

The radionuclide processing system of the CTBTO

Mika Nikkinen, Matthias Zähringer, Robert Werzi

Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty (CTBT) Organization, Vienna International Centre, P.O. Box 1200, A-1400 Vienna, Austria



Abstract

The Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation is the inter-national organisation establishing the global verification system under the provisions of the CTBT. The International Monitoring System (IMS), as part of the verification system, is a global network of monitoring stations, 80 of which monitor radionuclides, and a global communications infrastructure which transmits all raw station data to the International Data Centre (IDC) for storage, distribution and processing.

The IDC supports the verification responsibilities of the Commission by providing objective products and services for effective global monitoring. IDC collects data from the IMS network to detect, locate and analyse possible nuclear events. At the IDC, data are automatically processed and interactively reviewed, and data and products are distributed in near real time to the State Signatories.

The radionuclide component of the verification system has noble gas and particulate measurement systems. All the particulate systems and part of the noble gas systems are equipped with germanium detectors for high resolution gamma ray spectroscopy analysis of the samples. Part of the noble gas systems are using beta-gamma coincidence detectors. The samples are measured at the station and spectral data transmitted to the IDC. Special analysis software is used to calculate activity concentrations of the isotopes in the air and to categorize the samples. If needed, samples can be reanalyzed in Certified Laboratories. The presentation illustrates the capabilities of the radionuclide monitoring system and how the data is processed and results distributed to the state.

Particulate systems

Common requirements

- Timeliness (24h sampling, 24h decay, 24h spectrum collection)
- Sampling volume >500 m³/h
- MDC for Ba-140: 10µBq/m³
- Min 40% rel. efficiency for HPGe Detector
- FWHM <2.5keV @ 1332.5 keV
- State-of-health monitoring
- Calibrated at the station



Manual operation

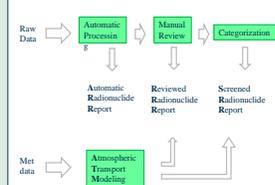
- Various systems
- Operator takes care of sample handling

Automatic operation

- RASA and ARAME
- Fully automatic

All of particulate stations are producing one sample spectra files (phd) that is sent to IDC for data analysis

Common flow of the data for both particulate and noble gas data



Noble gas systems

Common requirements

- Timeliness (Reporting within 48h from start of sampling)
- Sampling volume > 10 m³
- MDC for Xe-133: 1mBq/m³
- State-of-Health monitoring
- Calibrated at the station

HPGe based systems

- SPALAX
- Typically 1 sample a day
- Fully automatic

Beta-Gamma based system

- SAUNA and ARIX
- Typically 2 samples per day
- Fully automatic

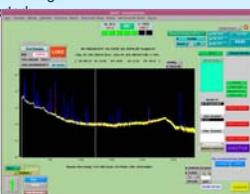
Noble gas systems are producing 1 or 2 sample spectra per day. These spectra are sent to the IDC for data analysis.



Particulate data analysis

Automatic processing ("autoSAINT") performs automatic analysis based on best knowledge on spectrum and calibrations supported by MCNP detector simulation

- Result are concentrations of the detected radionuclides (Bq/m³) and detection limits for the relevant nuclides



Review of the results ("SAINT")

- Specially tailored to review the relevant isotopes
- Includes special tools for example to differentiate Tc-99m (fission product) from Ge-75 (cosmogenic) and to assess the statistical detectability of a found gamma peak independent from subjective judgment.

Review of State-of-Health data

Operations center is receiving information on reception of data to verify that the system is performing as desired.



Laboratory analysis

- 16 certified laboratories
- Performs high sensitivity HPGe analysis
- Report to the IDC
- All level 5 samples are re-analyzed in laboratory
- Samples selected for QA/QC
- Other samples (certification etc.)

Categorization of the samples is applied according to the sample analysis:

- Level 1: Normal background
- Level 2: Anomalous background
- Level 3: contains relevant radionuclide(s) typically seen in this station
- Level 4: contains a relevant radionuclide not typically seen in this station
- Level 5: contains multiple relevant radionuclide not typically seen in this station

Products for data analysis

- Automatic Analysis Report (ARR) – automatic analysis, nearly instantly available
- Reviewed Radionuclide Report (RRR) – Results after the analysts have performed the review
- Radionuclide Laboratory Report (RLR) – results from a radionuclide laboratory analysis
- Standard Event Bulletin (SEB) – combined results from many samples and radionuclide analysis
- XML based reports are under testing for Noble Gas reporting

Noble gas data analysis

HPGe based systems

- Automatic processing (autoSAINT)
- Searches automatically for Xe-131m, Xe-133, Xe-133m and Xe-135 and checks the calibrations
- Results: concentrations and detection limits for 4 Xenon isotopes

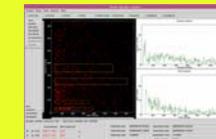
HPGe spectra review – XeSaint



Tool to verify the automatic results and to recalculate if problems are seen

Beta-gamma based systems

- Automatic processing ("Bg-analyze")
- Searches for Xe-131m, Xe-133, Xe-133m and Xe-135 and checks the calibrations.
- Based on experience within INGE and "Stockholm equations"
- Results: concentrations and detection limits
- BG spectra review – BGGui to check and correct the BG noble gas results



Categorization is under development as studies on background variation are under way (background variations due to industrial activities are usually observed). Basically three levels are foreseen:

- No noble gasses detected
- Noble gasses that are typical for these stations at these concentrations
- Abnormal noble gas detection

ATM support

Backward transport simulation: Field-of-Regard given for all Level 4 and Level 5 particulate samples in RRR.



After 1 day

After 3 days

After 5 days