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Stack release data analysis: progress and expected outcomes

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Abstract

Upon completion, the International Monitoring System (IMS) will comprise 80 radionuclide monitoring stations worldwide, of which 40 will be capable of measuring radioxenon. Radioxenon monitoring is a key component of the IMS as it provides forensic evidence of underground nuclear explosion. Radioxenon may however be emitted by civilian nuclear facilities, such as medical isotope production facilities, in routine operating conditions. A deep understanding of emissions originating from nuclear facilities would significantly enhance the capability to discriminate signals potentially originating from a nuclear explosion against the normal background.

The International Data Centre (IDC) is undertaking scientific studies to analyse stack release data provided by nuclear facilities on a voluntary basis to characterize the radioxenon background during historic episodes. The current progress and the expected outcomes of these studies are presented.

Context of the project

Several approaches are developed by the CTBTO to estimate and understand the impact of the radioxenon background at the station, e.g.:

- radioxenon background measurements using mobile systems (EU-funded project);
- controlled source experiments based on the voluntary participation of civil nuclear facilities (e.g. the ATM challenges);
- collection of stack release data on a voluntary basis for scientific studies on better understanding and characterization of the emissions from civil facilities

Experimental setup at a radioxenon source

The experiment started in 2012 at the initiative of the CTBTO and was financially supported under EU Council Decision III, with contribution in kind from Pacific Northwest National Laboratory. CTBTO received data collected at the stack of BATEK (now PT INUKI), Indonesia, with the following equipment (Fig. 2):

- 1.5"x1.5" LaBr3(Ce) scintillation detector;
- ruggedized housing and thermal insulation;
- multi-channel analyzer (OSPREY type);
- power-over-Ethernet connection;
- basic spectroscopy software included;
- continuous measurements;
- data saved every 600 sec.

Fig. 2 – Experimental setup as initially installed at BATEK and exploded view of the detector, housing, thermal insulation and OSPREY.

About 55.000 raw data files were shared by BATEK (now PT INUKI) on a voluntary basis for the period March 2013 – March 2014.

Additional information on this project are available in [1].

Data confidentiality – The Treaty

Aspects of data security, confidentiality and transparency were largely discussed with providers willing to share radioxenon emission data on a voluntary basis.

What the Treaty says about confidentiality?

CTBT Article II – General Provisions, Paragraph 6:
"[The Organization] shall take every precaution to protect the confidentiality of information on civil and military activities and facilities coming to its knowledge in the implementation of this Treaty…"

CTBT Article II – General Provisions, Paragraph 7:
"Each State Party shall treat as confidential and afford special handling to information and data that it receives in confidence from the Organization in connection with the implementation of this Treaty. It shall treat such information and data exclusively in connection with its rights and obligations under this Treaty."

CTBT Article IV – Verification, Paragraph 8:
"… all necessary measures shall be taken to protect the confidentiality of any information related to civil and military activities and facilities obtained during verification activities."

Data confidentiality

Which data may be provided?

Voluntary

1. Location of a MIPF
2. Operational status of a MIPF (on/off)
3. Absolute release data
   - Time resolution (annual, monthly, daily, hourly, …)
   - Isotopes (Xe-133 only, all four relevant isotopes, …)
   - Uncertainties, MDAs and other relevant information on measurement technology and analysis
4. Analysis reports on spectral data
5. Raw data of a stack detector
   - Time resolution (annual, monthly, daily, hourly, …)
   - Spectral resolution (high, medium, low, none)

Which data may be shared?

Level of disclosure

- Resulting overall predicted background at IMS stations
- Resulting concentration predictions at IMS stations broken down by the source
- Release values (isotopic activities of concentrations)
- Raw data (spectral pulse height data)

As required by data providers

Class of user

- Relevant CTBTO staff
- Delegations of States Signatories
- CTBTO contractors through vDEC
- Authorized users as designated by the States Signatories under confidentiality rules like IMS data
- Publicly open (no restriction)

To comply with the request of security, confidentiality and transparency, the vDEC platform will be used to make available data we are allowed to share. The first time vDEC was used for sharing stack emission data was the 2nd ATM Challenge, in 2016 [2]).

What is vDEC?

The virtual Data Exploitation Centre (vDEC) provides scientists and researchers from many different disciplines and from around the globe with access to the CTBTO and other data to conduct research and to publish new findings. Scientists have the opportunity to meet and exchange knowledge and information at a range of fora, workshops and technical meetings, or via the CTBTO dedicated vDEC page. Basic information can be found at: http://www.ctbto.org/specials/vdec/

For sharing the IMS data and IDC products, a zero-cost contract (no monetary remuneration between the parties but legal obligations are imposed) will be used. The main provisions of a vDEC contract are:

- restricted access to the data and products necessary for fulfilling the task;
- data and products will be used only for research associated with the development of the IMS and IDC, or for the purposes stated in the contracts;
- access provided to an organization for the purposes of fulfilling a contract will terminate when the contract is completed (usually after 2 years);
- data access is provided only to a maximum of three individuals per contract;
- the vDEC access credentials and the retrieved data may not be shared;
- the restrictions placed on all users will not exclude the presentation of data or products (or information derived therefrom) for peer review at scientific meetings or in scientific journals and other scientific publications. The inclusion of data and products in scientific journals and other scientific publications will be limited to those required to reflect the scientific achievements. This is subject to approval by CTBTO. Review and approval of the use and publication of data by a nuclear facility operator will take their conditions on confidentiality in due respect.

For the use of data under a vDEC contract, each contractor has to sign a separate confidentiality agreement.

Security of the vDEC platform

A virtual machine will be installed for a second vDEC platform dedicated to stack emission data. Its foreseen OS security main features are:

- platform VM runs Red Hat Enterprise Linux 6, (security-Enhanced Linux system);
- Linux account with username / password security;
- Access over SSH with IP-based whitelisting;
- File storage segregation based on Linux user and group rights.

Testing, processing and analysis of the data

The schematic flowchart used of the testing and the processing of the files shared by BATEK (now PT INUKI) is given in Fig. 3. The data shared by the facility are sent to the IDC in Vienna, where they are stored in a secured environment in the development area. As the files are received under different format, they are converted in a standard format and processed in an IDC secured database. After processing, data are available for further analysis by CTBTO or Member States experts.

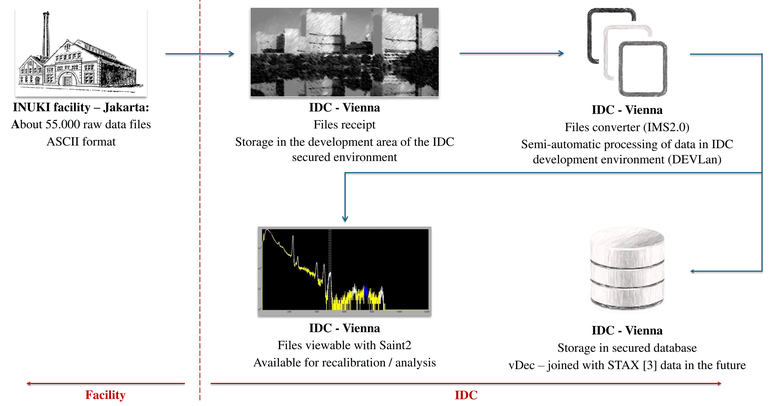

Fig. 3 – Flowchart of the data processing from BATEK (now INUKI) to the storage in an IDC secured database. Data are then available scientific studies on time periods of interest linked to the mission of the CTBTO.

Comments on the file conversion:

- several input formats are readable;
- raw data / processed data are automatically recognized by the converter and processed in the database accordingly;
- UTC time / units of measurement values are standardized;
- non-operational times and periods are taken into account;
- automatic sending of the data in the dedicated pipeline is under testing.

The data analysis in Saint2 will be optimized for LaBr spectra analysis and includes:

- the integration of an automatic re-calibration process for each spectrum (e.g. based on internal lines / ^{40}K / annihilation peaks);
- the possibility of a manual fine calibration correction.

An example data file is given in Fig. 4 (01/09/2013 00:03:22).

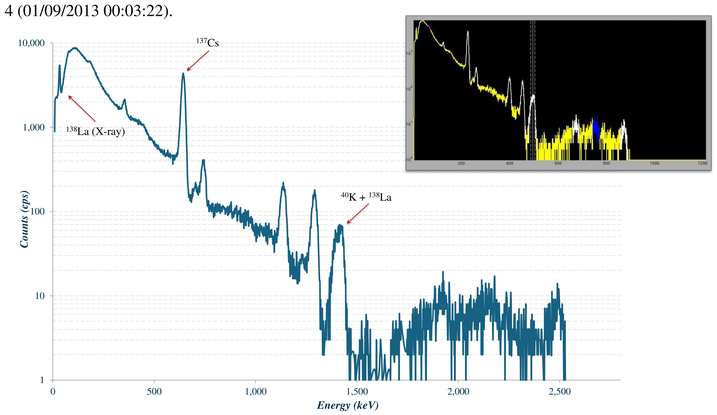

Fig. 4 – Example of stack measurement data file received from BATEK (now PT INUKI): identification of peaks used for automatic calibration (main graph) and view of the same data file in the CTBTO analysis software tool SAINT2.

Conclusions and outcomes

Among other approaches, the CTBTO is carrying out scientific studies on stack emissions data provided by facilities on a voluntary basis to estimate and understand the impact of the radioxenon background at IMS stations as well as to further develop advanced scientific methods based on atmospheric transport modelling. Confidentiality issues are carefully addressed by the CTBTO, the vDEC platform will be used to share the data we are allowed to share by the provider. As a first experiment, about 55.000 raw historical data files were provided by BATEK (now PT INKUKI) to support the technical implementation of the study. First data sets were tested, processed and analysed.

References

[1] J. I. McIntyre et al., *Real-time stack monitoring at the BATEK medical isotope production facility*, Journal of Radioanalytical Nuclear Chemistry, pp. 308:311 (2016).

[2] C. Maurer et al, *2nd ATM challenge 2016* , oral presentation T1.3-O1 at SnT2017 Conference, Vienna, Austria.

[3] J. Friese et al, *Source term analysis of xenon (STAX) – exploring methods for understanding radioxenon civilian source terms*, oral presentation T2.4-O2 at SnT2017 Conference, Vienna, Austria.