Verification highlights

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) includes a definition of a global verification regime to monitor compliance with the Treaty. Establishing this regime, which must be capable of detecting nuclear explosions underground, in water and in the atmosphere, is the main activity of the Preparatory Commission for the CTBTO. The verification regime must be operational at the Treaty's entry into force. The regime consists of an International Monitoring System (IMS) supported by an International Data Centre (IDC), consultation and clarification, on-site inspections (OSI) and confidence-building measures.

IMS station status

Since the last issue of *CTBTO Spectrum,* efforts in establishing and certifying IMS stations have progressed significantly. The number of certified facilities meeting all technical specifications has increased from 68 to 87, including four radionuclide laboratories. The site survey programme is nearing completion, with only 15 site surveys remaining to be concluded out of a total of 337 IMS facilities. Altogether 115 facilities have already been installed or upgraded and about 30 additional stations are under construction or in contract negotiation. More than 70 IMS facilities are currently funded for operation and maintenance, either for testing and evaluation prior to certification or for post-certification activities. The number of facilities contributing data to the IDC increased from 85 to 134.

All these facilities are currently taking part in the preparatory phase of the system-wide-performance test (SPT1). ■

IMS station installation: A challenging mission to Tristan da Cunha

CENTRAL PROCESSING FACILITY (CPF) AND RADOMES, TRISTAN DA CUNHA

In late March, three PTS staff members and one consultant returned from a ten week mission to Tristan da Cunha. The PTS team, together with a team of eleven contractors from eight countries, had successfully installed three IMS stations (hydroacoustic station HA09, infrasound station IS49 and radionuclide station RN68) on what is often referred to as the most remote inhabited island in the world.

Three thousand kilometres away from the nearest mainland, Tristan da Cunha is located about midway between the southernmost point of South Africa and South America. A United Kingdom overseas territory, it is named after the Portuguese sailor who discovered the island in 1506. To reach Tristan da Cunha, it is necessary to undertake a six day journey by ship from Cape Town, South Africa. The supply ship RMS St. Helena calls once a year, and the island is also visited from time to time by fishing vessels.

IS49 UNDER CONSTRUCTION

Tristan da Cunha is a volcanic island with an active volcano that last erupted in 1961. The central volcanic peak (2060 meters) is almost permanently covered with clouds. Arable land is limited to a 700 metres wide strip to the north- and southwest of the island. Today, the island is home to just under 300 people. The main settlement is called Edinburgh. The island is financially almost self-supporting. Earnings derive mainly from lobster fishery and the sale of postage stamps. For food, the islanders rely mostly on their own stock, poultry and potato crops. To conserve grazing, stock is limited to two cows and seven sheep per family.

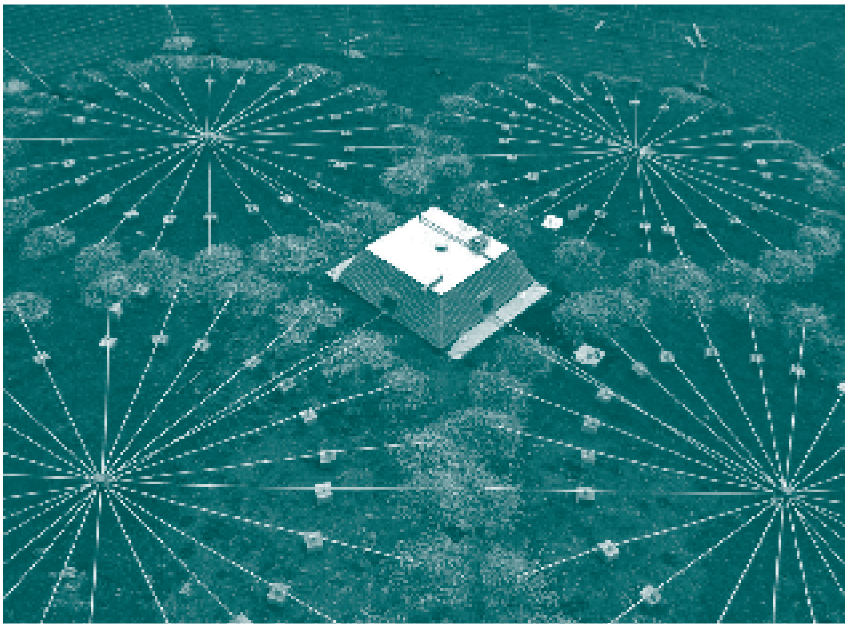
Preparations for the installation of the IMS stations began in 2001, when the PTS carried out site surveys. In 2003, the local power

ISLANDERS HELPING TO BUILD INFRASOUND STATION IS49

PTS STAFF INSTALLING PIPE ARRAY

station was upgraded to support the needs of the planned stations and interim construction work was carried out by a contractor. Three generators were donated to the islanders, which now provide a 24 hour power supply. More than 200 tonnes of equipment and construction materials had to be shipped to Tristan. Unloading was frequently difficult, as the island does not have a deep water harbour. Materials have to be offloaded from ships into smaller boats, often in high swells. During the final mission, the PTS hired a fishing vessel to bring the last 80 tonnes of equipment to the island. This included a complete Central Processing Facility (CPF), already set up in prefabricated containers. The CPF collects now data from all the IMS elements on the island and sends it to the International Data Centre in Vienna via satellite.

In addition to the challenge of getting equipment onto the island, the PTS mission also had to protect it from the elements and from livestock once it was installed. To protect infrasound station IS49 from curious cows, a circular fence was erected. Due to the scarcity of arable land, this was set as close to the arrays as possible. However, the grass inside proved too tempting for one animal, which somehow managed to enter the protected area. As a result, several of the array pipes were bent and had to be repaired. In addition to being protected from 'cow attacks', the IS49 arrays needed to be sheltered from extreme winds. This was achieved by covering the arrays with gravel to reduce wind turbulence. Special constructions, or radomes, were erected to protect the satellite dishes. Fences were also built around the other IMS stations and the CPF. To complete the work on the stations, the PTS employed between 10 and 25 islanders at various times. Following the successful completion of the mission, some islanders are now assisting in operating and maintaining the IMS stations. ■



COMPLETED INSTALLATION OF HIGH-FREQUENCY INFRASOUND ELEMENT H3
TRISTAN DA CUNHA, MARCH 2004

Verification highlights

Calibration of seismic regional travel-times to improve event location

In 1998, Working Group B identified a need to improve location accuracy. The Treaty restricts on-site inspections to an area of 1000 km2. This provides the target for the maximum size of the error ellipse for a seismic event location released by the International Data Centre (IDC). Such accuracy can only be achieved by using more sophisticated Earth models for seismic travel-time calculation. To tackle this challenge, the PTS initiated the Calibration Programme in the year 2000. This effort was guided by an expert group under the leadership of Dr. Frode Ringdal, Norway. Phase 1 of the Programme considered the regions of northern Eurasia, the Middle East and Australia, and ended successfully in 2003. Phase 2 has just started, with a first look at the African continent.

Source-Specific Station Corrections (SSSCs) are used in event location to account for the difference between the real Earth and a radially symmetric model. Such travel-time corrections are already being applied for North America and north-western Europe since delivery of the Release 3 software from the prototype IDC in Arlington, USA. Following the recommendation of the 2003 event location calibration expert group meeting in Oslo, the IDC evaluated the preliminary version of SSSCs available for northern Eurasia (Figure 1), and implemented them in IDC processing.

Controlled explosions provide a unique opportunity for regional travel-time calibration when such explosions are recorded by dense seismic networks. ■

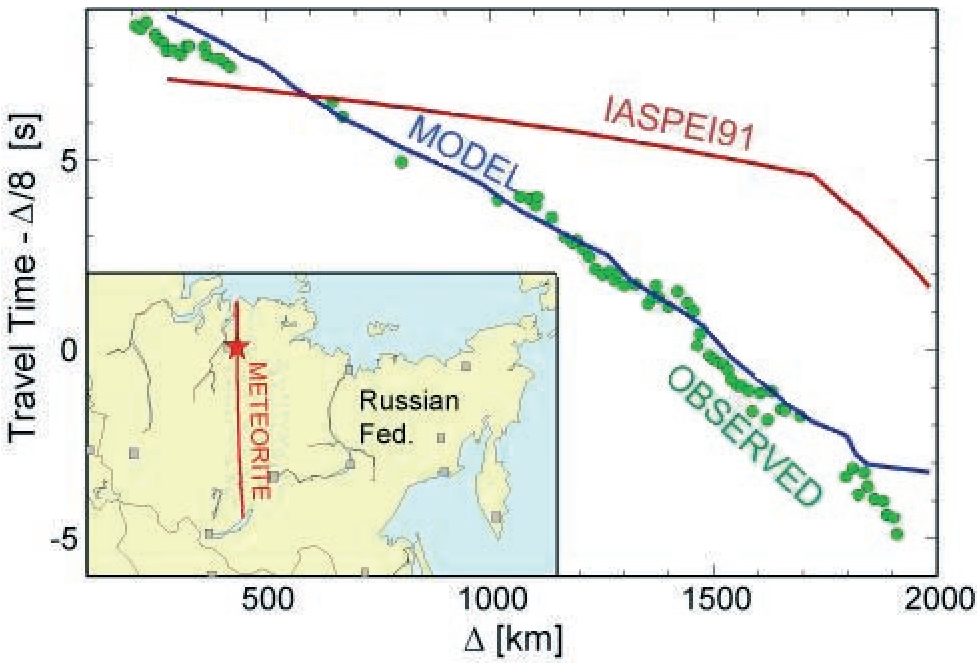


FIGURE 1: TRAVEL-TIMES FOR THE LONG-RANGE DEEP SEISMIC SOUNDING PROFILE OF A 'METEORITE' ACROSS THE RUSSIAN FEDERATION (GREEN), COMPARED WITH CALCULATED TRAVEL-TIMES FOR THE ONE-DIMENSIONAL STANDARD EARTH MODEL IASPEI91 (RED) AND TRAVEL-TIMES FOR A THREE-DIMENSIONAL MODEL THAT SERVED AS BASIS FOR THE SOURCE-SPECIFIC STATION CORRECTIONS (BLUE).

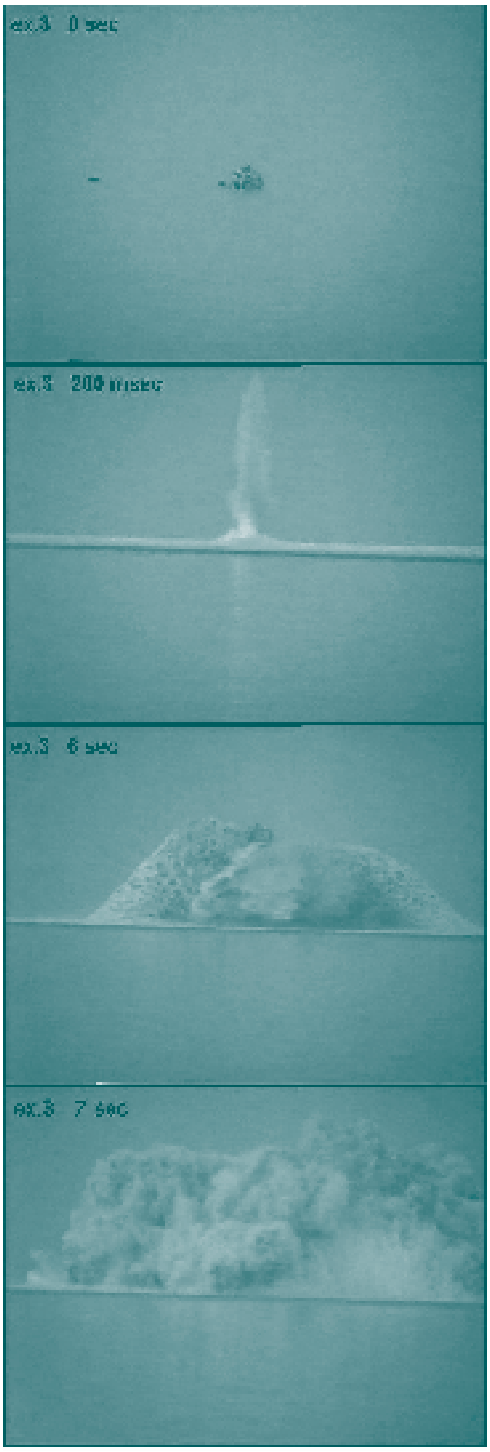


FIGURE 2:1999 CALIBRATION EXPLOSION IN THE DEAD SEA COORDINATED BY THE GEOPHYSICAL INSTITUTE OF ISRAEL.

Techniques for on-site inspections: Radionuclide survey and analysis equipment.

HAND-HELD RADIONUCLIDE SURVEY AND ANALYSIS TOOL

Preparing for an on-site inspection (OSI) is a major activity for the Preparatory Commission. During an OSI inspectors will be able to draw upon a 'suite' of technologies to clarify whether or not a nuclear test explosion has taken place. These include video and still photography, passive and active seismic methods and other geophysical methods such as magnetic and gravitational field mapping. However, the measurement of relevant radionuclides will be the primary indicator of whether an event had a nuclear origin. The results from radionuclide survey and analysis techniques are expected to be the ultimate evidence available to the Executive Council when deciding whether or not the Treaty has been violated.

Appropriate measurements allow OSI inspectors to determine the presence or absence of specific radionuclides that result from a nuclear event and that are most relevant from an OSI point of view. Furthermore, the calculation of the relevant ratio of radioactive pair concentrations enables the inspectors to determine when an event may have occurred.

During an OSI, it is likely that the inspectors will undertake a radionuclide survey and analysis both from the air and at, or under, the surface to search for and identify radiation anomalies. Radionuclide survey and analysis equipment that could enable inspectors to carry out these tasks include handheld and vehicle-portable search and limited gamma identification tools, a high-resolution gamma spectrometer tool for field and laboratory use, radioactive noble gas measurement equipment for Xenon and Argon-37 and a tool for aerial gamma spectroscopy.

FIELD USE OF HAND-HELD TOOL FOR RADIONUCLIDE SURVEY AND IDENTIFICATION

^{37}Ar, ^{95}Zr/^{95}Nb, ^{99}Mo/^{99m}Tc, ^{103}Ru, ^{106}Rh, ^{115m}Cd, ^{131}I/^{132}I, ^{132}Te, ^{140}Ba/^{140}La, ^{141}Ce, ^{144}Ce, ^{144}Pr, ^{147}Nd, and ^{131m,133m,133,135}Xe

RADIONUCLIDES OF INTEREST TO AN ON-SITE INSPECTION

The Commission has also elaborated an initial list of radionuclides of interest to an OSI. The technical criteria for inclusion in the list includes their relevance to a nuclear event, the half-life of the relevant radioisotopes and the OSI timelines established in the Treaty.

While all the equipment described above plays an important role during an OSI, the equipment for measuring the noble gases Xenon and Argon-37 is of special interest to the CTBT verification system. This is particularly because, if the event detected occurred underground or underwater, Xenon and Argon-37 will enter the atmosphere as a result of dynamic venting or atmospheric pumping. With the right type of equipment, these gases will be more readily detected. Based on the Commission's decisions, the Provisional Technical Secretariat has several projects underway to develop and/or obtain these unique radionuclide survey and analysis tools, initially for testing and training purposes, but with the goal that the use of this important category of equipment will ultimately form the core activity during future inspections. ■