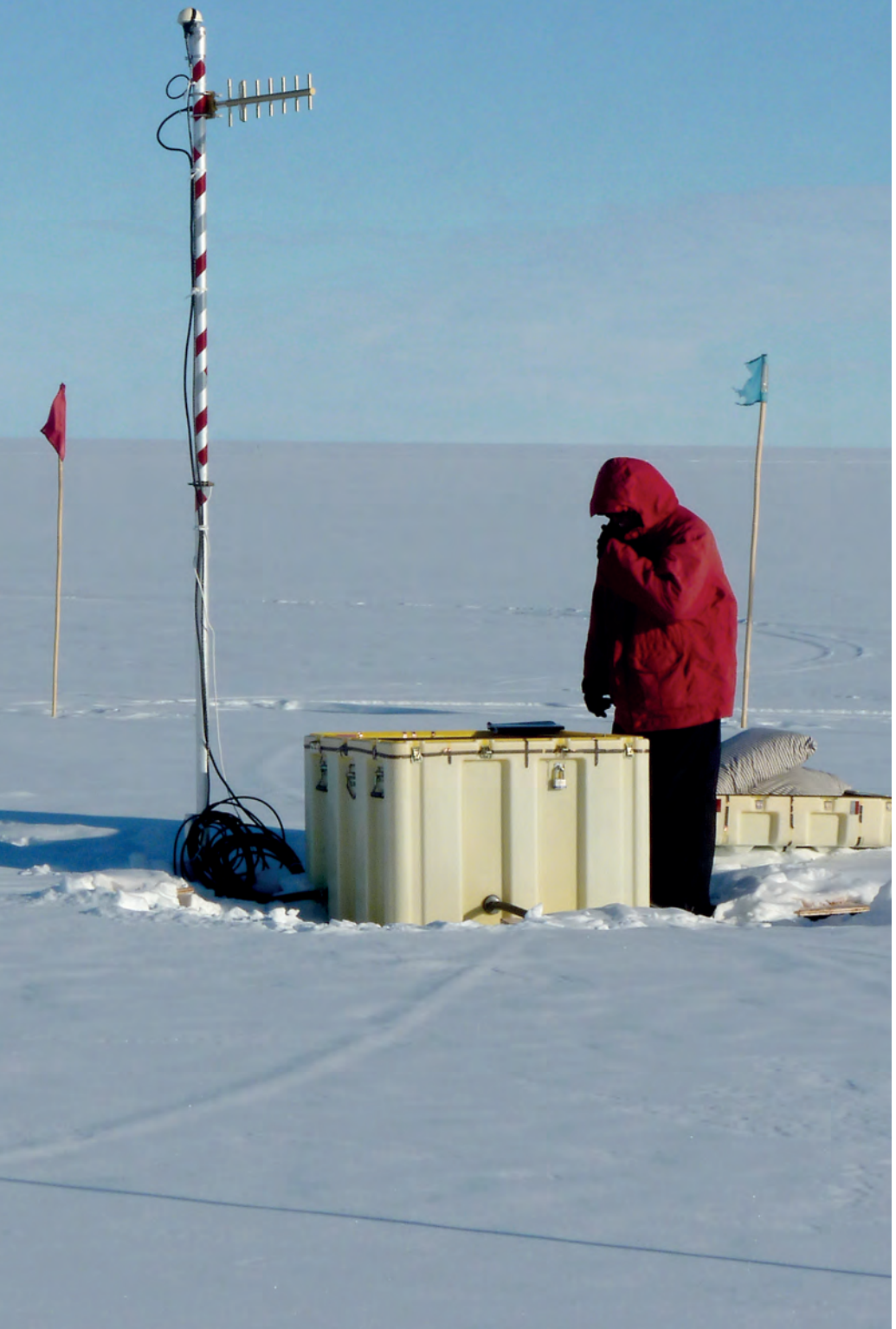
The International Monitoring System

Highlights in 2015

Preparations for the establishment of new IMS stations

Sustainment of the IMS network to ensure a high level of data availability

Maturity of the ability of radionuclide laboratories to analyse noble gas data



The International Monitoring System (IMS) is a global network of sensors for detecting and providing evidence of possible nuclear explosions. When completed, the IMS will consist of 321 monitoring stations and 16 radionuclide laboratories in 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, at a growing number of stations, noble gases from the atmosphere. The samples are then 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.

Revalidation of infrasound station IS55, Windless Bight, Antarctica (USA)

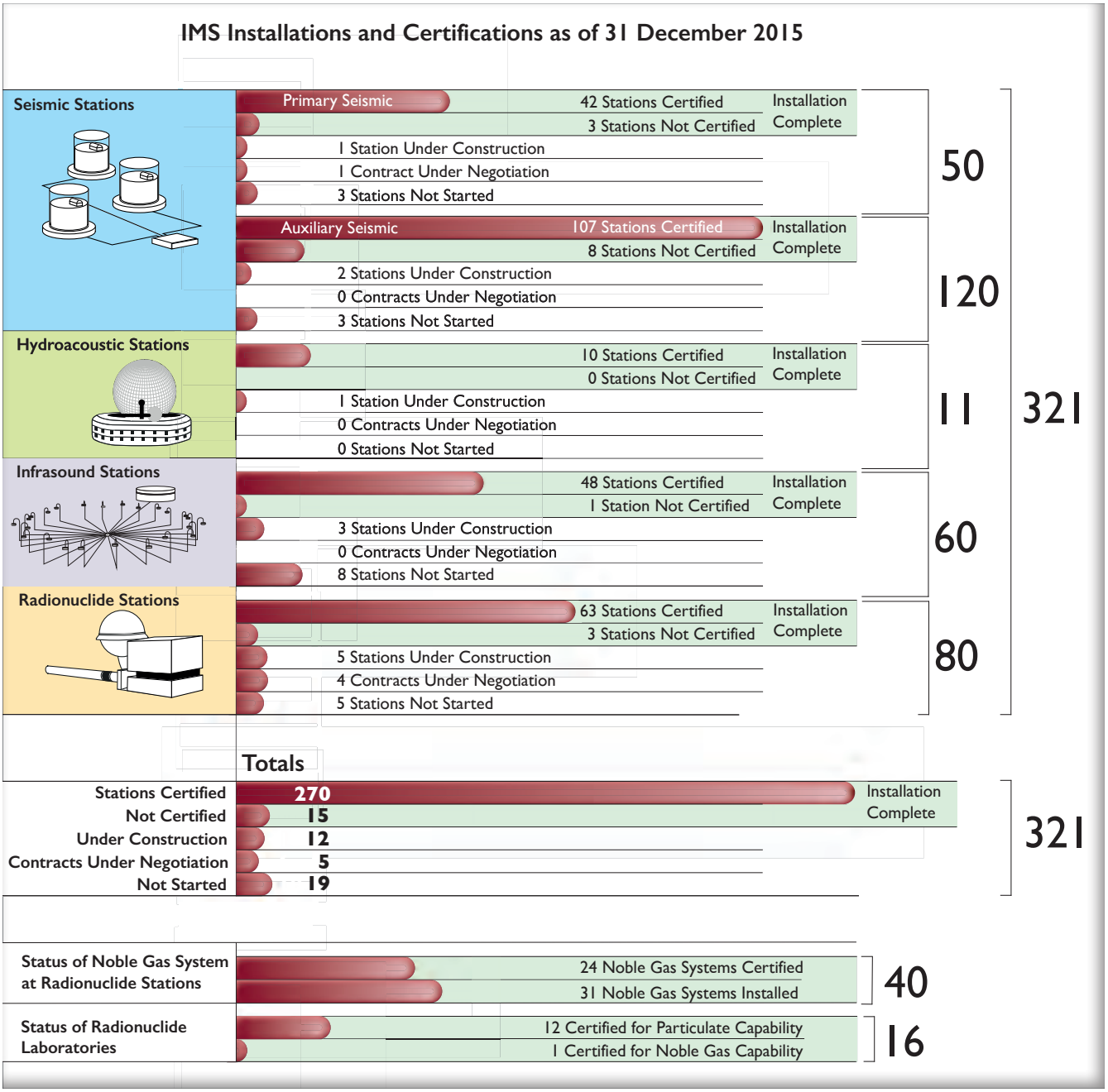
Completing the International Monitoring System

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

In 2015, following outreach to host States, the Commission reached political agreements to establish stations in States in Africa and South America, among other places, where there had been slow progress in the past. The preparatory work for installation of the new facilities has started. The organization also took major steps towards the completion of IMS stations in the Russian Federation.

At the end of the year, preparations were under way to install or certify about 15 further IMS stations, noble gas systems and laboratories in 2016–2017.

China recommenced transmission of data from IMS primary seismic and radionuclide stations for testing and



Wake Island, location of infrasound station IS60 (USA)

evaluation purposes. Together, China and the Commission made concerted efforts to prepare the upgrade of these stations to IMS specifications in order to certify them as soon as possible.

With the installation of infrasound station IS60 (USA), the certification of radionuclide laboratory RL13 (Russian Federation) and the certification of noble gas systems at IMS radionuclide stations RN4 and RN9 (Australia), additional progress was made towards the completion of the IMS.

> "The total number of certified IMS stations and laboratories reached 282 (84% of the network foreseen by the Treaty), improving both the coverage and the resilience of the network"

The total number of certified IMS stations and laboratories thus reached 282 (84% of the network foreseen by the Treaty), improving both the coverage and the resilience of the network.

Substantial progress was also made with the major installation project to re-establish hydroacoustic station HA4 (France) on Crozet Island in the southern Indian Ocean, which is the only uncertified IMS hydroacoustic station. At the end of 2015 preparations were finalized for an at-sea pre-installation survey and preparatory land infrastructure activities at Crozet Island.

Monitoring of radionuclide noble gases plays an essential role in the Treaty's verification system, 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 in 2015 continued to focus on the noble gas monitoring programme. As well as certifying noble gas systems at radionuclide stations RN4 and RN9 (as noted above), it upgraded the uncertified system at RN19 in Chile.

By the end of the year, 31 noble gas systems were installed (78% of the planned total of 40) at IMS radionuclide stations. Of these, 24 systems were certified as meeting the stringent technical requirements. The addition of these systems significantly strengthens the detection capacity of the IMS network.

The Commission also continued its preparations to certify additional IMS laboratories for noble gas measurement capability. The Commission adopted certification requirements and processes for noble gas laboratories in 2012 and the first certification of an IMS laboratory for noble gas measurement capability took place in 2014. In 2015 work continued to assess the analysis of noble gas data at IMS laboratories. Inter-comparison exercises demonstrated excellent performance of IMS laboratories. This new functionality is crucial for the quality

assurance and quality control (QA/QC) of IMS noble gas measurements.

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

Upgrading radionuclide station RN19, Hanga Roa, Easter Island (Chile)

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 derive full 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 2015 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 causes 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, 48 have signed a facility agreement or arrangement with the Commission, and 39 of these agreements and arrangements are in force. At the end of 2015, the Commission was in negotiation with 5 of the 41 host States that had not yet concluded a facility agreement or arrangement. States are showing increased interest in the subject and it is hoped that ongoing negotiations may be concluded in the near future and that negotiations with other States may be initiated soon.

Maintenance of infrasound station IS41, Villa Florida (Paraguay)

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 Commission's total expenditure related to PCAs in 2015 was US$18 167 552. This amount covers the costs related to PCAs for 164 facilities and noble gas systems certified up to 31 December 2015, including the 12 certified radionuclide laboratories and 18 of the noble gas systems at radionuclide stations.

Each station operator submits a monthly report on PCA performance, which the organization 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 station operators of all newly certified stations and of existing stations that submitted new budget proposals to develop O&M plans in accordance with a standard template. In 2015 O&M plans for 7 more stations were submitted in the standard format. This brought the number of stations under PCA contracts with O&M plans in the standard format to 102.

> "The life cycle of the IMS station network proceeds from conceptual design and installation to operation, sustainment, disposal and rebuild"

Sustaining Performance

Preparing a global monitoring system of 337 facilities supplemented by 40 noble gas systems involves much more than just the building of stations. It requires a holistic approach to establishing and sustaining an intricate 'system of systems' that should be completed to meet the verification requirements of the Treaty while protecting the investment already made by the Commission. This can be achieved by testing, evaluating and sustaining what is in place, and then further improving on this.

The life cycle of the IMS station network proceeds from conceptual design and installation to operation, sustainment, disposal 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

Installation of a seismic borehole sensor at the Commission's test facility, Vienna

Sensor installation at auxiliary seismic station AS56, Tel-Alasfar (Jordan)

all components of each facility in order to minimize downtime and optimize resources.

The support activities for IMS facilities in 2015 continued to focus on preventing interruptions to the flow of data. They also aimed at preventive and corrective maintenance and recapitalization of IMS stations and station components as they reach the end of their lives. The Commission intensified its efforts to develop and implement engineering solutions to improve the robustness and resilience of IMS facilities.

Optimizing and enhancing performance also involve the continuous improvement of data quality, reliability and resilience. Hence, the Commission continued to place importance in 2015 on QA/QC, on state of health monitoring, on IMS facility calibration activities (which are essential for the reliable interpretation of detected signals) and on improvement of IMS technologies. These activities contribute to maintaining a credible and technologically relevant monitoring system.

Logistics

The support required to ensure the highest levels of data availability from a global network of facilities such as the IMS calls for an integrated approach to logistics that seeks continuous validation and optimization. In 2015 the Commission undertook an in-depth assessment of its logistics requirements and started establishing an organization-wide integrated logistics support structure and plan of action.

The Commission also 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 280 certified IMS facilities around the world, often in remote sites, maintaining the highest levels of data availability requires continuous analysis, refinement and validation of IMS station life cycle costs and reliability variables. During 2015 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 IMS 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, it reduces costs, effort and unforeseen drops in data availability.

In this context the Commission continued to implement and improve the internal IMS configuration management procedures that had been introduced at the end of 2013. It also worked with host States and station operators to further streamline State specific shipment procedures for IMS equipment and consumables and ensure their timely and cost free customs clearance. Nonetheless, shipping and customs clearance processes continued to be very time consuming and resource intensive. This increases the time to

repair an IMS station and reduces the data availability of that station. The Commission therefore continued to analyse and optimize the availability of IMS equipment and consumables at IMS stations, at its regional depots, at suppliers' depots and at the depot in Vienna.

Maintenance

The organization provides maintenance support and technical assistance at IMS facilities around the globe. During 2015 it addressed more than 104 maintenance requests, including long running data availability problems at eight IMS facilities. It also conducted preventive and corrective maintenance visits at eight certified IMS facilities. This low figure reflects an increased reliance on station operators, contractors and other sources of support to perform such tasks, following the strategy of the Secretariat.

The Commission continued to establish and manage long term support contracts with manufacturers of IMS equipment and support providers. Some of these contracts were also 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, materials 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.

"During 2015 the Commission addressed more than 104 maintenance requests, including long running data availability problems at eight IMS facilities"

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 do occur. In 2015 the Commission continued to emphasize development of the technical capabilities of station operators. As well as technical training for operators, station visits by staff of the Secretariat included hands-on training for local staff, with the aim of avoiding the need for staff to travel from Vienna to resolve future problems.

Up to date and reliable technical documentation for each IMS station is essential to ensure its sustainability and to maintain a high level of data availability. In 2015 the Commission made substantial progress with the establishment of a platform for station specific documentation (SSD) in the Database of the Technical Secretariat (DOTS). This enables the users to retrieve information pertinent to each station. The station operators started to enter SSD into the DOTS platform. Progress was also made to optimize processes to routinely keep such documentation up to date.

The combination of technical training for station operators, enhanced 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 capabilities of station operators to undertake more sophisticated maintenance tasks at their stations. This is essential for optimizing the sustainment and performance of the IMS network.

Repair of a noble gas system compressor at the Vienna International Centre

Installation of a new transformer at radionuclide station RN13, Edea (Cameroon)

Recapitalization

The final phase in the life cycle of equipment for IMS facilities involves its replacement (known as recapitalization) and disposal. In 2015 the Commission continued to recapitalize IMS facility components as they reached the planned end of their operating lives.

In managing recapitalization, the Commission and the 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 where failure would cause significant downtime. At the same time, recapitalization of components that proved to be robust and reliable was delayed beyond the planned ends of their lives, where suitable, in order to optimize the use of available resources.

Several recapitalization projects were completed at certified IMS facilities in 2015, involving substantial investment of human and financial resources. In six cases (IS7 in Australia, HA3 in Chile and AS112, IS53, IS55 and IS56 in the United States of America), recapitalization was followed by revalidation in order to ensure that the stations continued to meet technical requirements. Three stations were relocated within their host State (RN31 in France and AS112 and RN75 in the USA). Major upgrades of noble gas systems at three certified radionuclide stations were also completed (RN66 and RN68 in the UK and RN74 in the USA).

Engineering Solutions

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

In 2015 the Commission carried out several complex repairs, requiring substantial engineering work, 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 upgrade.

The Commission continued its work to optimize the performance of the IMS facilities and the monitoring technologies. Analysis of station failures helped identify the main causes of data loss and assisted the subsequent analysis of subsystem failures responsible for downtime. In particular, in 2015 the Commission carried out trend analyses of downtime of each subsystem for all waveform technologies. It also continued systematic failure analysis based on incident reports for the radionuclide particulate and noble gas systems. The outcome of these activities provided valuable inputs to prioritize the design, validation and implementation of improvements for IMS stations and technologies.

> "In 2015 the Commission carried out several complex repairs, requiring substantial engineering work, to return stations to operation"

In 2015 the Commission concentrated its engineering efforts on the following:

- Enhancement of IMS power and grounding and lightning protection systems;

- Improvement of equipment and services for IMS intra-site communication systems;
- Implementation of the first on-site calibration capability at an IMS infrasound station (IS26, Germany);
- Procurement and testing of the new generation of wind noise reduction systems;
- Completion of a pilot interlaboratory comparison study for the infrasound technology as a major step towards better understanding and standardization of infrasound metrology;
- Assessment of high resolution digitizers;
- Development of software for the analysis and evaluation of seismoacoustic calibration and orientation activities;
- Development and testing of meteorological filter boxes intended to improve the quality of meteorological data recorded at IMS infrasound stations;
- Assessment of the next generation of hydroacoustic stations and potential temporary solutions;
- Improvement of high purity germanium detectors, which were identified as a major source of radionuclide station downtime in 2014;
- Testing and evaluation of detector cooling techniques for radionuclide stations;
- Improvement of the SAUNA noble gas system;
- Testing of new technology for the next generation of the SPALAX noble gas system;
- Testing of prototype silicon PIN high resolution beta–gamma detectors for noble gas measurements, which improve discrimination between metastable xenon isotopes.

These initiatives further improved the reliability and resilience of IMS facilities. They also enhanced the performance of the network and increased the robustness of the IMS stations, thus contributing to extension of their useful life and containing the risks of data downtime. Moreover, they 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 2015. The data availability of auxiliary seismic stations was maintained during the year.

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

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

To address this, in 2015 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

Certification of the noble gas system at radionuclide station RN9, Darwin, Northern Territory (Australia)

additional Secretariat 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 2015 continued to focus on measures for data surety and calibration.

The Commission further developed calibration methodologies. In particular, it performed the first full frequency on-site calibration at an infrasound station (IS26, Germany). It also made progress with the integration of T phase hydroacoustic stations into the calibration planning.

In addition, the Commission continued the scheduled calibration of primary and auxiliary seismic stations and started the deployment of the standard station interface (SSI) calibration module to ease and standardize actions by station operators.

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

The QA/QC programme for laboratories consisted of interlaboratory comparison activities. The Commission both assessed the 2014 Proficiency Test Exercise (PTE) and conducted the 2015 PTE, which involved analysis of test samples in the geometry of RASA automatic systems. The Commission also undertook laboratory surveillance visits to radionuclide laboratories RL7 (Finland) and RL16 (USA) and completed assessment of RL9 (Israel).

QA/QC activities for noble gas continued with the reanalysis at laboratories of 24 samples from five radionuclide stations. The Secretariat also completed the evaluation of an intercomparison exercise of the noble gas capability of radionuclide laboratories and continued the testing and implementation of pilot QA/QC procedures for this capability.

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.

IMS Technologies

Seismic Stations

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

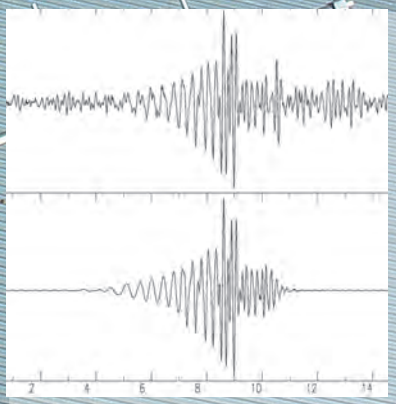
Seismic technology is very efficient at detecting a suspected nuclear explosion as seismic waves travel fast and can be registered within minutes of an event. Data from seismic stations of the International Monitoring System provide information on the location of a suspected underground nuclear explosion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

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

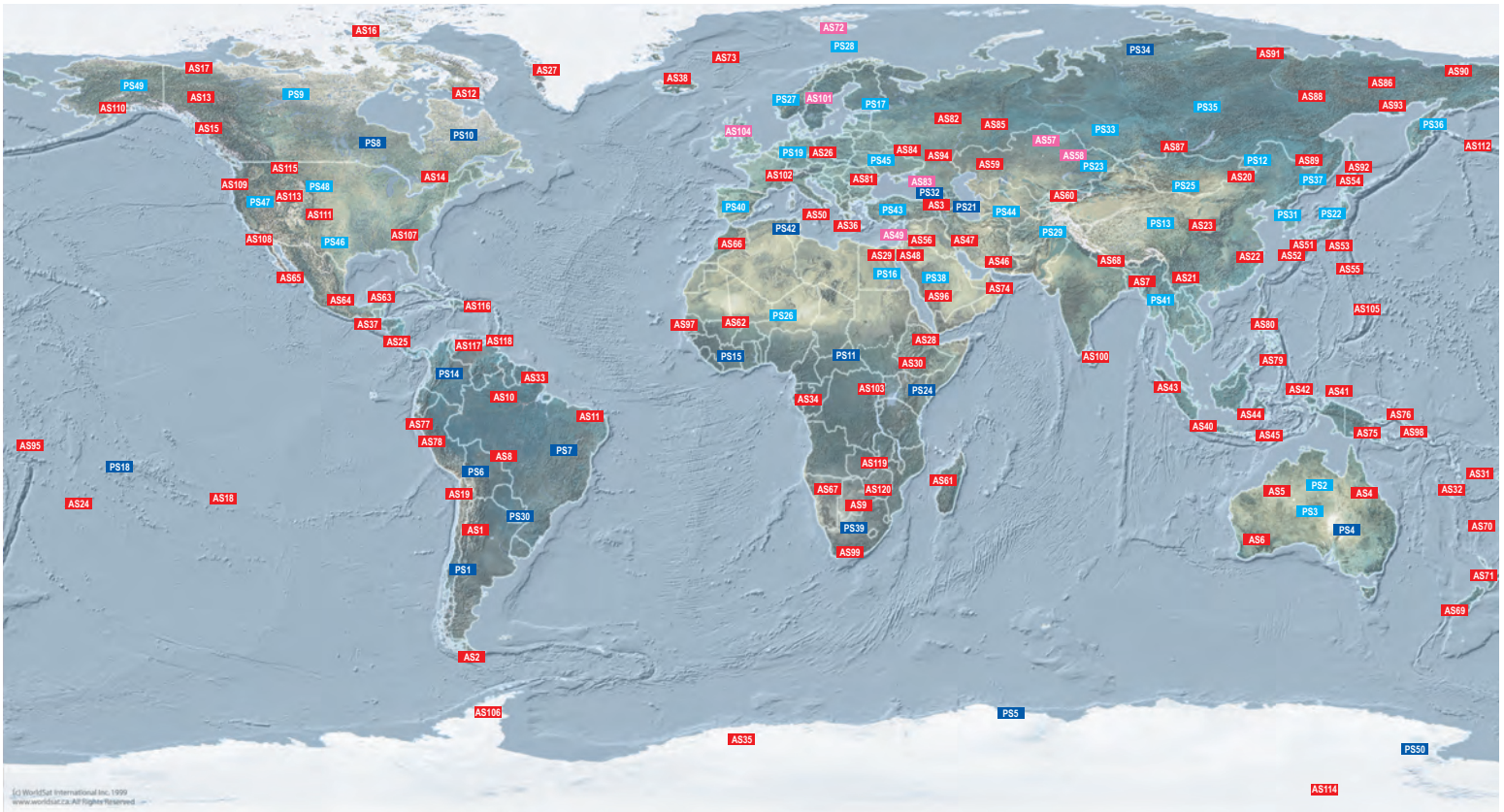
An IMS seismic station typically has three basic parts: a seismometer to measure ground motion, a system to record the data digitally with an accurate time stamp, and a communication system interface.

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).

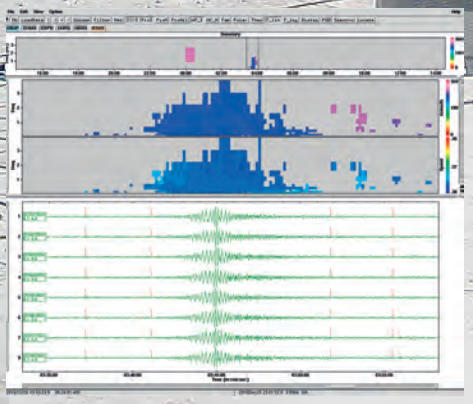
170 stations – 50 primary and 120 auxiliary – in 76 countries



Example of seismic waveform



60 stations in 34 countries



Example of infrasound waveform

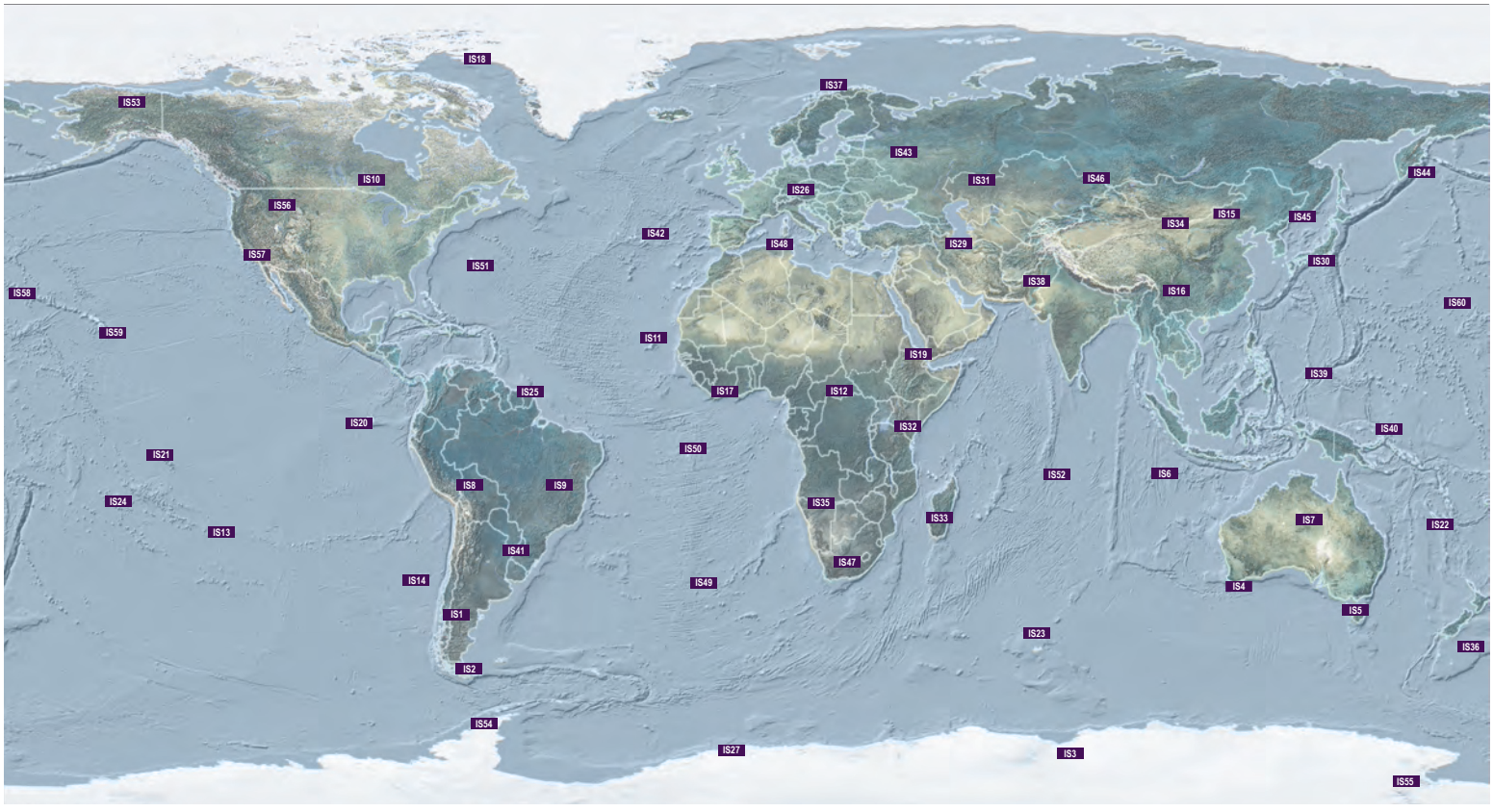
Infrasound Stations

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

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



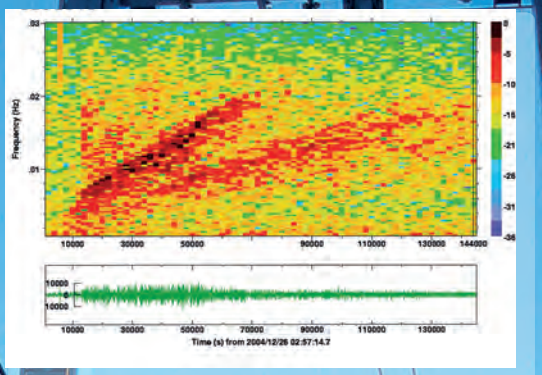
Hydroacoustic Stations

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

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

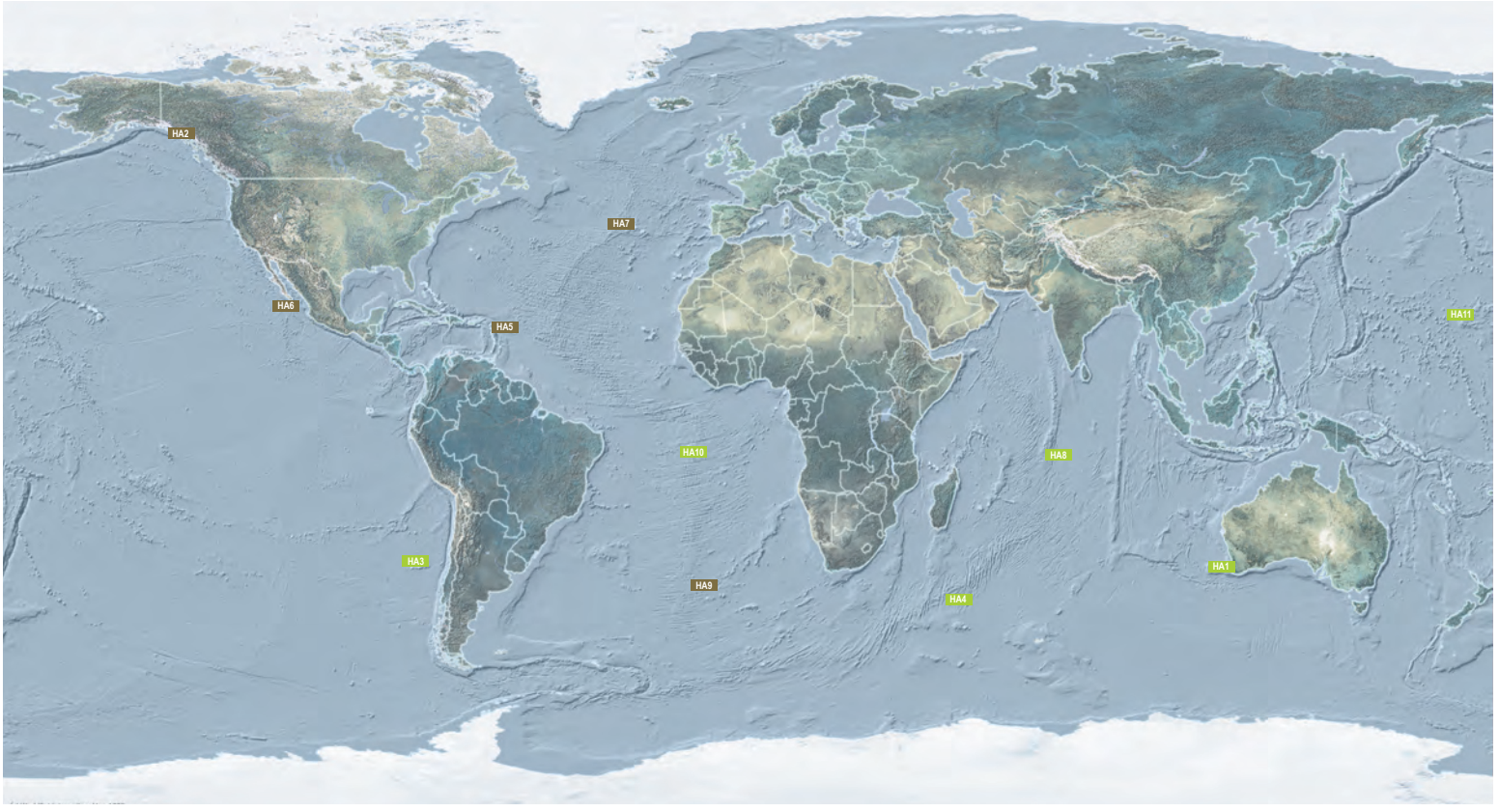
There are two types of hydroacoustic station: underwater hydrophone stations and T phase stations on islands or on the coast. The underwater hydrophone stations are among the most challenging and most costly monitoring stations to build. They must be designed to function in extremely inhospitable environments,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

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



Example of hydroacoustic waveform

11 stations – 6 underwater hydrophone stations and 5 T phase stations on land – in 8 countries

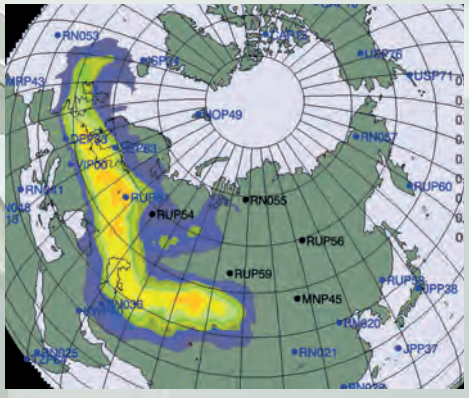


80 stations and 16 laboratories in 41 countries, with additional noble gas detection capabilities at 40 of the stations

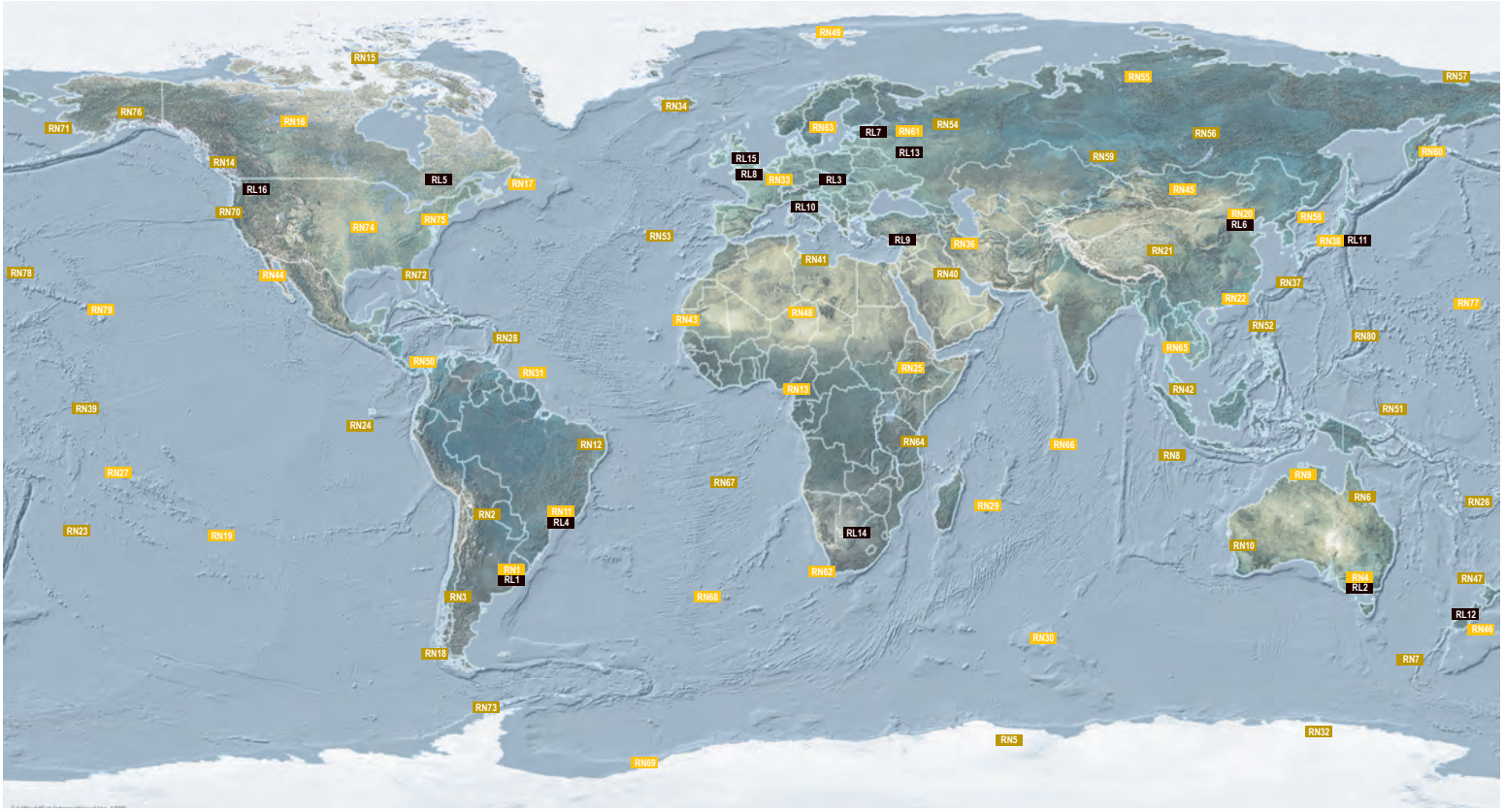
Radionuclide Particulate Stations

Radionuclide monitoring technology complements the three waveform technologies employed in the Treaty verification regime. This 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 radionuclide waveform



Noble Gas Detection Systems

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

Noble gases are inert and rarely react with other chemical elements. Like other elements, noble gases have various naturally occurring isotopes, some of which are unstable and emit radiation. There are also radioactive noble gas isotopes that do not occur naturally but which can be produced only by nuclear reactions. By virtue of their nuclear properties, four isotopes of the noble gas xenon are particularly relevant to the detection of nuclear explosions. Radioactive xenon from a well contained underground nuclear explosion can seep through layers of rock, escape into the atmosphere and be detected later, thousands of kilometres away.

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

Radionuclides 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 gives an assurance that the results provided by a laboratory are accurate and valid. These laboratories also participate in the annual Proficiency Test Exercises 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 2015

High GCI availability maintained

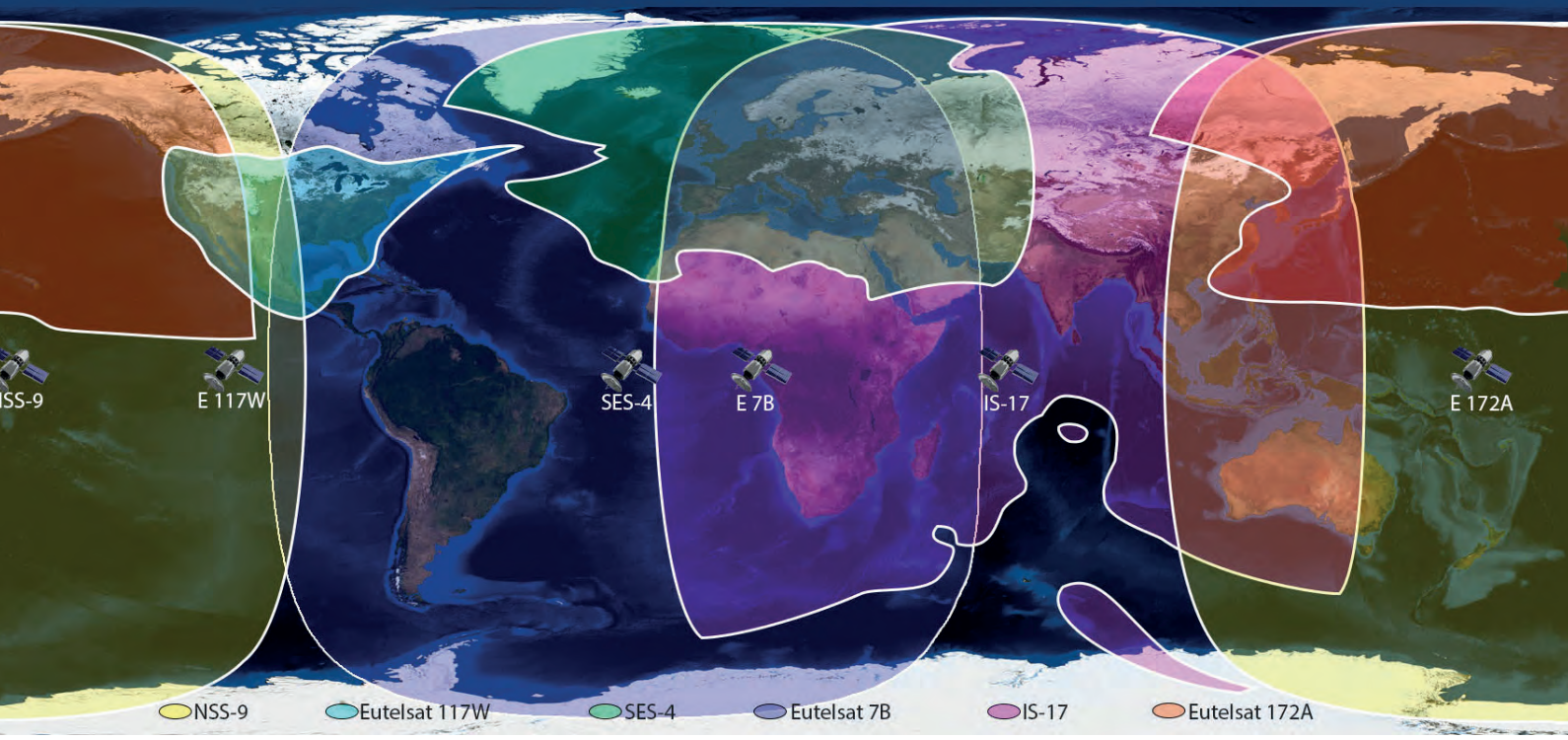
An average of 37 gigabytes of data and products transmitted per day

Teleport services consolidated

The Global Communications Infrastructure uses a combination of satellite and terrestrial communication links to enable the exchange of data by IMS facilities and States around the world with 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, second generation GCI began operation in 2007 under a new contractor. Its satellite 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.

Artist's impression Eutelsat



The footprints of the six geostationary satellites of the GCI

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 six geostationary satellites. The six satellites cover all parts of the world other than those near the North and South Poles: three cover the Pacific, Atlantic and Indian Oceans and three focus on the North Pacific (Japan), North and Central America, and Europe and the Middle East. 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 a communications node connected to the GCI, from where the data are routed to the IDC.

In situations where VSATs are still not in use or are not operational, a virtual private network (VPN) can provide an alternative means of communication. A VPN uses existing telecommunications networks to transmit data privately. Most of the

The GCI teleport at Santa Paula, California (USA)

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 2015 the GCI network included 217 VSAT stations (of which 25 had backup VPN links), 36 stand-alone VPN links, 5 independent subnetworks on terrestrial links using multiprotocol label switching (MPLS), a terrestrial MPLS link for US stations located in Antarctica, 2 satellite teleports (in Blåvand, Denmark, and Santa Paula, California, USA) for the 6 geostationary satellites, and a network operations centre (in Maryland, USA). All of these are managed by the GCI contractor. In addition, a total of 68 independent subnetwork links and 6 Antarctic communication links are operated by 10 States Signatories to carry IMS data to a GCI connection point. In total, the combined networks have nearly 330 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 2015 this was above or close to 99.5% in each month. The rolling 12 month actual availability, which is a measure of the raw uptime of each GCI link over one year, was up to 2.4% lower than the adjusted availability.

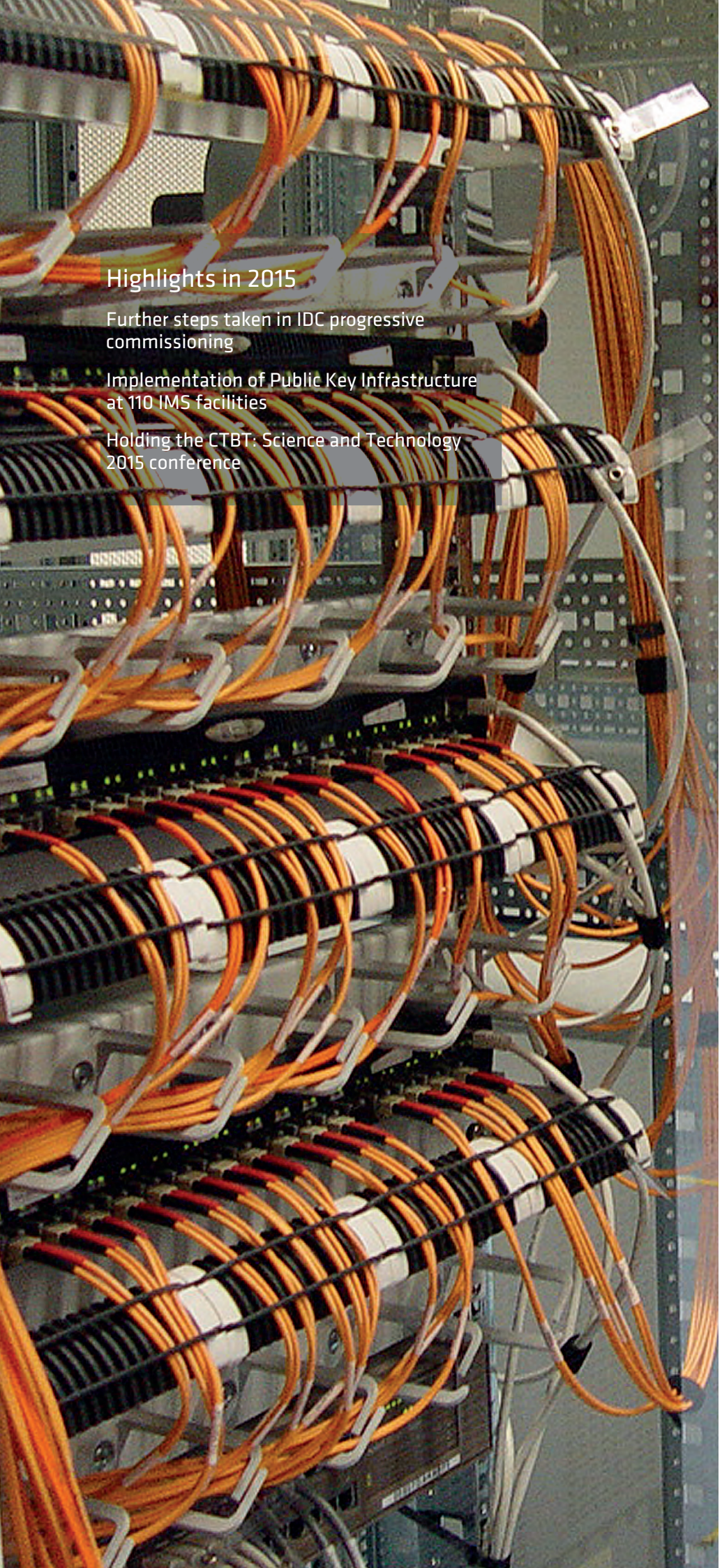
Over the year, the traffic transported over the GCI from IMS facilities to the IDC and from the IDC to NDCs averaged 37 gigabytes per day. In addition, data sent to NDCs that are directly connected to the IDC averaged 11.5 gigabytes per day.

While preparations were made for the installation of a new communications link at AS112, recently relocated on Shemya Island, Alaska, United States of America, the station started to send data to the IDC over a provisional communications channel.

> "In 2015 adjusted availability was above or close to 99.5% in each month"

Consolidation of VSAT services to two teleports began in 2014. In 2015 the satellite covering the Indian Ocean was migrated to a teleport at Blåvand, Denmark, to complete the project. This major restructuring of the GCI network is intended to improve the reliability of GCI services at no cost to the Commission.

Auxiliary seismic station AS112 on Shemya Island, Alaska (USA), the most recent IMS facility to be connected to the GCI



Highlights in 2015

Further steps taken in IDC progressive commissioning

Implementation of Public Key Infrastructure at 110 IMS facilities

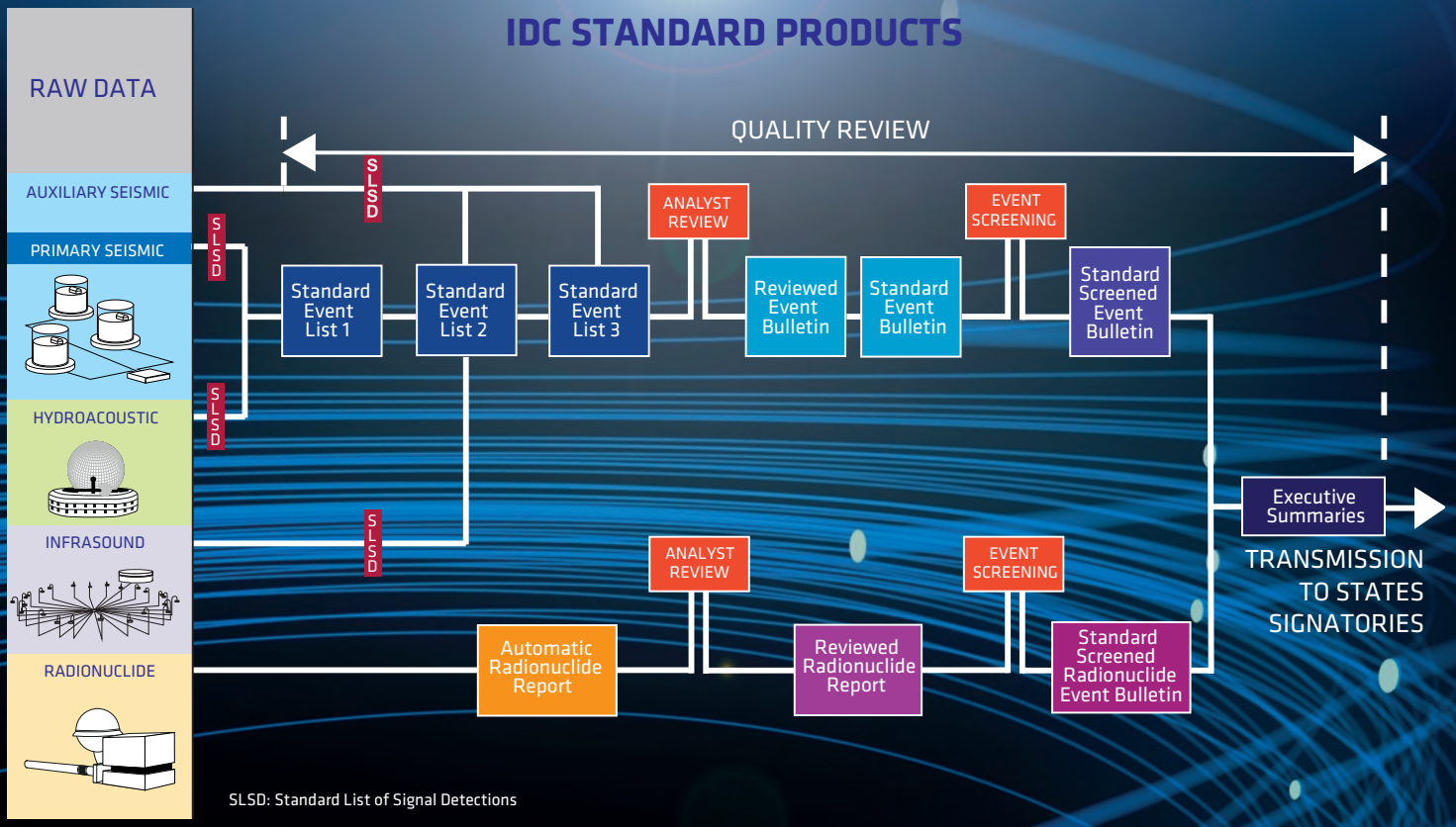
Holding the CTBT: Science and Technology 2015 conference

The International Data Centre

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 the States Signatories.

The Commission has created full computer network redundancy at the IDC in order 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.

The IDC Operations Centre



SLSD: Standard List of Signal Detections

Operations: From Raw Data to Final Products

Seismic, Hydroacoustic and Infrasound Events

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

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

The IDC's 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 Spectra 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 (ARR) 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 (RRR) 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; these are appended to each particulate RRR. Using software developed by the Commission, States Signatories can combine these calculations 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 the 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.

Services

A National Data Centre is an organization in a State Signatory that has technical expertise in the Treaty verification technologies and has been designated by the State's national authority. 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.

The Commission provides an 'NDC in a box' software package that enables NDCs to receive, process and analyse IMS data. In 2015 it provided additional functionality in the package that allows users to read and process waveform data in additional standard formats and to work with an open source database (PostgreSQL). This enables users to more easily combine data from the IMS network with data from other stations and global networks.

Build-up and Enhancement

IDC Commissioning

Build-up, continuous enhancement, and 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 the Secretariat has developed.

During 2015 the organization drafted a detailed road map for Phase 5b of the IDC Progressive Commissioning Plan for review by Working Group B (WGB) in 2016. It also updated its validation and acceptance test plan and detailed plans for the first full scale experiment contained in the road map.

Security Improvements

The Commission continued to identify and evaluate risks to its operational environment and to strengthen security controls on information technology (IT). These measures to safeguard IT assets included mitigating risks of malware attacks and a 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 developed an awareness and training programme to educate the staff of the organization on security best practices and to serve as a foundation for organization-wide security policies. The training course 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 with a phased implementation of security best practices.

Software Enhancements

As part of the first phase of the IDC re-engineering programme, the Commission has developed a new distributed application control system (DACS) to manage the entire automatic waveform processing.

Another project that neared completion during 2015 under the first phase of IDC re-engineering was the development of new software for waveform quality control and a related data model. The software preserves waveform quality control information, thus capturing more complete information on data provenance, which helps to reproduce processing results. The new software also captures more complete information on waveform quality and improves the identification of some waveform quality problems, in particular for single point spikes. The software is now undergoing final pre-release testing.

The Commission continued to make progress with the new regional seismic travel time (RSTT) software and model that have been provided as a contribution in kind by the United States of America. It derived travel time correction files for a total of 150 primary and auxiliary IMS seismic stations. In 2014 the Commission initiated an operational test to compare automatic processing results across all stages of the processing pipeline. This test was completed in 2015 and the results were made available to experts of States Signatories for independent evaluation.

The Commission continued to develop new automatic and interactive software that uses state of the art machine learning and artificial intelligence. It also enhanced the NET-VISA software to be able to process infrasound data in addition to seismic and hydroacoustic data. In 2015 the testing of NET-VISA at the IDC focused on determining the effect of running NET-VISA in all stages of the network processing pipeline. The preliminary results of the inclusion of a model for infrasound technology, as evaluated by experts from States Signatories, were positive.

For three years, the Commission has been developing jointly with the Commissariat à l'énergie atomique et aux énergies alternatives (CEA) of France a toolkit for infrasound station processing and interactive review, DTK-PMCC/DTK-GPMCC. This toolkit is undergoing continuous enhancement to meet IDC and CEA criteria. When ready, it will be included in the extended NDC in a box software package and delivered to NDCs and will be used by the Commission for field activities. In 2015 the toolkit was deployed in the development area of the IDC. It is going through validation testing and is being compared against the current processing software using the results from the framework for the detector evaluation project. The toolkit is expected to be easier to use and to provide more accurate detection parameters for IDC operational activities.

The Commission also continued to develop the verification data messaging system (VDMS) and released two major versions of this software. Since March 2015 all data and products disseminated through the VDMS have been digitally signed. A new product that provides information on the results of calibration activities at seismic stations was released in 2015 and the waveform data quality products underwent significant upgrades.

A first release of the extension of the alternative radionuclide analysis system (ARAS) pipeline to SPALAX based noble gas data was delivered to the Secretariat in 2015. A further enhancement of the ARAS pipeline that is under way is the automatic processing of spectra based on lanthanum bromide ($LaBr_3$) detectors.

The Commission's investigation of an alternative method for the categorization of particulate samples was completed during 2015. It had studied a long term distribution, quartile based filtering algorithm using 13 years of released samples from IMS stations. The results for five selected Treaty relevant radionuclides were presented in August 2013. The new categorization approach, which reduces the number of unusual detections by up to 90%, was promoted to IDC operations.

Efforts to enhance the IDC software for operational radionuclide processing focused on two areas: increasing the level of consistency between automatic and reviewed categorization of particulate spectra; and reducing the workload of analysts. Important enhancements carried out in the second half of 2015 included the optimization of key

aspects of the radionuclide library; automatic assignment of comments to false positives; and the implementation of a software tool for automatic discrimination of technetium and germanium isotopes (^{99m}Tc and ^{75m}Ge) in particulates samples.

Interactive review tools for particulate and noble gas data were enhanced with new features to provide analysts with further details on radionuclide sample spectra.

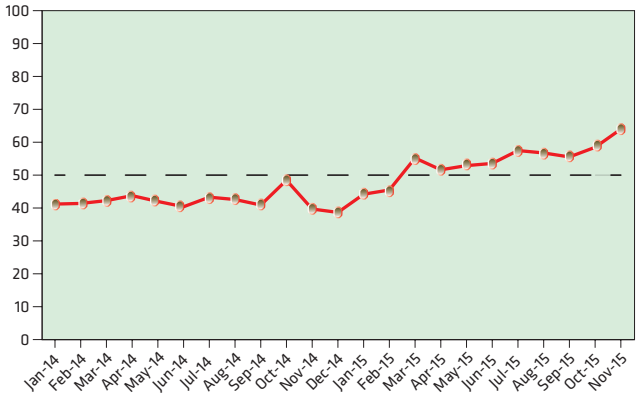
As a result of these software enhancements, the IDC exceeded its target of 50% consistency between the results of automatic and reviewed categorization for most of 2015.

The existing version of the UniSampo-Shaman software of the ARAS pipeline was upgraded to process daily data from all certified particulate radionuclide stations of the IMS. A new feature to support a Monte Carlo based isotope response function for particulate samples has been implemented. This is expected to further enhance analysis results based on the ARAS pipeline.

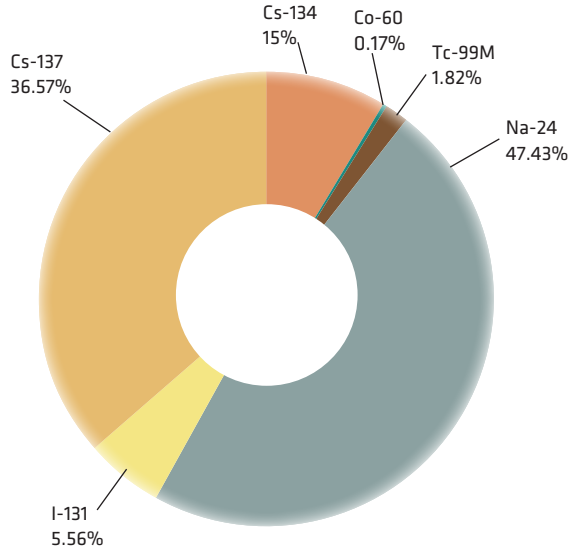
The Commission is making a longer term exploration of alternatives to the net count calculations method for beta–gamma analysis in the framework of the alternative for beta–gamma analysis method (ABGAM) project. Specifically, ABGAM studies the applicability of multidimensional peak search and peak fitting techniques to automatic

Correctly Categorized Automatically Processed Radionuclide Spectra

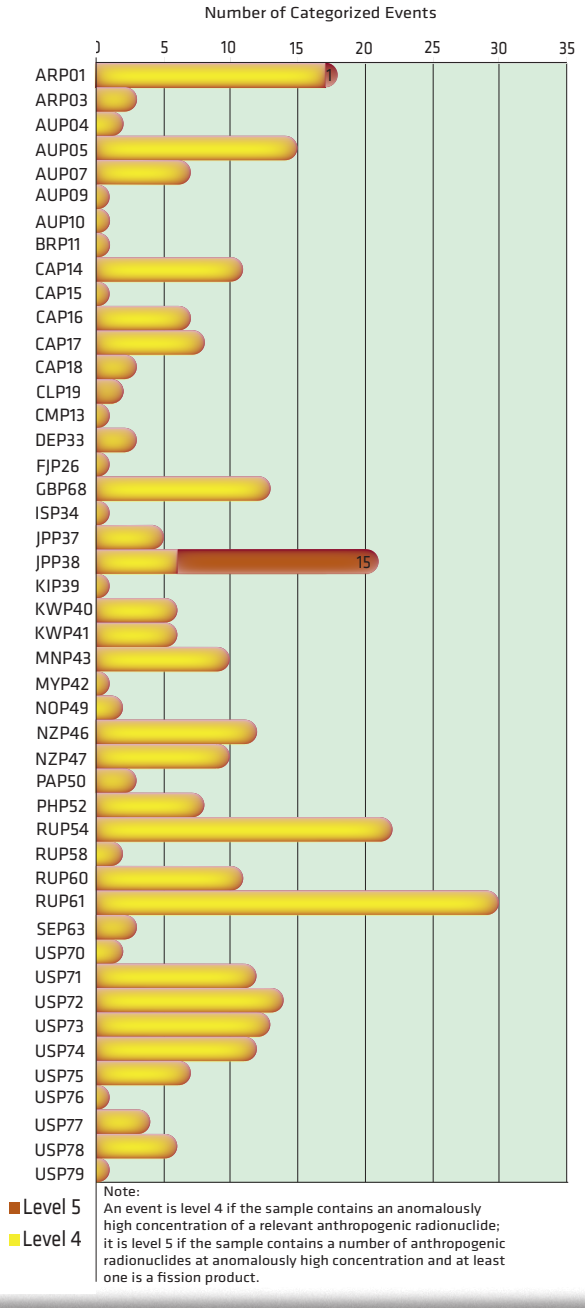
(The dotted line shows the target performance of 50%.)



Treaty Relevant Radionuclides Detected in 2015



Radionuclide Events Recorded by IMS Stations in IDC Operations in 2015



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.

processing of beta–gamma spectra. It also studies the applicability of these techniques to the prototyping of interactive review tools for the results of such automatic processing.

During 2015 the Commission further optimized a software tool for providing automatic multidimensional peak search and peak fitting, including deconvolution and decomposition methods and basic interactive graphical visualization. The results that this tool produces are being benchmarked against the results of recent radionuclide laboratory PTEs for noble gas samples. A feasibility study was initiated to define options for the integration of these novel methods into the IDC processing pipeline.

It is a complex task to discriminate between background radioxenon from civil nuclear applications and radioxenon from nuclear testing. The scientific challenge is to develop algorithms and tools that facilitate background assessment in order to provide adequate understanding of the background for use as an event screening parameter. A longer term vision is to be able to predict the impact of civilian sources on the radioxenon detections at IMS stations. With the goal of gaining initial experience and scientific insight, the IDC developed a prototype software application, Simulated IMPAct of Xenon (SIMPAX), to calculate hypothetical radioxenon concentrations at IMS stations. SIMPAX is based on a combination of source–receptor sensitivity (SRS) fields and estimated civilian radioxenon releases as published in peer reviewed papers.

In 2015 the Commission implemented an automatic suite for high resolution simulations of regional meteorological and atmospheric transport modelling (ATM). The suite also creates animations to illustrate ATM simulations and the relevant meteorological information. The suite can be triggered on demand to support an analysis of an event of interest influenced by regional factors. It can be configured for any region on the globe. Both forward and backtracking ATM simulations are enabled.

The organization also released a new version of the WEB-GRAPE software that allows the possible source region to be calculated and displayed for several nuclides.

The organization initiated a second phase of IDC reengineering in 2014 with support from a contribution in kind from the United States of America. This project aims to specify a unified architecture for all waveform software, across processing stages, to pave the way for further development and future sustainment of the software. The project's inception phase, which focused on requirements definition, was completed in February 2015. The elaboration phase, targeted at system design, then began. Experts from States Signatories reviewed the project deliverables at technical meetings in Vienna in June 2014 and June 2015.

The 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 2015. The 24 certified systems and 1 system that is in the process of certification sent data to IDC operations, while data from the remaining 6 non-certified systems were processed in the IDC testing environment. 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 34 locations as part of the International Noble Gas Experiment (INGE), 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.

> "It is a complex task to discriminate between background radioxenon from civil nuclear applications and radioxenon from nuclear testing"

An initiative funded by the EU (under Council Joint Action III and Decision V) to improve understanding of the global radioxenon background, which started in December 2008, continued in 2015. The objective of this project is to supplement knowledge on the global radioxenon background over longer periods. By performing measurements for at least six months, this project will provide more representative periods at selected sites. This will provide empirical data for validating network performance, for testing xenon equipment, for data analysis, and for training local experts.

EU Council Decision V supported a three year project that ended in December 2015 to further measure the noble gas background using mobile measurement systems. This work was also supported by a contribution in kind from the United States of America, through which the

Pacific Northwest National Laboratory conducted background measurements using an additional mobile detection system. The Commission installed a mobile system in Manado, Indonesia, in February 2015 that operated during the year. The mobile noble gas system in Kuwait experienced successive hardware problems in various modules that necessitated a series of maintenance visits. The system restarted in August 2015 and the subsequent sporadic failures were solved with the assistance of local operators. The mobile system now automatically sends data to the Commission on a regular basis. After processing and review by the IDC, the data from both campaigns are made available to radionuclide experts for further analysis.

The Commission plans to use the results and conclusions from this campaign to further develop its noble gas categorization scheme and to gain a better understanding of the inventory, transport and time variation of radioxenon in the atmosphere.

Civic and Scientific Applications of the Verification Regime

In November 2006 the Commission agreed to provide continuous IMS data in near real time to recognized tsunami warning organizations. The Commission subsequently entered into agreements or arrangements with a number of tsunami warning centres approved by the United Nations Educational, Scientific and Cultural Organization (UNESCO) to provide data for tsunami warning purposes. In 2015 the Commission finalized the negotiations on an agreement with the Instituto Português do Mar e da Atmosfera (IPMA), Portugal. Such agreements or arrangements have now been made with 15 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 (Alaska and Hawaii).

The eruption of the volcano Calbuco, Chile

IMS infrasound data and IDC products can provide valuable information on a global scale regarding bodies entering the atmosphere. As a consequence of the 2013 meteor airburst in Chelyabinsk, Russian Federation, infrasound technology continued to attract interest beyond the verification regime. The IMS infrasound network observed several airbursts, such as one in Thailand on 7 September 2015, and these appeared in the IDC Reviewed Event Bulletin.

Quick detection of a volcanic eruption can reduce the hazard to air traffic of ash clouds clogging jet engines. The eruption of the volcano Calbuco in Chile on 22 April 2015 was the largest eruption registered by the IMS network in 2015. The Commission reported detections at seven IMS infrasound stations, at distances up to 5000 kilometres, while extended infrasound processing allowed signals to be detected at IS32 (Kenya), 12 000 kilometres away.

The Commission is collaborating with international organizations such as the WMO and the International Civil Aviation Organization (ICAO), and with the scientific community of the Volcanic Ash Advisory Centres (VAACs) and the Atmospheric dynamics Research InfraStructure in Europe (ARISE) project to develop an infrasound volcanic notification system. The Commission extended its commitment to the ARISE community by accepting the invitation to serve on the ARISE2 advisory board for the duration of the project (2015–2017).

CTBTO
PREPARATORY COMMISSION

COMPREHENSIVE NUCLEAR-TEST-BAN TREATY:
SCIENCE AND TECHNOLOGY
CONFERENCE
22-26 JUNE 2015
HOFBURG PALACE, VIENNA

LISTEN TO OUR EARTH

CTBT: Science and Technology 2015 Conference

To keep abreast of scientific developments, the Treaty verification regime relies on the latest advances in science and technology as well as interaction with the global scientific and technological community. The ongoing interaction allows the Commission to build partnerships with the scientific communities engaged in various aspects of test-ban monitoring. Against the backdrop of a dynamic technological landscape, the process is one of collaboration, support and sharing insights. This helps to maintain the relevance of the verification regime by understanding and overcoming challenges. It also means that required improvements in the verification regime benefit from cutting edge research.

CTBT: Science and Technology 2015, the fifth conference in the series, was held on 22–26 June in Vienna. Keynote speeches were given by Ms Naledi Pandor, Minister of Science and Technology of South Africa; Mr Ahmet Üzümcü, Director-General of the Organisation for the Prohibition of Chemical Weapons (OPCW); and Mr Des Browne, former Secretary of State for Defence of the United Kingdom and vice-chairman of the Nuclear Threat Initiative (NTI).

Following introductory remarks by Ms Laura Rockwood, Executive Director of the Vienna Center for Disarmament and Non-Proliferation (VCDNP), speeches were given on collaboration on nuclear test monitoring science by Mr Frank Klotz, Under Secretary of Energy for Nuclear Security and Administrator of the National Nuclear Security Administration of the United States of America, and Mr Robin Grimes,

"A significant share of the work of the Commission is exploring new and improved verification methods"

Chief Scientific Adviser to the Foreign and Commonwealth Office of the United Kingdom.

Panel discussions on diverse topics of interest to the monitoring community were held throughout the conference. These topics included enhancing governmental, industry and scientific engagement on nuclear non-proliferation and disarmament; citizen networks and the promise of technological innovation; and scientifically credible scenarios for OSI integrated field exercises.

Over 850 participants from 99 States drawn from scientific and technology communities, academia, civil society and governments attended the conference and engaged in its deliberations. In addition, a significant effort to engage young scientists was made in the citizen science panel and through the young scientists evening as well as in the Academic Forum sessions.

One of the goals of the conference was to promote the wider scientific application of data that are used for test-ban verification. This goal was pursued by the Listen to Our Earth exhibit – a three dimensional multimedia installation – and the significant number of oral presentations and posters on civil and scientific topics.

The conference also sought to enhance the exchange of knowledge and ideas between the Commission and the broader scientific community. During the conference, arrangements were made for interactions among participants during the oral presentations and poster sessions, demonstrations, exhibits, field trips and associated workshops. The 2015 CTBT Academic Forum, which took place alongside the conference, identified ways to integrate Treaty related topics into existing policy- or science-based academic curricula and to develop educational resources.

A comprehensive public and media outreach strategy promoted the conference. A global media campaign, including a short film "Nothing Escapes the Global Ear: Nuclear Tests, Volcanoes, Earthquakes or Meteors", reached an estimated audience of 600 million through television, radio, print, the Internet and social media.

Over 40 newspaper, online or radio reports on the conference were published, including by *The Wall Street Journal*, *Nature*, *Science*, the BBC World Service, Bloomberg and Austrian ORF radio. Professional branding, video, photographic and online coverage significantly raised the profile of the conference, as well as innovative exhibitions such as Listen to Our Earth and a hands-on display of OSI equipment. With over 6 million impressions on Twitter for the conference hashtag #SnT2015, the conference was well covered on social media.

A significant share of the work of the Commission is exploring new and improved verification methods and implementing promising technologies and methods introduced at Science and Technology conferences. Among these are self-calibrating microbarometers, network performance tools, improved velocity models of the earth and atmosphere, waveform association routines and cross-correlation techniques.

Pages 28, 30, 31: Scenes from CTBT: Science and Technology 2015

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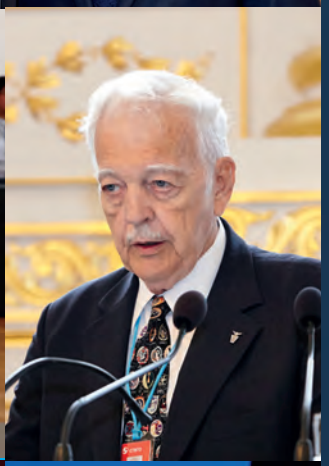


SCIENCE AND TECHNOLOGY
2015 CONFERENCE


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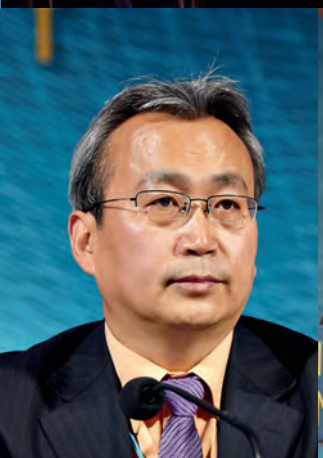
SCIENCE and TECHNOLOGY
CONFERENCE
22-26 June 2015
Video streaming of this event will commence
Monday, 22 June at 10:00 (GMT+1)
CTBTO




CTBTO

On-Site Inspection

Highlights in 2015

Building on the 2014 Integrated Field Exercise

Development of the new OSI action plan and programme for the next OSI training cycle

Arranging for an interim location for the Equipment Storage and Maintenance Facility

The IMS and IDC monitor the world for evidence of a nuclear explosion. If such evidence were to be detected, the Treaty provides for concerns about possible non-compliance with the Treaty to be addressed through a consultation and clarification process. After the Treaty enters into force, States could also request an on-site inspection, 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 could 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 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.

Trainees at OSI regional introductory course 22 in Sri Lanka complete chain of custody forms for field samples

Over the years the Commission has continuously strengthened its OSI capabilities, through preparation and development of OSI elements, conduct of field exercises, and evaluation of its OSI activities. With the conclusion and evaluation of the 2014 Integrated Field Exercise (IFE), the Commission has started a new cycle of OSI development. In 2015 it began development of a new action plan to lead the OSI activities of the organization in 2016–2019.

Policy Planning and Operations

OSI policy planning and operations focused on the follow-up of the 2014 IFE to capture and understand the lessons learned from the exercise. The Commission's efforts centred on a holistic review process, which included completion of a comprehensive report on the preparation and conduct of the IFE. The process had the objective of identifying lessons and recommendations from the IFE with a view to develop future projects to further improve OSI capabilities. The Commission obtained feedback from various sources, including States Signatories, the 2014 IFE external evaluation team, OSI Workshop-22, exercise participants and seven expert meetings. These lessons and recommendations provided the input for the preparation of the OSI action plan for 2016–2019.

Two expert meetings related to OSI policy planning and operations were held in 2015. The first, on deployment and operations support during an OSI, was held in September. It involved 24 experts from six States Signatories and the Secretariat as well as representatives from six other international organizations. The participants discussed the lessons identified during the 2014 IFE and reviewed the experience of similar organizations with the deployment and support of field operations. This led to recommendations being proposed for the new OSI action plan.

> "OSI policy planning and operations focused on the follow-up of the 2014 Integrated Field Exercise"

The second expert meeting, in October, was on the further development of the Field Information Management System (FIMS), the Integrated Information Management System (IIMS) and inspection team functionality (ITF). It brought together 33 experts from 14 States Signatories and the Secretariat at the Equipment Storage and Maintenance Facility (ESMF). The participants made a number of valuable recommendations on the way forward for ITF and field team functionality. The meeting underlined the need for closer alignment to ITF of the IIMS and FIMS applications and the need to improve the graphic user interface used by the inspection team to enter data into the IIMS. It also recognized that the performance of virtual machines in working areas should be optimized, that the IIMS need to be more stable, and that a more uniform look and feel for the IIMS and FIMS systems is desired.

Lessons from 2014 IFE were also prominently addressed at the CTBT: Science and Technology 2015 conference. Secretariat staff members prepared several posters on technical and conceptual aspects of the onsite verification element. Moreover, in one of the high level panel discussions, experts from States Signatories shared their feedback and presented conclusions on the preparation and implementation of the IFE scenario.

As part of the IFE follow-up activities, the Secretariat developed an exercise plan for the five year period 2016–2020. Exercises will serve as a means to validate the products of the OSI action plan and

Participants in the expert meeting on the next training programme, June 2015

The opening session of OSI Workshop-22

their contribution towards improving OSI operational capability.

The exercise plan is closely aligned with the OSI action plan for 2016–2019. This will help to ensure a coherent and harmonized planning approach for the further development of OSI capabilities. As the action plan is implemented, exercises will gradually increase in their scope, complexity and level of ambition. The integration of the exercises will likewise increase as the action plan progresses. The Commission will make use of proven exercise concepts using, in particular, tabletop, directed and build-up exercises.

Operations Support and Logistics

In 2015 OSI logistics and operations support focused on input for the new OSI action plan, relocation of the ESMF to an interim location and continued development of OSI capability for rapid deployment and in-field support operations.

Subject and expert group co-leaders prepared for and facilitated the systematic debriefing of the IFE participants during OSI Workshop-22, with a particular focus on deployment, operations support, health and safety.

Operations support and logistics was a major element of the detailed analysis of lessons identified during the 2014 IFE and the outcomes and inputs received during OSI Workshop-22 and the expert meeting on deployment and operations support. Based on these, the Secretariat prepared detailed project proposals, including initial resource requirements, for the new OSI action plan in the areas of rapid deployment, operations support and sustainment in various environmental conditions, and security, health and safety.

Activities at the ESMF during the first half of the year focused on the inventory and management of equipment returned from the 2014 IFE. Over 40 tonnes of equipment provided as contributions in kind were checked, re-packed and returned to the contributing States. All major equipment modules, including auxiliary equipment, were inventoried, serviced and re-stocked to ensure full operability.

In preparation for the relocation of the ESMF, the Commission identified obsolete equipment and separated it for redistribution or disposal. Obsolete but usable items, including tents and generators, were donated to the United Nations High Commissioner for Refugees. Consumables and some laptops were redistributed within the organization to ensure efficient use and to reduce the storage space required for temporary storage.

Secretariat staff also developed a concept for an interim ESMF and defined logistical requirements that contributed to ultimately identifying and securing a suitable facility.

During the second half of the year, all items of OSI equipment and consumables were checked, packed and prepared for relocation to the

interim ESMF at Seibersdorf. Furniture, office items and infrastructure elements in the ESMF used for training and for the OSI Operations Support Centre (OSC) were also dismantled and packed for transportation. The Commission initiated and sealed the service contracts required for the relocation and reviewed the actions required for the handover of the ESMF facility to the owner.

Relocation activities were a Secretariat-wide effort. Additionally, substantial contributions were made to the integrated logistics support project, which aims to optimize and harmonize the organization's logistics activities.

By the end of the year, the majority of OSI equipment and machinery had been relocated to the temporary storage area. While this was done, support for OSI development, testing and training activities continued uninterrupted.

To develop the Commission's capability for efficient deployment and field operations, two projects were initiated to further improve the use of the intermodal rapid deployment system (IMRDS) during deployed operations. This will be achieved through the installation of customized cabinets for more efficient use of space and of heat management systems for the server and uninterrupted power supply units. These projects are planned to be completed during 2016.

Training

The main OSI training activities in 2015 focused on the further development of the OSI training programme and the plan for the third OSI training cycle. Detailed plans and preparations were made for regional introductory courses 21 in South Africa (RIC-21) and 22 in Sri Lanka (RIC-22). There was also further development of OSI computer based training tools.

An expert meeting on the next OSI training programme in June brought together 50 participants from 17 States Signatories and the Secretariat. The aim was to capitalize on the participant's diverse and extensive expertise and experience in OSI and training. The meeting contributed to the development of the OSI training programme and the next training cycle, which seeks to expand the pool of surrogate inspectors, to provide refresher training for existing inspectors and to serve as a model programme for use after the Treaty enters into force.

The plan for the further development of the OSI training programme is firmly based on the lessons, evaluations and recommendations of the first and second OSI training cycles and the 2014 IFE and the outputs of the expert meeting. The third training cycle is intended to be implemented during 2016–2020.

RIC-22 took place in Dambulla, Sri Lanka, in November and December. A total of 54 trainees from 13 States Signatories participated in the course. The course had two objectives. First, it introduced national technical experts and personnel from States Signatories of the region to the Treaty's on-site inspection regime through a comprehensive

Trainees at regional introductory course 22 being briefed on decontamination procedures

introduction to OSI related concepts, technologies and operations. Second, it sought to broaden the pool of experts from States Signatories of the region available to participate in future OSI training activities and potentially become surrogate inspector trainees.

RIC-22 primarily focused on providing practical hands-on learning experiences through tabletop exercises, simulations and a one day field exercise. Topics covered included negotiation on point of entry procedures, managed access, the initial overflight, and the dynamics of the relations between the inspected State Party and the inspection team. The hands-on part included navigation, communications, sample taking and contamination control, and visual observation.

The Commission's new knowledge and training portal was used to provide preparatory e-learning modules for RIC-22 and to provide relevant course documents. The Government of Sri Lanka and its Geological Survey and Mines Bureau hosted the course and provided all types of preparatory, logistical, and administrative assistance.

Detailed preparations, including correspondence with the host State, development of the programme and receipt of official nominations, were undertaken for RIC-21, held in April 2016 in Arniston, Western Cape, South Africa.

The Secretariat established a dedicated OSI virtual LAN network to perform computer based training activities and tests of operational

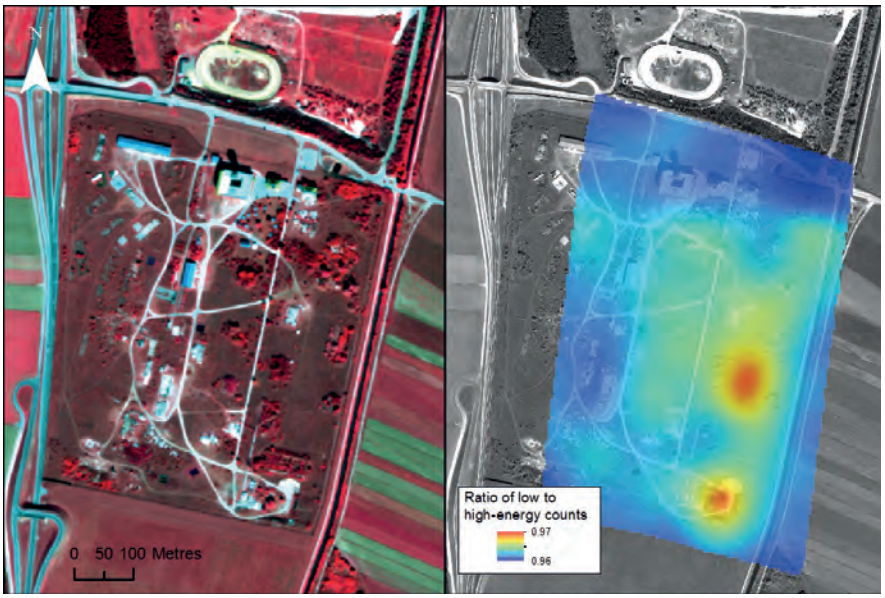
Trainees at regional introductory course 22 record coordinates on a chain of custody form (top); Participants in regional introductory course 22 discuss the strategy of the inspected State Party during a tabletop exercise (bottom)

An OSI airborne systems field test at the Langenlebarn air base, Tulln, Austria

tools and procedures and to practice OSI confidentiality measures. Feedback from the second training cycle highlighted the need to provide surrogate inspectors with remote access to OSI operational tools such as the IIMS and the FIMS. Detailed planning and initial steps for the development of these training platforms began in 2015.

The OSI e-training and simulation system is being developed by the All-Russia Research Institute of Automatics (VNIIA). Developers from VNIIA visited the Secretariat three times in 2015 and participated in planning meetings on the integration of their field data collection simulation tool with the IIMS and FIMS training platforms. The existing system, which consists of seven physical workstations, was virtualized and installed on the new training server. This provides the capability to run the system from any computer connected to the Secretariat network.

The Commission conducted a call-up exercise on 29–30 June to assess the level of inspectorate readiness for a fictional OSI deployment. The exercise call-up was sent to 94 surrogate inspectors (Secretariat staff members on the roster were not included in the exercise). A total of 68 responses were received (a response rate of 72%) and 52 (55%) of the respondents indicated their availability for deployment within the time frame that would enable a full inspection team to be assembled within Treaty timelines. The conduct of the exercise satisfactorily demonstrated the ability of the organization to quickly assess inspectorate availability for an OSI deployment. It was determined that a transmission error on the response form and not having access to a reliable Internet connection were the two primary reasons for non-responses.



Two products derived from MSIR and gamma surveys undertaken from an airborne platform: bare ground (left) and ratio of low to high energy counts (right)

During the CTBT: Science and Technology 2015 conference, the United States of America offered to make the former Nevada test site available for trained surrogate inspectors to familiarize them with some observables of legacy nuclear explosives testing.

Techniques and Equipment

The 2014 IFE in Jordan allowed the comprehensive testing of procedures, equipment and techniques in an integrated manner. Following its conclusion, the initial focus of work on techniques and equipment was on the recovery, functionality testing and basic maintenance of the deployed inspection equipment. Most equipment provided by States Signatories as contributions in kind was returned, ending the relevant agreements. The exceptions were selected equipment for the further development of radionuclide particulate and noble gas inspection techniques, for which new agreements have been put in place. In particular, the Commission accepted the transfer of ownership of the radionuclide mobile field laboratory, including three high-efficiency germanium detectors, which had been provided as a contribution in kind since 2006 in support of the OSI programme.

In addition, the Commission's comprehensive review of the 2014 IFE provided lessons of direct relevance to the further development of the inspection techniques and the drafting of relevant projects for inclusion in the new OSI action plan. For this, the Secretariat started reanalysis of raw data acquired during the exercise, which earlier in the year had also been transferred to a dedicated web portal for access by States Signatories. The objective of the exercise was to identify options for streamlining data processing and identifying additional analysis tools required for the future. In addition, three expert meetings were conducted. The first, on Treaty permitted continuation period techniques, was held in May in Vienna, with 19 experts from 14 States Signatories and the OPCW plus Secretariat staff. The second addressed radionuclide particulate and noble gas related inspection activities and techniques and brought 39 experts from 20 States Signatories to join Secretariat staff in Vienna in June and July. The third expert meeting, on seismic techniques in November in Vienna, involved 16 experts from 9 States Signatories plus Secretariat staff. These meetings aimed to assess the current status of capabilities and to provide direction to the further development of methodologies and equipment as input for the preparation of the new OSI action plan. The participating experts had a demonstrated understanding of and involvement in applications of OSI techniques.

Demonstration of OSI satellite communications equipment during regional introductory course 22

Substantial contributions on techniques and equipment were also made to OSI review activities. Subject or expert group co-leaders from the Secretariat prepared for and facilitated the systematic debriefing of IFE participants during the two part OSI Workshop-22 (in April in Israel and in June in Austria) with a particular view to the application of the inspection techniques. Similar support was provided to the expert meeting on OSI training in order to ensure that the next OSI training programme was relevant to and closely aligned with the development of OSI inspection activities and techniques. In-depth reviews were undertaken and feedback provided to the IFE external evaluation reporting

process. Significant efforts related to techniques and equipment were made for the preparation and input provided during the expert meeting on ITF, the IIMS and the FIMS and for the preparation of the OSI regional introductory course in Sri Lanka.

The experience gained from the development and testing of the OSI inspection techniques to date, including from the 2014 IFE, was also used and shared at a number of workshops and conferences during 2015. This included contributions for oral and poster presentations at the Workshop for Radionuclide Laboratories, the Workshop on the Signatures of Medical and Industrial Isotope Production, the International Conference on Radionuclide Metrology and Its Applications, the General Assembly of the International Union of Geodesy and Geophysics, the CTBT: Science and Technology 2015 conference, meetings of the United Nations Geographic Information Working Group and the United Nations Committee of Experts on Global Geospatial Information Management, the INGE Workshop 2015, and the 2015 Fall Meeting of the American Geophysical Union.

There was a practical development focus in 2015 on visual observation and specific airborne inspection activities and techniques. To assess post-IFE modifications to the airborne multispectral imaging including infrared (MSIR) and gamma survey configuration, and to consider options for future development of hardware, software, procedures and documentation, with a view to providing inputs for the new OSI action plan, the Commission conducted an operational test with the participation of nine experts

> "The Commission's comprehensive review of the 2014 Integrated Field Exercise provided lessons of direct relevance to the further development of the inspection techniques"

from seven States Signatories as well as Secretariat staff in September near Vienna. The multifaceted field test allowed for the testing of revised installation procedures and routines for acquisition and data processing based on overflights conducted over known visible and radioactive targets. For the first time, the system was deployed and certified for use on a Black Hawk helicopter of the Austrian Air Force.

Equipment development related to the ongoing development of the OSI noble gas laboratories continued in 2015. Technical coordination meetings were held in March and December with the University of Bern, Switzerland, and in May and November with the Institute of Nuclear Physics and Chemistry (INPC) of the China Academy of Engineering Physics and the Northwest Institute of Nuclear Technology (NINT), China. During these meetings, major technical outcomes from IFE related activities were discussed, remaining tasks identified and the final reports presented.

In order to gain synergies from the development of OSI inspection techniques and other techniques of the verification regime of the Treaty, the Secretariat fostered cooperation across its Divisions, such as

- The IMS seismic calibration project;
- The joint testing with the IMS Division of OSI detector systems for the silicon PIN development project;

The OSI field library during the 2014 Integrated Field Exercise

- A cross-Divisional strategy for calibration validation of nuclear detectors;
- The exchange of expertise on the calibration of radionuclide detectors and data assessment;
- The streamlining of support contracts with manufacturers of equipment.

Participants in the expert meeting on OSI Quality Management System documents

Documentation and Procedures

Documentation and procedures activities during 2015 involved providing support to WGB and conducting OSI Workshop-22 and an expert meeting on the development of the OSI Quality Management System (QMS) documents. In addition, preparations for OSI Workshop-23 started.

The Secretariat provided substantive, technical and administrative assistance to WGB during its third round of elaboration of the draft OSI Operational Manual. This included the preparation of a new consolidated version of the Model Text for the draft OSI Operational Manual, reflecting the results of the third round of discussion.

OSI Workshop-22 was a significant part of the review and follow-up process for the 2014 IFE. A total of 141 participants from all geographical regions, representing 33 States Signatories, the United Nations Department of Safety and Security and the Secretariat participated in both parts of the workshop.

OSI Workshop-22 included a thorough debriefing based on the experience of all aspects of the IFE. It gave both IFE participants and non-participants a chance to review the preparation and execution of the IFE with the aim of providing recommendations for the development of the next OSI action plan and future exercises.

The workshop offered an opportunity for intensive and parallel in-depth discussions in different expert groups on OSI topic areas that included all aspects of inspection implementation. A number of useful findings, recommendations and suggestions for improvements were generated.

As part of the IFE follow-up process, the Secretariat identified and analysed IFE lessons learned related to the OSI QMS documentation and other OSI documents. This also included a review of the development of OSI QMS documents since 2010, the rolling list of OSI QMS documents and the OSI libraries (the e-library, the e-library replica in the IIMS, the OSC library and the field library).

The expert meeting on the development of the OSI Division's QMS documents, in November was another part of the review and follow-up process for the 2014 IFE. The meeting was attended by a total of 30 experts from the Secretariat, five States Signatories and the OPCW. The main goal of the meeting was to contribute to the further development and revision of the OSI QMS documents and the integrated use of post-IFE OSI documentation. The expert meeting was the first to focus entirely on the development of QMS documentation. It generated a number of suggestions, proposals and ideas on OSI documentation, document control and information management.

Some technical improvements to the OSI e-library were identified following its use during the 2014 IFE. The Secretariat implemented these improvements during 2015 to increase the search efficiencies and user friendliness of the e-library.

On-Site Inspection Action Plan for 2016–2019

As requested by States Signatories, the Secretariat developed a new OSI action plan for 2016–2019 based on the lessons from the 2014 IFE. The plan will serve as a tool for furthering OSI capabilities, leading to the establishment of a balanced, coherent and robust verification regime when the Treaty enters into

force. It builds on the products of the OSI action plan for 2010–2013, which were tested and evaluated during the 2014 IFE and the three build-up exercises that preceded it. This approach ensures continuous and consistent development of the OSI regime.

The Secretariat applied a two step, bottom-up planning approach for the development of this OSI action plan. In the first step, it assessed the findings and recommendations from the 2014 IFE review and evaluation process and transformed them into concrete project proposals. In the second step, it collected, harmonized and merged them into larger, high level projects and eventually categorized them into five functional categories: OSI policy development, methodology and documentation; OSI operations and operations support; OSI techniques and equipment development; OSI inspectorate development; and OSI infrastructure development.

The OSI action plan for 2016–2019 identifies the following priorities:

- Further development, harmonization and improvement of OSI policies, methodology, operational concepts, procedures and documentation and tools;
- Further development and consolidation of inspection techniques within an OSI context;
- Continued development of the draft list of equipment for OSI with a view to having a near final draft equipment list ready for final discussion and approval at the first session of the Conference of the States Parties;
- Continued development of the OSI training programme with a view to having a roster of 150 trained surrogate inspectors by the conclusion of the action plan and a near final model programme ready for the first session of the Conference of the States Parties;
- Further development of operational support capabilities including the infrastructure necessary to launch, sustain and recover an OSI (i.e. an ESMF and a prototype OSC in the Vienna International Centre (VIC));
- Support for the further elaboration of the draft OSI Operational Manual with a view to having a near final draft manual ready for final discussion and approval at the first session of the Conference of the States Parties and further development of QMS documentation, including standard operating procedures and other OSI documentation.

The OSI action plan consists of 43 projects within the five categories. In order to ensure integrated, Secretariat-wide approach to development, testing and cooperation, mixed project teams consisting of staff from different Secretariat units will be established. Additionally, the plan actively seeks close cooperation with States Signatories for the further development of OSI capabilities and provides information about areas where support is requested.

Improving Performance and Efficiency

Highlights in 2015

Further development and consolidation of the Quality Management System

Enhancement of the performance reporting tool and refinement of the key performance indicators

Evaluation of the 2014 Integrated Field Exercise

At all stages of the process of establishing the Treaty verification system, the Commission aims for effectiveness, efficiency, client (i.e. States Signatories and NDCs) orientation and continual improvement through the implementation of its Quality Management System. The QMS aims to ensure that the organization's work to establish the verification regime complies with the requirements of the Treaty, its Protocol and relevant Commission documents.

Establishing the QMS is a continual process. During this process, the Commission aims to fulfil the goals and objectives set out in its Quality Policy and, in particular, to instil a quality culture in the organization.

The workshop on the presentation of the evaluation report on the 2014 Integrated Field Exercise

The Quality Management System

To ensure continuous provision of high quality products and services, the Commission pursued further improvement of the QMS in 2015. 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.

The procedure for controlling and coding QMS documents has been consolidated and a completely new release of the QMS document management system has been deployed. This release includes customizations to facilitate the distribution of relevant technical documentation to States Signatories through DOTS.

The Commission continued its discussions with States Signatories on the consolidation of a glossary of terms related to the QMS. A Secretariat-wide approach to management and sharing of a common vocabulary is an ongoing activity associated with the development of the QMS.

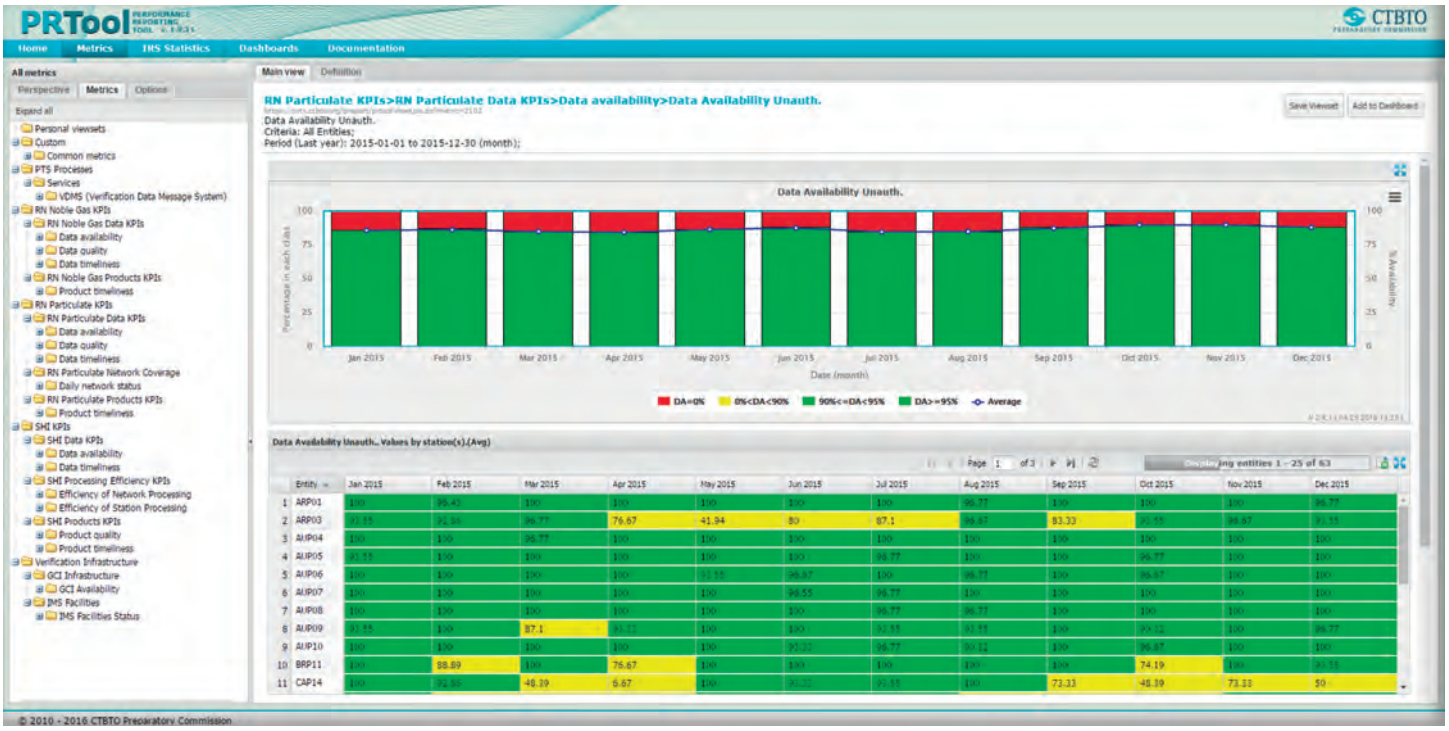
In its Quality Policy, the Commission underlines its focus on client orientation. It therefore continued to prioritize receiving feedback from NDCs, which are the main users of its products and services. The organization encourages NDCs to provide feedback, to relay questions through the established channels and to review the implementation of recommendations during follow-up sessions in workshops.

The United Nations General Assembly marked 2015 as the International Year of Evaluation. In April the Commission, jointly with the International Atomic Energy Agency (IAEA), the Organization for Security and Cooperation in Europe (OSCE), the United Nations Industrial Development Organization (UNIDO) and the United Nations Office on Drugs and Crime (UNODC), and in collaboration with the Austrian Development Cooperation, organized a high level panel discussion on the use of evaluation in evidence based policy making. Around 150 participants representing 30 States attended the event, which was held at the Hofburg conference centre, Vienna.

Performance Monitoring

The Commission continued its work to make its performance reporting tool (PRTool) fully operational. The validation of the key performance indicators reported by PRTool was completed and the first non-beta version was released.

Together with the release of new versions of PRTool, a revision of the Process Metrics Manual was also completed. This consolidated the consistency of reporting information

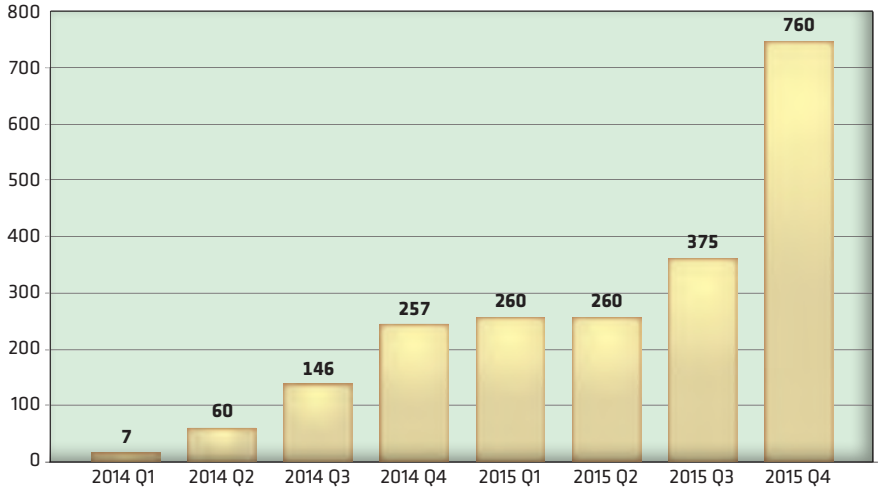


The performance reporting tool, PRTool

and incorporated new definitions of IMS data performance metrics.

Aiming to assess and improve the quality of products and services, and as part of its continual work on performance monitoring, the Commission investigated the refinement and implementation of additional key performance indicators in PRTool. This investigation was supported by a quality assurance process within a validation framework.

Number of QMS Documents in the Repository



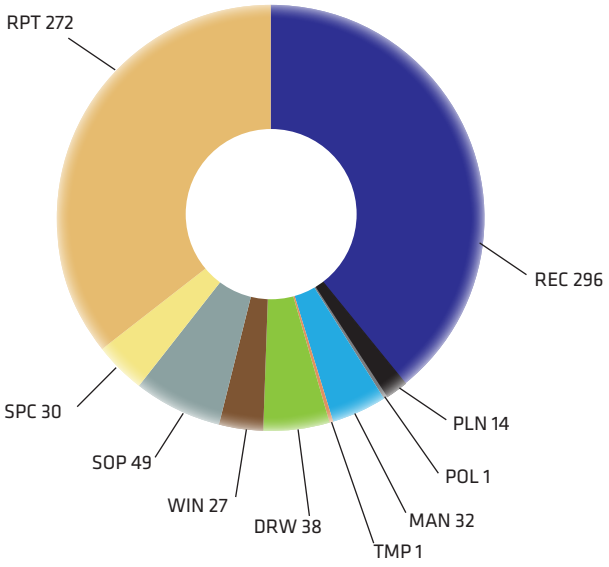
Evaluation

During 2015 the Commission completed the evaluation of the 2014 IFE. A written report on the findings and recommendations of the evaluation team was presented to the States Signatories. This helped in the development of the OSI action plan for 2016–2019.

The organization also made significant progress in the ongoing evaluation of IDC progressive commissioning. This included the preparation of detailed reports on the fulfilment of the requirements of Phase 5a of IDC commissioning and the preparation of an evaluation plan for the 2016 activities.

The evaluation plan comprises an evolving blueprint to serve as a conceptual context for the evaluation of the different activities planned to meet the milestones of Phase 5b of IDC commissioning.

Number of Files by Document Type



Highlights in 2015

Increase in capacity building activities

Integration of NDC capacity building with policy and educational outreach activities

Consolidation of all e-learning activities into a single knowledge and training portal

Integrated Capacity Building

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 political, diplomatic and legal aspects of the Treaty. These courses help to strengthen national scientific and decision making capabilities in relevant areas to 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.

Workshop on the operation and maintenance of the IMS, October 2015

By enhancing the technical capabilities of States Signatories, these activities empower all stakeholders to participate in 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.

Capacity Building Activities

As part of its integrated capacity building approach, the Commission continued to expand its education and outreach activities in 2015.

The activities included 9 NDC training courses; 11 station operator training courses; 10 technology workshops and technical meetings; 2 NDC development workshops; 3 NDC sessions on the margins of the CTBT: Science and Technology 2015 conference; 7 donations of capacity building systems; 2 installations of capacity building systems; the purchase of 10 additional capacity building systems; and continued development of the extended NDC in a box.

As a part of the CTBT: Science and Technology 2015 conference, the fourth annual CTBT Academic Forum was held on 26 June. Organized with financial support from the EU, Norway and the Swedish Radiation Safety Authority, the Academic Forum was a results oriented, interactive event for academics already engaged in or interested in CTBT education.

Building on past sessions, the purpose of the 2015 Academic Forum was to identify ways to integrate CTBT related topics into existing policy or science based academic curricula and to develop educational resources to further this objective. Over 100 participants explored opportunities for academics to engage in studies related to the CTBT, such as joint research and the use of verification technologies and data for civil and scientific applications; legal and policy research opportunities related to the Treaty; and technology foresight. They also discussed how to share best practices in promoting CTBT education worldwide.

An integrated capacity building information booth at the CTBT: Science and Technology 2015 conference provided material and advice on CTBT related capacity

The panel discussion on forging links with academia at the 2015 CTBT Academic Forum

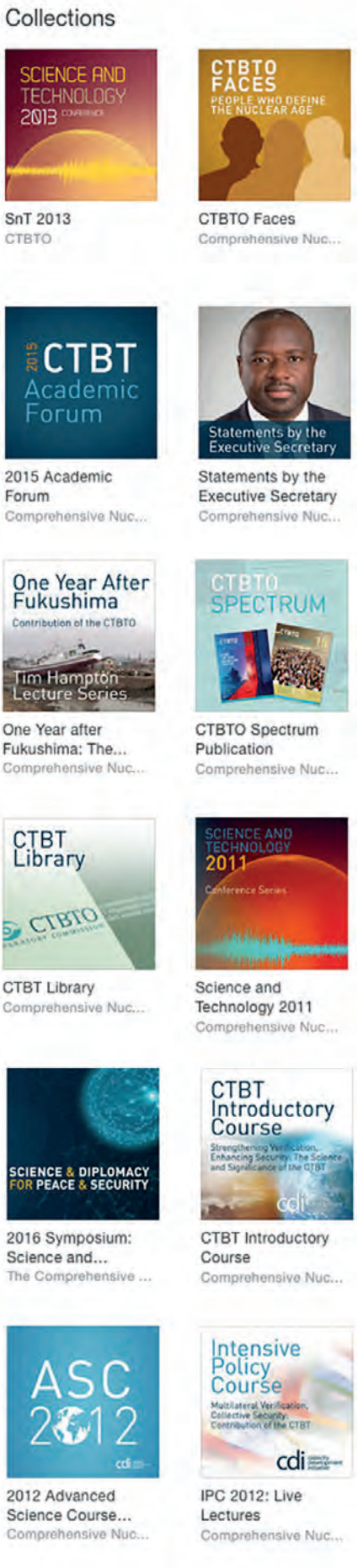
building, as well as on the inspectorate development and training programme for on-site inspections.

With funding from the EU, the Commission launched a CTBT research fellowship initiative in early 2015. Following a competitive application process, a candidate was selected in April to conduct research with the objective of improving the learning experience of trainees participating in capacity building activities and to foster interdisciplinary cooperation with academia and CTBT related university courses. The research fellow submitted a final report with an assessment and recommendations in November.

The Commission hosted a component of the United Nations disarmament fellows programme in September 2015, including a series of presentations on the verification regime and an OSI tabletop exercise.

The OSI regional introductory course in Sri Lanka aimed to acquaint national technical experts and personnel from States Signatories with the CTBT and the OSI regime with the aim of broadening the pool of experts for participation in OSI related activities and to identify potential candidates for the roster of surrogate inspectors.

In keeping with the integrated capacity building approach, all e-learning activities were consolidated into a single knowledge and training portal in November 2015. The Commission also promoted online education and training material on the Treaty through its iTunes U site, which currently has 17 collections, including four seminar courses with more than 415 freely shareable files.



iTunes U collections on the CTBTO

The site had over 2500 subscribers by the end of the year, with almost 16 000 visitors and over 18 000 downloads of content.

Preparations were made during 2015 for a symposium in early 2016 on Diplomacy and Science for Peace and Security: The CTBT@20. The symposium aimed to provide diplomats and representatives of national agencies with information on the Treaty and its verification regime, as well as to seek innovative solutions to achieving entry into force.

Outreach

Highlights in 2015

Increased high level engagement with States

Implementation of a comprehensive public and media outreach strategy

Outreach activities by the Group of Eminent Persons

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

A delegation of a State Signatory visits the headquarters of the Commission

Towards Entry into Force and Universality of the Treaty

The Treaty 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 have not yet ratified.

Nonetheless, the Treaty continued to gather momentum towards entry into force and universalization, with Angola becoming the most recent State to ratify the Treaty. In addition, Cuba, a non-signatory State, was granted observer status by the Commission. As of 31 December 2015, 183 States had signed and 164 States had ratified, 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 2015. 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

The Group of Eminent Persons (GEM) was established by the Executive Secretary in 2013 to advance entry into force of the Treaty. It held two major meetings in 2015.

GEM gathered in Seoul in June to rally support for the Treaty's entry into force and highlight the threat posed by nuclear weapons testing. During the meeting, which was hosted by the Ministry of Foreign Affairs of the Republic of Korea, GEM members considered the current status of the Treaty, identified ways to advance its entry into force, and assessed developments on the Korean peninsula and their implications for regional peace and security. The group issued the Seoul Declaration, containing a strong call for the Treaty's entry into force.

GEM also met in Hiroshima, Japan, in August to discuss practical ways to advance the efforts towards the entry into force of the Treaty. The meeting was hosted by the Government of Japan and the city of Hiroshima. The group adopted the Hiroshima Declaration, which reaffirmed GEM's commitment to achieving the global elimination of nuclear weapons and, in particular, to

The Group of Eminent Persons meeting in Seoul, Republic of Korea

the entry into force of the Treaty as "one of the most essential practical measures for nuclear disarmament and non-proliferation". The declaration also called for a "multilateral approach to engage the leadership of the remaining eight Annex 2 States with the aim of facilitating their respective ratification processes".

Interacting with States

The Commission continued efforts to facilitate establishing the verification regime and to promote participation in its work. It also maintained a dialogue with States through bilateral visits in capitals and interactions with Permanent Missions in Berlin, Geneva, New York and Vienna. A major focus of such interactions 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 engagement at high level with States to promote the Treaty, advance its entry into force and universalization, and promote the use of the verification technologies and data products.

The Executive Secretary participated in several bilateral meetings and other high level events at which he met several heads of State and Government. These included President Michel Kafando of Burkina Faso, Pope Francis of the Holy See, President Hassan Rouhani of the Islamic Republic of Iran, President Mahamadou Issoufou of Niger, President Vladimir Putin of the Russian Federation, President Maithripala Sirisena of Sri Lanka, King Mswati III of Swaziland, President Gurbanguly Berdimuhamedov of Turkmenistan and President Barack Obama of the United States of America.

During his visits and in Vienna, the Executive Secretary also met with several foreign ministers and other ministers of States Signatories and observers. They included the foreign ministers of Costa Rica, Finland, Gambia, the Holy See, Japan, Kazakhstan, Myanmar, Niger, the Republic of Korea, Romania, Swaziland, Sweden and Turkmenistan and the EU High Representative for Foreign Affairs and Security Policy. He also met the Minister of Energy, Environment and Sustainable Development of Belgium; the Minister of Science and Technology of Ethiopia; the Minister of Strategic and Intelligence Affairs of Israel; the Minister of Energy, Mines, Water and Environment of Morocco; the Minister of Science and Technology of South Africa; and the Ministers of Justice and Constitutional Affairs, of Information and Communication Technology, and of Education and Training of Swaziland. The Executive Secretary also met with a former Secretary of State and a former Secretary of Defense of the United States of America and a former

> "The Treaty continued to gather momentum towards entry into force and universalization"

Origami cranes at the Nagasaki Peace Ceremony

Minister of Justice and of Foreign Affairs of Israel.

In addition, the Executive Secretary met other senior government representatives from the following States Signatories and observers: Angola, Australia, Argentina, Canada, Chile, the EU, Germany, Israel, Kazakhstan, Kenya, Niger, Norway, the Republic of Korea, Senegal, Sri Lanka, Swaziland, Thailand, the United Kingdom and the United States of America. He also met with the President of the 2015 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).

The Commission took advantage of the following events to promote the Treaty and raise awareness of its activities:

- Part I of OSI Workshop-22, held in Israel in April;
- A mission by the Executive Secretary to Swaziland in June to advance the ratification process;
- The ceremonies marking the 70th anniversary of the atomic bombings of Hiroshima and Nagasaki in Japan in August;
- A mission by the Executive Secretary to Argentina in October to obtain the necessary high level approvals to secure the land for the establishment of RN2 in Salta, among other outcomes;
- A mission by the Executive Secretary in November to visit several US national laboratories and the former Nevada test site, which are overseen by the NNSA;
- The OSI regional introductory course held in Sri Lanka in November–December;
- The signing ceremony for the facility agreement with the Government of Turkmenistan in December.

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 African Union (AU), the IAEA, the United Nations General Assembly, the NPT Review Conference, the World Economic Forum, the European Leadership Network and the OPCW, among others. The Executive Secretary also participated in several conferences and seminars organized by leading think tanks.

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 Chairperson of the AU Commission; the President of the Commission of the Economic Community of West African States; the Director General of the IAEA; the Director-General of the OPCW; and the Secretary-General and the Under Secretary-General and acting High Representative for Disarmament Affairs of the United Nations.

In January a representative of the Commission delivered a statement at the opening session of the annual conference of the Academic Council on the United Nations System in Vienna. Later in January, a representative of the organization participated in the 24th AU Summit in Addis Ababa. On the margins of the summit, meetings were held with the AU Commission as well as with delegations from non-ratifying States.

In late January and early February a representative of the organization was invited as a guest speaker at the Kshitij 2015 conference organized by Indian Institute of Technology Kharagpur.

In February a representative of the Commission delivered a statement on behalf of the Executive Secretary at the ceremony for the handover of the G77 chairmanship in Vienna.

In March the Executive Secretary attended the opening ceremony of the International Women's Day event in Vienna and the panel discussion on

women in power. Also in March a representative of the Commission attended the high level conference on the post-2015 development agenda and Sustainable Development Goals organized in Vienna by the Organization of the Petroleum Exporting Countries (OPEC) Fund for International Development. Later in the month, Secretariat staff members took part in the third United Nations World Conference on Disaster Risk Reduction in Sendai, Japan, where they shared information on the role of the IMS in disaster warning. Staff members also participated in a special forum on recovery from the Great East Japan Earthquake, hosted by the Reconstruction Agency of Japan.

In April the Executive Secretary made a keynote presentation on the CTBT in the NPT review process during an event organized by Stockholm International Peace Research Institute (SIPRI) in Vienna. At the end of the month the Executive Secretary participated in the NPT Review Conference, held at the United Nations in New York. He addressed the conference and met with several high ranking government and United Nations officials to discuss ways and means to advance entry into force of the Treaty, with particular emphasis on what could be achieved in the context of the NPT Review Conference. He then participated in a high level panel on "Contributing to International Peace and Security in an Increasingly Unstable World: The Urgency of Action on the CTBT", organized by the Commission on the margins of the NPT Review Conference.

In June the Executive Secretary participated in the World Economic Forum on Africa, held in Cape Town, South Africa, where he led discussions in the sessions dealing with Africa's security landscape and with building resilience to global risks. He also served as a panellist in the session on the future of cross-border mergers and acquisitions in Africa.

In August the Executive Secretary participated as a speaker at the 25th United Nations Conference on Disarmament Issues, held in Hiroshima, Japan.

In September Commission representatives participated in the General Conference of the IAEA in Vienna and delivered a statement on behalf of the Executive Secretary. Also in September the Executive Secretary addressed 25 United Nations disarmament fellows during their annual visit to the Commission. The fellows received in-depth briefings on the Treaty and its verification regime and on the challenges of bringing it into force. At the end of the month, in New York, the Executive Secretary participated in the general debate of

Informal meeting of the United Nations General Assembly to mark the International Day Against Nuclear Tests

Marking the International Day Against Nuclear Tests in Vienna

the 70th session of the United Nations General Assembly, the United Nations Sustainable Development Summit, a UNIDO event on the operationalization of the 2013 agenda for Africa's industrialization, and the ninth Conference on Facilitating the Entry into Force of the Treaty (the Article XIV conference). During this time in New York he met with a number of heads of state or government, foreign ministers and high level government officials, the United Nations Secretary-General and other senior officials of the United Nations and other international organizations.

In October, in New York, the Executive Secretary participated in the high level exchange on the current state of affairs in arms control and disarmament and the role of international organizations with related mandates at the First Committee of the United Nations General Assembly. Other participants included the acting High Representative for Disarmament Affairs and other high level officials. The Executive Secretary also addressed the opening of the International Conference on Global Emergency Preparedness and Response in Vienna. Later in the month, in his capacity as vice-chairperson of the Global Agenda Council on Nuclear Security, he participated in the World Economic Forum Summit on the Global Agenda in Abu Dhabi, where he met with a range of senior figures from government, academia and civil society.

In late October and early November a representative of the organization participated in the 61st Pugwash Conference on Science and World Affairs in Nagasaki, Japan, and delivered a keynote address on behalf of the Executive Secretary.

In December the Executive Secretary attended the 14th Republic of Korea–United Nations Joint Conference on Disarmament and Non-Proliferation Issues, held in Seoul, where he participated as panellist in a session on regional non-proliferation issues.

The Executive Secretary also attended several conferences, meetings and seminars, where he gave keynote speeches or participated in panels or discussions on the Treaty. These included the annual NPT diplomatic workshop held in Annecy, France (March), organized by the James Martin Center for Nonproliferation Studies (CNS), where he gave a keynote address; the 2015 Carnegie International Nuclear Policy

Conference held in Washington, DC, where he participated in a plenary panel on the Treaty (March); a diplomatic workshop organized by the VCDNP in Baden, Austria, where he was an opening speaker; an event organized by the European Leadership Network and a roundtable discussion at Chatham House, the Royal Institute of International Affairs, London (June); the opening ceremony of an art exhibition entitled "Against nuclear tests and bring peace to the world" in Hefei, Anhui, China (August); the commemoration of the International Day Against Nuclear Testing held at the VIC (August); the opening of an exhibition on the Treaty entitled "Never again nuclear tests" at the German Foreign Office in Berlin (September); meetings and briefings at the Lamont–Doherty Earth Observatory near New York, United States of America (September); a roundtable seminar organized by the Belfer Center for Science and International Affairs of Harvard University and a meeting with the president of the American Academy of Arts and Sciences, Cambridge, Massachusetts, United States of America (October); and the annual Wilton Park conference on nuclear non-proliferation, where he gave the keynote address (December).

During these conferences, meetings and seminars around the world and at meetings in Vienna, the Executive Secretary met with a number of prominent figures from academia, leading think tanks and other non-governmental entities, including the president of the American Academy of Arts and Sciences; the director and other managers of the Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard University; the director of the CNS; the research director of international security of Chatham House; the special research scientist for seismology, geology and tectonophysics of the Lamont–Doherty Earth Observatory; the vice-chairman of the NTI; the executive director of the Preventive Defense Project at Stanford University; the president and the secretary general of the Pugwash Conference on Science and World Affairs; the managing director of IHS Aerospace, Defence and Security; and the current and former executive directors of the VCDNP.

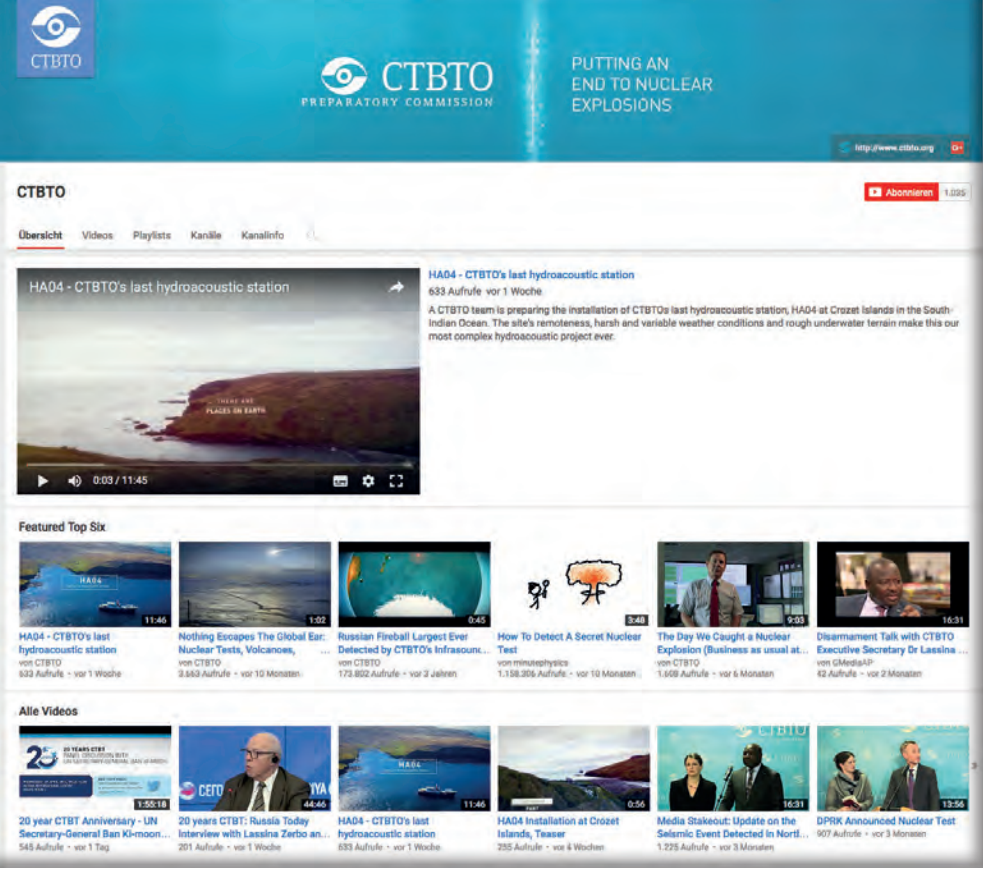
The exhibition in the Vienna International Centre for the International Day Against Nuclear Tests

Public Information

During 2015 the public web site and social media outlets of the Commission received an average of nearly 218 000 visits per month, representing an increase of 9% compared to 2014. The web site was updated with 60 highlight articles and 12 press releases and media advisories. The Commission also continued to expand its presence on YouTube, Facebook, Twitter and Flickr.

The 22 videos that were added to the Commission's YouTube channel attracted around 144 000 views, with a total viewing time of over one year, an increase of more than 60% compared to 2014. A video illustrating the functioning of the IMS produced in cooperation with the MinutePhysics YouTube channel reached nearly one million views by the end of the year and was translated into three additional languages: French, German and Spanish.

Two issues of *CTBTO Spectrum* were published, one in April and one in September to coincide with the Article XIV conference. Contributors



The CTBTO YouTube Channel

include the Foreign Ministers of Japan and Kazakhstan, and Ms Federica Mogherini, a GEM member and the EU High Representative for Foreign Affairs and Security Policy, as well as renowned experts in the field of nuclear arms control and verification. Over 4000 copies of each issue were distributed worldwide to States Signatories, non-governmental organizations (NGOs), research institutions, universities and journalists.

Over 57 000 visitors to the VIC toured the permanent CTBTO exhibition, with over 1000 visitors receiving individual presentations on the Treaty and its verification regime. The permanent displays on the CTBTO at the United Nations in New York and Geneva were viewed by around 350 000 and 100 000 visitors, respectively. An exhibition featuring works of art relating to the nuclear test ban was shown in Hefei, Anhui, China, at the VIC and at the United Nations in New York.

Global Media Coverage

Global media coverage of the Treaty and its verification regime remained high, with around 900 articles and citations in online media, including 26 interviews by the Executive Secretary with media outlets. Interviews and op-ed articles by the Executive Secretary were published by prominent media outlets.

Other significant articles on the Treaty and its verification regime were published by *Earth*, Politico, *The Hindu*, Inter Press Service, *The Economist*, *The Philadelphia Inquirer*, *Le Sahel*, Project Syndicate, The Huffington Post, *The Daily Telegraph*, *The Japan Times*, *The Jerusalem Post*, *Haaretz*, *Scientific American* and *Physics Today*.

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 give 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 2015 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.

Facilitating the Entry into Force of the Treaty

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

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

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

The Secretary-General of the United Nations at the ninth Conference on Facilitating the Entry into Force of the Treaty

Conditions for Entry into Force

The entry into force of the Treaty requires ratification by all 44 States listed in its Annex 2. These so-called Annex 2 States are States that formally participated in the final stage of the negotiation of the Treaty in the Conference of Disarmament in 1996 and possessed nuclear power reactors or nuclear research reactors at that time. As of 31 December 2015, 36 of these 44 States had ratified the Treaty. Of the eight Annex 2 States that had yet to ratify the Treaty, three had still not signed it.

New York, 2015

Convened on 29 September 2015 at the United Nations Headquarters in New York, the ninth Conference on Facilitating the Entry into Force of the Treaty served to demonstrate the continued political determination of the international community to achieve the Treaty's entry into force and its universality. At the conference, over 90 States Signatories gathered to take stock of progress, discuss strategies and coordinate efforts to generate further support for the Treaty and its universality. A significant number of foreign ministers and high level officials from ratifying, signatory and non-signatory States participated in the conference, including representatives from five States whose ratification is required for entry into force: China, Egypt, the Islamic Republic of Iran, Israel and the United States of America.

In addition to foreign ministers and high level representatives, the conference was attended by members of GEM, including Ms Federica Mogherini, EU High Representative for Foreign Affairs and Security Policy, Mr Desmond Browne, a former Secretary of State for Defence of the United Kingdom, Mr Nobuyasu Abe, Commissioner of the Japan Atomic Energy Commission, Ms Angela Kane, former United Nations High Representative for Disarmament Affairs, and Mr Wolfgang Hoffmann, Executive Secretary Emeritus of the Commission, as well as officials from international organizations, specialized agencies and NGOs.

Shared Presidency

The presidency of the conference was shared by the Minister of Foreign Affairs of Japan, Mr Fumio Kishida, and the Minister of Foreign Affairs of Kazakhstan, Mr Erlan Idrissov. This reflected the global nature of the Treaty. In his opening remarks, Mr Kishida stated "together with Foreign Minister Idrissov, I stand ready to spread the knowledge about the reality of the consequence of the use of nuclear weapons, as I know such reality. I will lead this initiative so that the world does not lose sight of why we work on nuclear disarmament". Mr Idrissov in his opening remarks stressed that "Japan and Kazakhstan have the moral right

The presidents of the Article XIV conference

to be aggressive about abolishing nuclear weapons".

Expressions of Strong Support

The conference was characterized by numerous expressions of strong support for the Treaty and its entry into force, including by the Secretary-General of the United Nations, Mr Ban Ki-moon, who opened the conference. He stated that:

> "The CTBT is essential to realizing our vision of a world free of nuclear weapons".

He also promised that:

> "as a former Chairman of the CTBT Preparatory [Commission], I am personally committed to doing everything possible to see this Treaty enter into force . . . and I am determined to ban any nuclear tests".

The Executive Secretary, Mr Lassina Zerbo, highlighting the importance of the Treaty added:

> "2016 will mark twenty years since the CTBT was opened for signature. I don't regard this as a reason for celebration. Almost twenty years later, we find ourselves at a conference provided for under Article XIV of the Treaty to accelerate entry into force. At the ninth such Conference, in fact, we need something more."

"The Final Declaration also offers 14 practical measures to accelerate the ratification process and bring the Treaty into force"

He also expressed his fervent wish that States Signatories show real leadership in advancing the entry into force of the Treaty.

The conference unanimously adopted a Final Declaration that affirms that:

> "a universal and effectively verifiable Treaty constitutes a fundamental instrument in the field of nuclear disarmament and non-proliferation".

The Final Declaration also offers 14 practical measures to accelerate the ratification process and bring the Treaty into force. These include support for bilateral, regional and multilateral outreach initiatives, capacity building and training activities, and cooperation with civil society, international organizations and NGOs.

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

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

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

Moreover, the Final Declaration welcomes the range of mutually supportive ratification outreach activities, including activities of GEM and individual efforts by States Signatories such as the biennial "Friends of the CTBT" Ministerial Meeting, which share the objective of early entry into force of the Treaty.

Policy Making

Highlights in 2015

Adoption of biennial budgeting and a multiyear funding modality

Decision on the procedures for appointments of the officers of the subsidiary bodies of the Commission

Appointment of a new Chairperson of Working Group A

The plenary body of the Commission, which is composed of all States Signatories, provides political guidance and oversight to the Secretariat. The plenary is assisted by two Working Groups, Working Group A (WGA) and Working Group B (WGB).

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

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

Sessions of the Policy Making Organs in 2015

The Executive Secretary and Directors at the Forty-Fifth Session of the Commission

Meetings in 2015

The Commission and its subsidiary bodies each met in two regular sessions in 2015. There were also joint meetings of WGA and WGB on 20 March and 31 August.

Among the major issues addressed by the Commission during 2015 were promotion of the Treaty; procedures for appointment of the Chairpersons and Vice-Chairpersons of WGA and WGB; introducing biennial budgeting; multiyear funding; preparation for the twentieth anniversary of the Treaty and the Commission; and progress in completion of the IMS.

The Commission also appointed Ambassador Adnan Othman (Malaysia) as the new Chairperson of WGA for a term of three years starting from 1 January 2016.

Supporting the Commission and Its Subsidiary Bodies

The Secretariat is the body that executes the decisions adopted by the Commission. It is multinational in composition: its staff is recruited from States Signatories on as wide a geographical basis as possible. The Secretariat 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 official documents of the various sessions, planning the annual schedule of sessions, and providing substantive and procedural advice to the Chairpersons, the Secretariat is a vital element in the work of the Commission and its subsidiary bodies.

Virtual Working Environment

Through the Experts Communication System (ECS), the Commission provides a virtual working environment for those 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.

With the adoption of a new, more interactive and collaborative method of work by WGB, the ECS has become even more important as a tool for continuous and inclusive discussion among States Signatories and experts on complex scientific and technical issues related to the verification regime.

As part of the virtual paper approach, through which the

Meetings of the Commission and its Subsidiary Bodies in 2015

Body	Session	Dates	Chairperson
Preparatory Commission	Forty-Fourth	18 June	Ambassador Abel Adelakun Ayoko (Nigeria)
	Forty-Fifth	16–18 November	
	Resumed	7 December	
Working Group A	Forty-Seventh	26–27 May	Ambassador Aliyar Lebbe Abdul Azeez (Sri Lanka)
	Forty-Eighth	27–28 October	
Working Group B	Forty-Fourth	16–27 March	Mr Heim Haak (Netherlands), 16 March Mr Joachim Schulze (Germany), 17–27 March
	Forty-Fifth	24 August – 4 September	Ambassador Abel Adelakun Ayoko (Nigeria)
	Resumed	16–18 November	
Advisory Group	Forty-Fourth	4–8 May	Mr Michael Weston (United Kingdom)
	Forty-Fifth	5–7 October	

Commission is seeking to limit its output of printed documentation, the Secretariat provided a 'print on demand' service at all sessions of the Commission and its subsidiary bodies. In place of supplying printed copies of all documents to each participant, this service enables delegates to print copies of those documents that they require directly from their computers and mobile devices during the meetings.

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 (ISTHAR) 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 ISTHAR interface is integrated into the Commission's single sign-on infrastructure and is available to all users of the ECS.

Participation of Experts from Developing Countries

The Commission continued to implement a project, initiated in 2007, 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. In November 2015 the Commission extended the project for a further three years (2016–2018), subject to availability of sufficient voluntary contributions. The latest detailed annual report on the status of implementation of the project was issued in October.

Ten experts were supported under the project in 2015. They came from Albania, Burkina Faso, Ecuador, Jordan, Kyrgyzstan, Madagascar, Nepal, Niger, Viet Nam and Yemen. The experts took part in the Forty-Fourth and Forty-Fifth Sessions of WGB, including formal meetings and meetings of the expert groups. In addition, the experts benefited from technical discussions with the Secretariat on key verification related issues.

The project has supported a total of 29 participants, including 7 female experts, since its inception. The participants came from 8 States in Africa (Algeria, Burkina Faso, Ethiopia, Kenya, Madagascar, Niger, South Africa, Tunisia), 1 in Eastern Europe (Albania), 7 in Latin America and the Caribbean (Bolivia, Brazil, Dominican Republic, Ecuador, Mexico, Paraguay, Peru), 5 in the Middle East and South Asia (Kyrgyzstan, Jordan, Nepal, Sri Lanka, Yemen), and 8 in South East Asia, the Pacific and the Far East (Indonesia, Mongolia, Papua New Guinea, the Philippines, Samoa, Thailand, Vanuatu and Viet Nam). Eight of these are least developed countries.

The most recent voluntary contributions received from China, Norway, the Netherlands, Turkey, the United Kingdom and the EU were used to finance the project in 2015, and part of these funds will be carried over to 2016. The Commission continues to seek additional voluntary contributions to ensure the financial sustainability of the project.

Management

Highlights in 2015

Efforts to improve geographical and gender representations in the Secretariat

Adoption of a biennial budgeting system

Establishment of four multiyear funds

The organization 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 Secretariat 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 IT 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 VIC over planning of office and storage space, maintenance of the premises, common services, and security.

Throughout 2015 the Commission continued to focus on smart planning to streamline its activities and to increase synergies and efficiencies. It also accorded priority to results based management.

The annual management retreat

Oversight

The Internal Audit Section 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 organization.

In order to ensure its independence and objectivity, the Internal Audit Section reports directly to the Executive Secretary and has direct access to the Chairpersons of the Commission and its subsidiary bodies. The Chief of Internal Audit also independently submits an annual activity report for consideration by the Commission and its subsidiary bodies.

In 2015 the Internal Audit Section issued five audit reports, one evaluation report and two reports on the implementation status of its recommendations. It also performed several fact-finding missions.

The Internal Audit Section is actively engaged in forums such as the Representatives of Internal Audit Services of the United Nations Organizations and Multilateral Financial Institutions (RIAS), whose goal is to share expertise amongst organizations dealing with similar issues.

Finance

The 2015 Programme and Budget

The Budget for 2015 totalled $38 011 400 and €70 287 200, corresponding to slightly less than zero real growth. The Commission uses a split currency system to lessen its exposure to fluctuations in the value of the US dollar against the euro. At the budget exchange rate of €0.796 to $1, the total US dollar equivalent of the 2015 Budget was $126 307 600. This represented a nominal growth of 1.7% but was almost constant in real terms (a decrease of $21 000).

On the basis of the actual average exchange rate in 2015 of €0.8995 to $1, the final total US dollar equivalent of the 2015 Budget was $115 592 344. Of the total Budget, 80% was originally allocated to verification related activities, including $13 854 486 for the Capital Investment Fund (CIF), which is dedicated to the build-up of the IMS.

Assessed Contributions

As of 31 December 2015 the collection rates of the assessed contributions from States Signatories for 2015 were 94.3% of the US dollar portion and 94.2% of the euro portion. The number of States that had paid their 2015 assessed contributions in full as of 31 December 2015 was 97.

Expenditure

The expenditure for the Programme and Budget in 2015 amounted to $104 563 349, of which $12 240 815 was from the CIF and the remainder from the General Fund. For the General Fund, the unused budget was $9 415 647.

Procurement

The Commission obligated $55 308 456 through 916 procurements for high value purchases and $1 456 820 through 758 contractual instruments for low value purchases.

As of 31 December 2015, 139 IMS stations, 11 radionuclide laboratories and 28 noble gas systems were under contract for testing and evaluation or for PCAs.

Voluntary Support Forum

The Voluntary Support Forum (VSF) 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 the efforts to mobilize extrabudgetary funding, to strengthen the interaction with donors, and to increase transparency and accountability regarding the use of voluntary contributions.

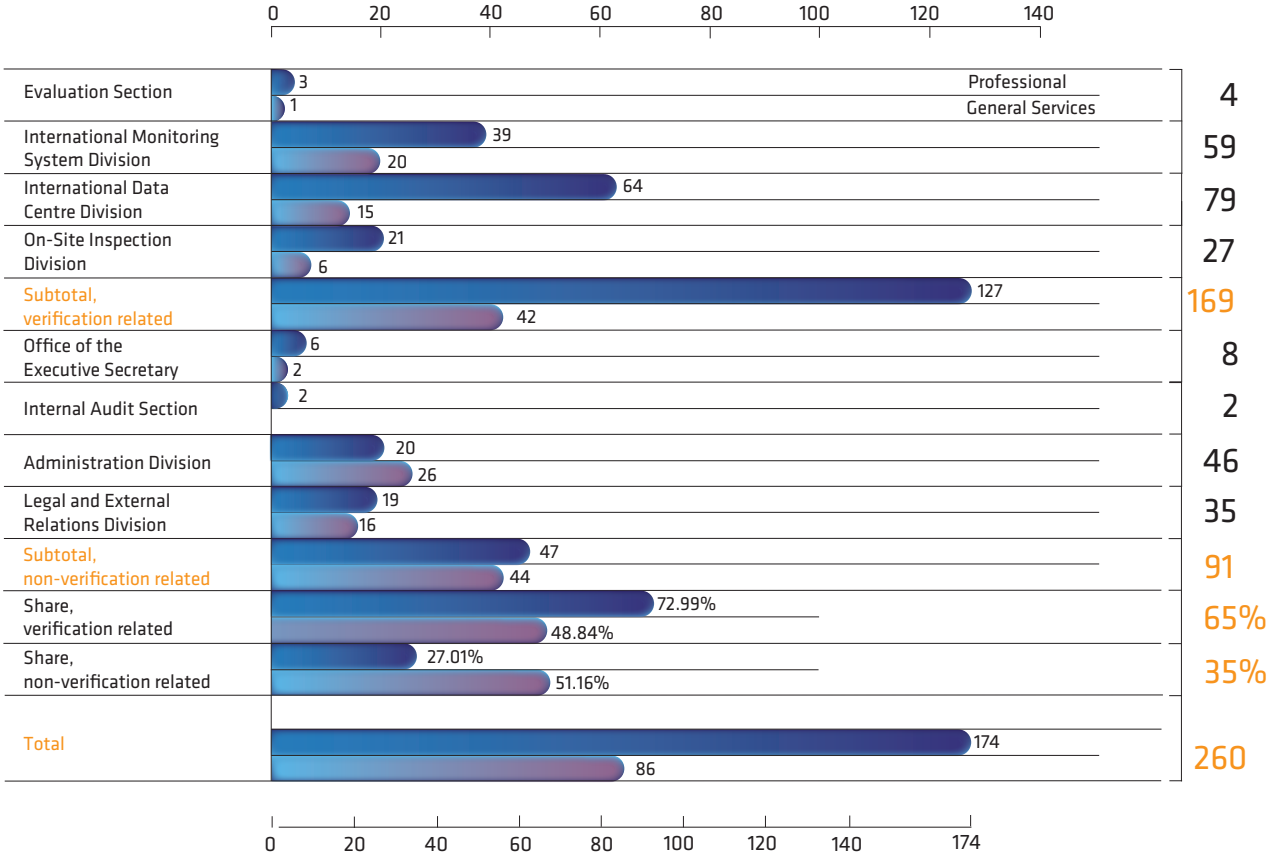
The VSF held one meeting in 2015, shortly after the session of the Commission in November. All States Signatories and observers were invited.

During the meeting the Secretariat presented several projects for which it sought voluntary contributions. The projects ranged from strengthening the technical capabilities of the organization, via integrated capacity building and training, to outreach to mark the 20th anniversary of the Treaty in 2016. The total amount sought for all the projects was approximately $3 million.

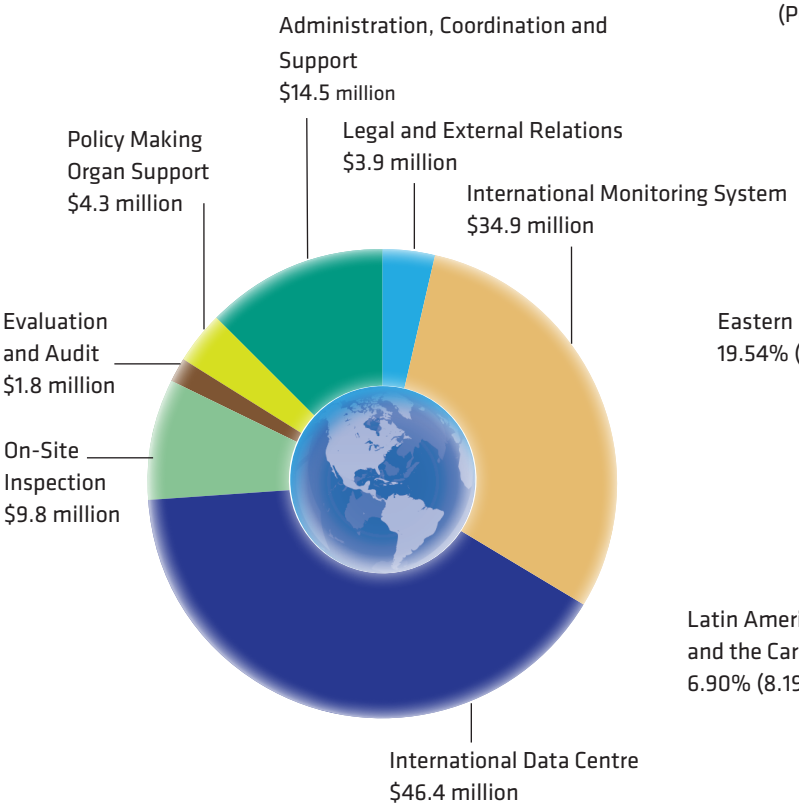
Human Resources

The organization secured the human resources for its operations by

Regular Staff Members by Field of Work as of 31 December 2015

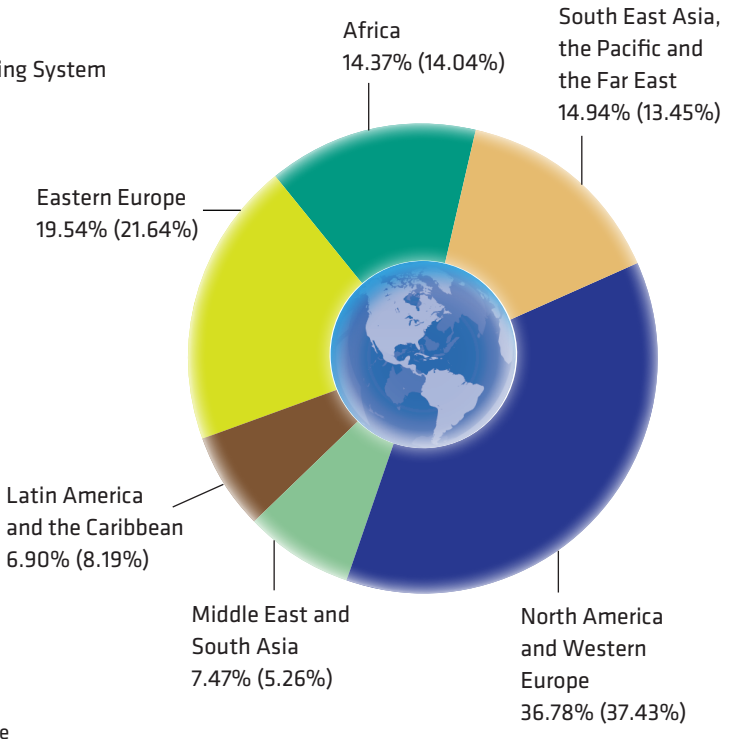


Distribution of the 2015 Budget by Area of Activity



Staff Members in the Professional Category by Geographical Region as of 31 December 2015

(Percentages as of 31 December 2014 are shown in brackets.)



To convert the euro component of the 2015 Budget, an average exchange rate of €0.8995 to $1 was used.

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

As of 31 December 2015 the organization had 260 staff members from 77 States, compared with 258 staff members from 76 States at the end of 2014.

The Secretariat continued its efforts to increase the representation of women in the Professional category. At the end of 2015, there were 60 women in Professional positions, corresponding to 34.48% of the Professional staff. In comparison with 2014, there was a decrease of 7.69% in the number of female staff at the P2 level and an increase of 12.50% at the P4 level. Female representation at the D1, P5 and P3 levels did not change.

Biennial Budgeting and Multiyear Funding

To improve the financial and budgetary structure of the organization and allow for better long term planning and resource allocation, the Commission decided to introduce a biennial budgeting mechanism to finance the activities of the organization.

The Commission also decided to establish a multiyear funding modality. Four multiyear funds are to be established: the IT Infrastructure Fund, the Application Software Fund, the Capacity Building Through OSI Exercises and Inspectorate Development Fund, and the OSI Facility and Equipment Fund.

The Commission also adopted the necessary changes to its Regulations and Rules to implement its decisions on biennial budgeting and multiyear funding.

Signature and Ratification Status as of 31 December 2015

183 Signed | 164 Ratified | 19 Signed but not ratified | 13 Not signed

States Whose Ratification is Required for the Treaty to Enter into Force

41 Signed | 36 Ratified | 5 Signed but not ratified | 3 Not signed

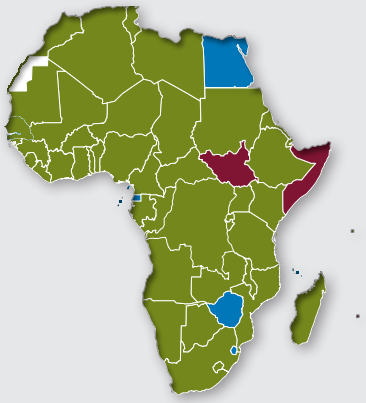
State	Date of Signature	Date of Ratification
Algeria	15 Oct. 1996	11 Jul. 2003
Argentina	24 Sep. 1996	4 Dec. 1998
Australia	24 Sep. 1996	9 Jul. 1998
Austria	24 Sep. 1996	13 Mar. 1998
Bangladesh	24 Oct. 1996	8 Mar. 2000
Belgium	24 Sep. 1996	29 Jun. 1999
Brazil	24 Sep. 1996	24 Jul. 1998
Bulgaria	24 Sep. 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

"This Treaty shall enter into force 180 days after the date of deposit of the instruments of ratification by all States listed in Annex 2"

Status of Signature and Ratification of the Treaty (31 December 2015)

Africa
54 States:
51 Signatories
44 Ratifiers



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
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
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
Swaziland	24 Sep. 1996	
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 Signatories
23 Ratifiers

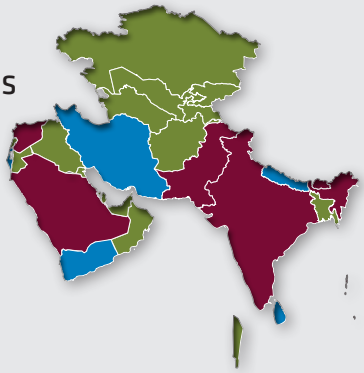
State	Date of Signature	Date of Ratification
Albania	27 Sep. 1996	23 Apr. 2003
Armenia	1 Oct. 1996	12 Jul. 2006
Azerbaijan	28 Jul. 1997	2 Feb. 1999
Belarus	24 Sep. 1996	13 Sep. 2000
Bosnia and Herzegovina	24 Sep. 1996	26 Oct. 2006
Bulgaria	24 Sep. 1996	29 Sep. 1999
Croatia	24 Sep. 1996	2 Mar. 2001
Czech 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 Signatories
31 Ratifiers

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:
21 Signatories
16 Ratifiers



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:
28 Signatories
27 Ratifiers

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:
29 Signatories
23 Ratifiers

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	
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	
Timor-Leste	26 Sep. 2008	
Tonga		
Tuvalu		
Vanuatu	24 Sep. 1996	16 Sep. 2005
Viet Nam	24 Sep. 1996	10 Mar. 2006

The Comprehensive Nuclear-Test-Ban Treaty bans nuclear explosions by everyone, everywhere. The Treaty has been signed by 183 States, of which 164 have also ratified it, but it has not yet entered into force.

The Treaty has a comprehensive verification regime to make sure that any nuclear explosion is detected. The Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization is building-up the verification regime so that it is operational when the Treaty enters into force. The regime has three pillars:

The International Monitoring System will consist of 337 facilities around the world to monitor the planet for signs of a nuclear explosion. Around 90% of the facilities are already up and running.

The International Data Centre at the Commission's headquarters in Vienna receives gigabytes of data from the monitoring stations each day. The data are processed and distributed to the Treaty's States Signatories.

After the Treaty enters into force, if the data from the IMS indicate that a nuclear test has taken place, an on-site inspection could be sent to the area of the suspected explosion to collect evidence.