CTBTO PREPARATORY COMMISSION | preparatory commission for the comprehensive nuclear-test-ban treaty organization

The Current Status of IMS Radionuclide Network

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IMS Division

Eighth Annual Radiation Measurements Cross Calibration Conference

Third Annual Cooperative R&D on Environmental Radiation Detection Stations Workshop

Amman, Jordan •
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Preparatory Commission for the
Comprehensive Nuclear-Test-Ban Treaty Organization
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Plan

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1. **CTBTO Verification Regime**
2. **Radionuclide Monitoring (Why? What is measured?)**
3. **Particulate Monitoring**
4. **Noble Gas Monitoring**
5. **Format and Protocols**
6. **IMS data are available**

1. CTBTO Verification Regime –Treaty

- **Comprehensive Nuclear-Test-Ban Treaty (CTBT)**
  Opened for signature on **24 September 1996**
  Signature 183 countries; Ratification 159 (Annexe2: 36).

- **CTBT prohibits all nuclear test explosions** in all environments.


Underwater Tests


Atmospheric Tests


Underground Tests

- Establishes the Comprehensive Nuclear-Test-Ban Treaty Organization (**CTBTO**) to **achieve its object and purpose** and **ensure implementation of its provisions.**

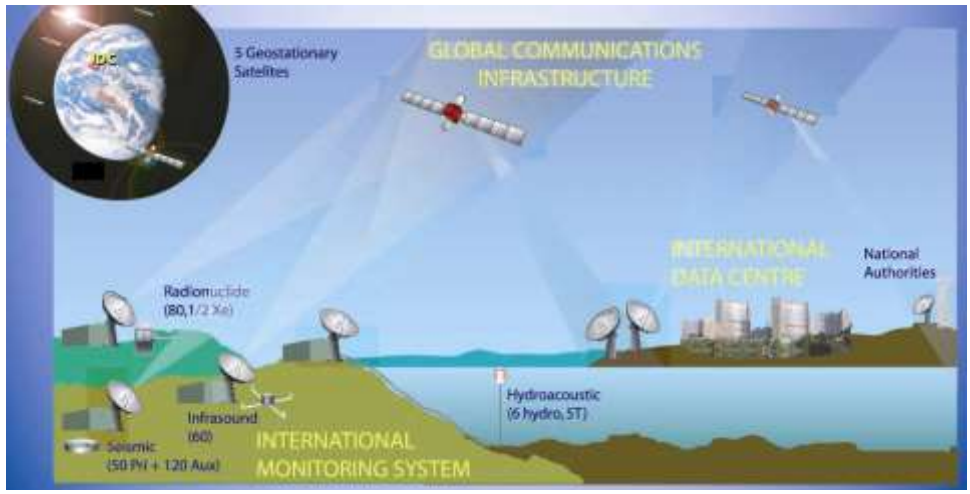
1. CTBTO Verification Regime –IMS

Four Monitoring Technologies

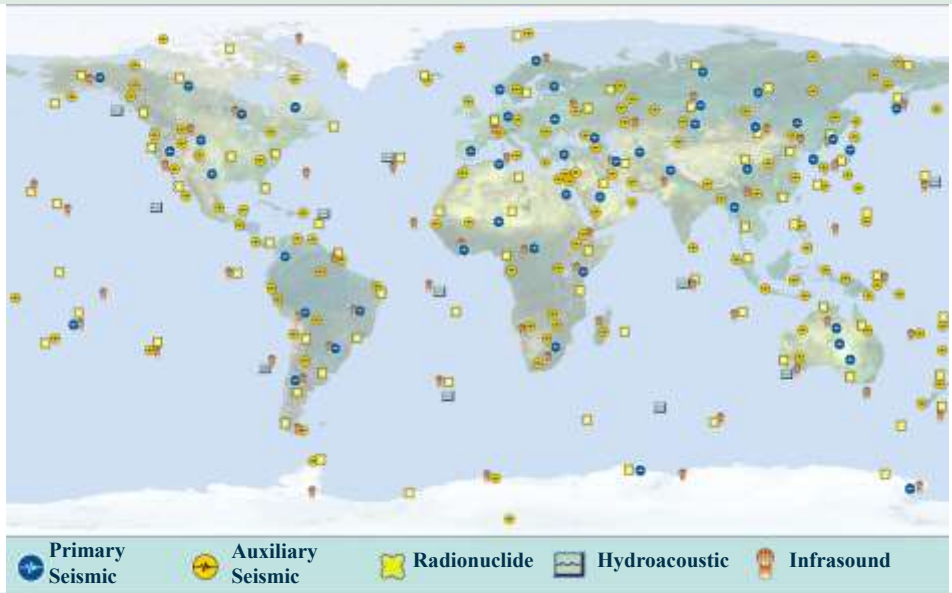
✓ **Seismic**
Primary Seismic station
Auxiliary Seismic stations
✓ **Infrasound**
Infrasound stations
✓ **Hydro acoustic**
Hydro acoustic station
✓ **Radionuclide**
RN Particulate Stations
Noble Gas Monitoring capability

321 stations and 16 laboratories

1. CTBTO Verification Regime –IMS -IDC



1. CTBTO Verification Regime - IMS Network



2. Radionuclide Monitoring: Why?

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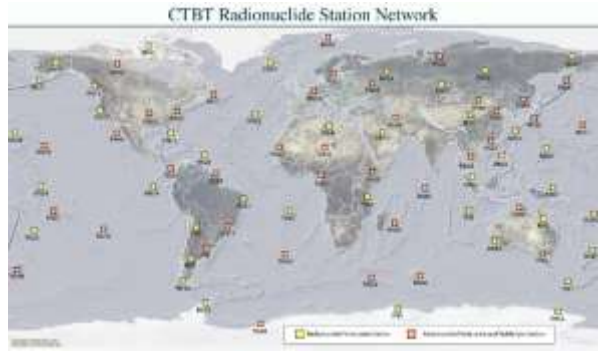
What makes the Radionuclide Monitoring Distinguished?

The ability to discriminate between nuclear and non-nuclear events is unique among the other verification technologies.



Provide **unambiguous evidence** of a nuclear explosion through the **detection** and **identification** of fission products.

2. Radionuclide Monitoring: Why?

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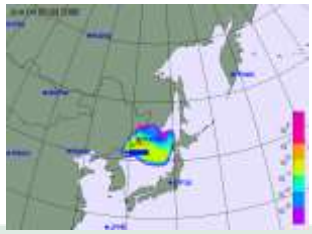
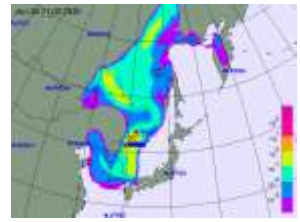
85% → **Air blast, shock**
Thermal radiation
Heat

15% → **Radiation:**
5% Initial
10% Residual

- Ratios of various fission products
- Meteorological data
- AT Modeling,

→ Provide information on the **timing** and **location** of a suspicious event.





2. Radionuclide Monitoring: What is measured?

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Particulate

Nuclide	Half-life	Nuclide	Half-life
^{95}Zr	64 d	^{134}Cs	2.1 y
^{95}Nb	35 d	^{136}Cs	13.2 d
^{97}Zr	17 h	^{137}Cs	30 y
^{99}Mo/ ^{99m}Tc	2.75 d	**^{140}Ba**	**12.8 d**
^{103}Ru	39 d	^{140}La	40.2 h
^{106}Ru	1.008 y	^{141}Ce	31.5 d
^{131}I	8 d	^{143}Ce	1.4 d
^{132}Te	3.3 d	^{144}Ce	284.3 d
^{133}I	20 h	^{147}Nd	10.99 d

Radionuclides relevant as nuclear test indicators

Gas

^{131m}Xe	11.9 d	^{133}Xe	5.24 d
^{133m}Xe	2.19d	^{135}Xe	9.10 h

3. Particulate Monitoring: Station Design

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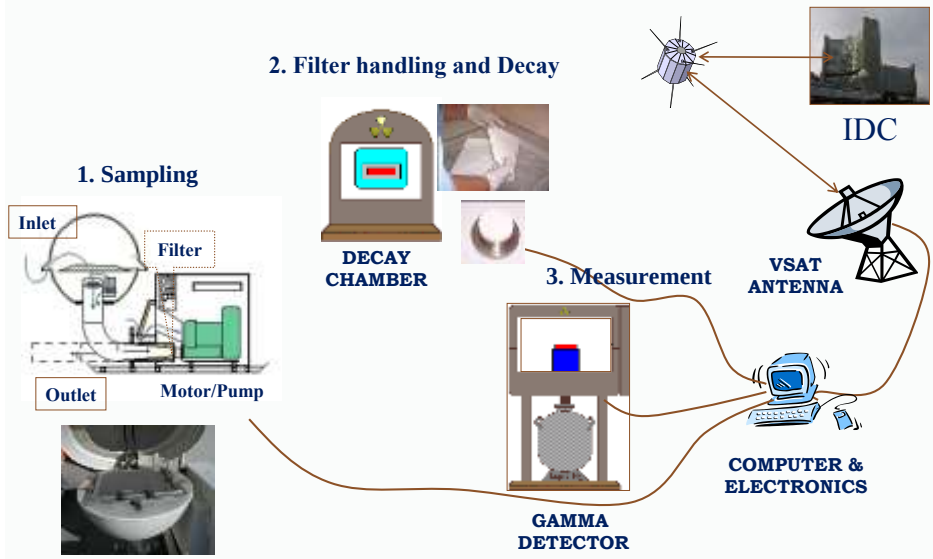


3. Particulate Monitoring

Minimum Requirements

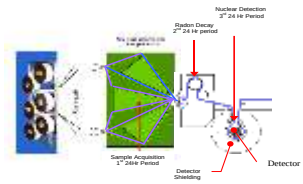
Characteristics	Minimum requirements
System	Manual or automated
Air flow	500 m^{-3} h^{-1}
Collection time [1]	24 h
Decay time [2]	≤ 24 h
Measurement time [3]	≥ 20 h
Time before reporting	≤ 72 h
Reporting frequency	Daily
Filter	Adequate composition for compaction, dissolution and analysis
Particulate collection efficiency	For filter :≥ 80 % at ∅ = 0.2 µm Global [4]:≥ 60 % at ∅ = 10 µm

Characteristics	Minimum requirements
Measurement mode	HPGe High resolution gamma spectrometry
HPGe relative efficiency	≥ 40 %
HPGe resolution	**< 2.5 keV at 1332 keV**
Base line sensitivity [5] [6]	**10 to 30 µBq m^{-3} for ^{140}Ba**
Calibration range	88 to 1836 keV
Data format for gamma spectra and auxiliary data	RMS (Radionuclide Monitoring System) format [7]
State of health	Status data transmitted to IDC
Communication	Two-way
Auxiliary data	Meteorological data Flow rate measurement every 10 minutes
Data availability	≥ 95 %
Down time [8]	≤ 7 consecutive days ≤ 15 days annually

3. Particulate Monitoring - IMS Station

3. Particulate Monitoring

RASA Radionuclide Automated Sampler/Analyzer



Cinderella

3. Particulate Monitoring: Network

4. Noble Gas Monitoring

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Minimum Requirements

Characteristics	Minimum requirements
Total Volume of sample	10 m^3
Air flow	0.4 $m^3 h^{-1}$
Collection time	≤ 24 h
Measurement time	≤ 24 h
Time before reporting	≤ 48 h
Reporting frequency	Daily
Measurement mode	Beta gamma coincidence or High resolution gamma spectrometry
Isotopes measured	^{131m}Xe, ^{133m}Xe , ^{133}Xe, ^{135}Xe
Minimum Detectable	**1 mBq m-3 for 133Xe**

4. Noble Gas Monitoring

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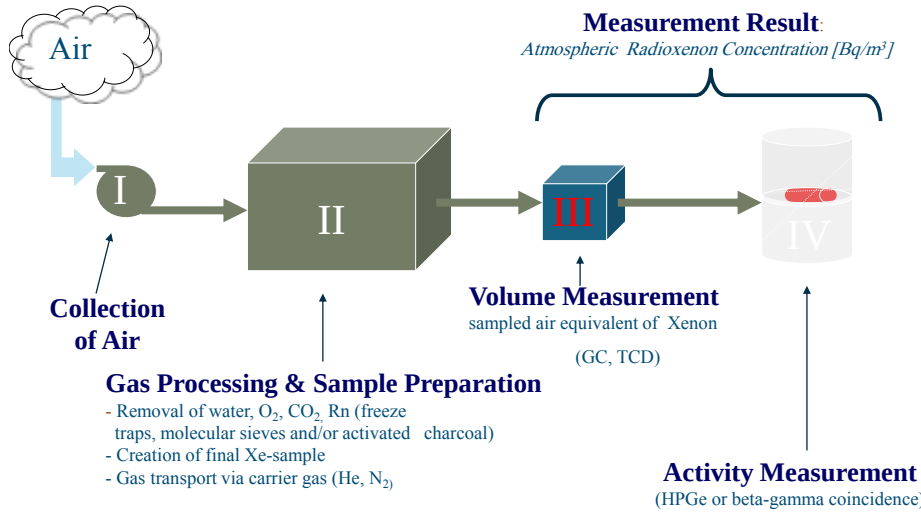
Principle of Xenon Sampling and Analysis



4. Noble Gas Monitoring

SAUNA (Sweden)

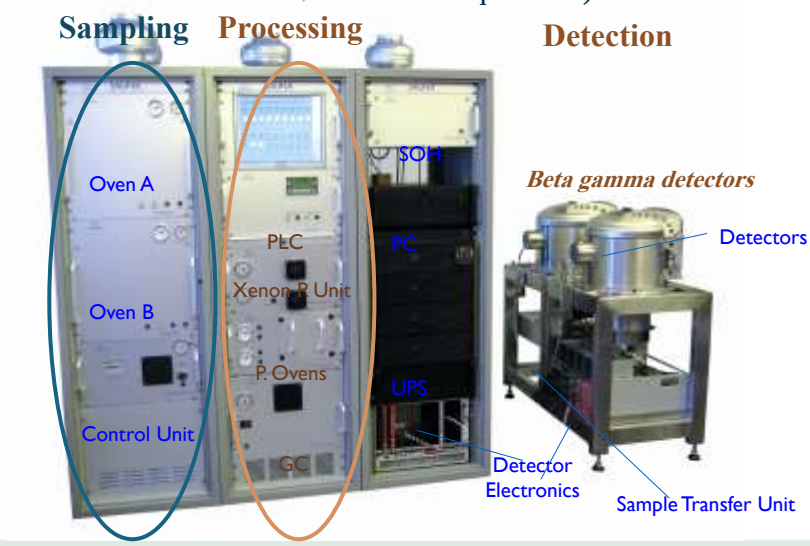
SPALAX (France)

ARIX (Russia)

3 NG Systems

4. Noble Gas Monitoring

SAUNA
(**S**wedish **A**utomatic **U**nit for **N**oble Gas **A**cquisition)



4. Noble Gas Monitoring

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SPALAX

Système de **P**rélèvement **A**tmosphérique en **L**igne avec l'**A**nalyse du **X**énon

4. Noble Gas Monitoring

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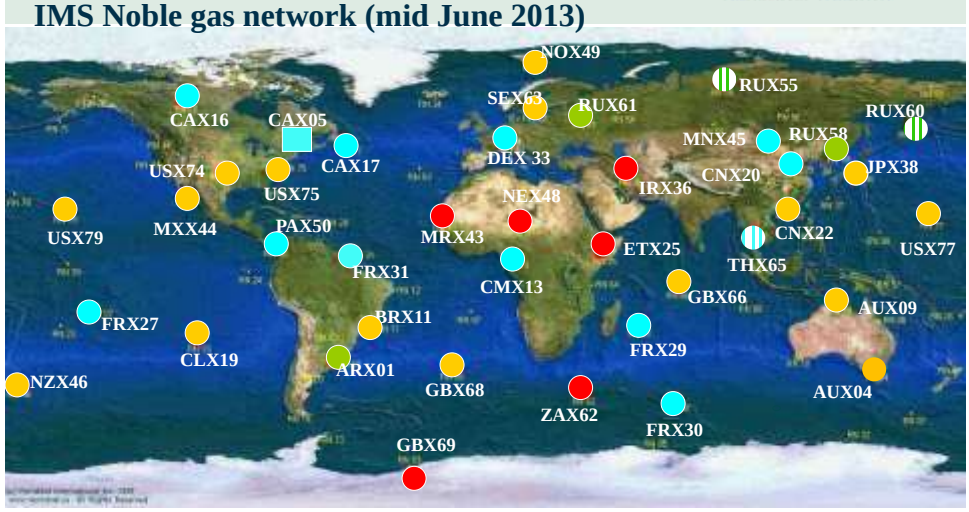
ARIX

Analyser of **R**adioactive **I**sotopes of **X**enon

4. Noble Gas Monitoring

IMS Noble gas network (mid June 2013)



SPALAX 11 ● SAUNA 15 ● ARIX 3 ● not started ● National Systems

…Systems under installation

12 systems certified, 31 installed

5. Radionuclide Laboratories

Support role of 16 Radionuclide Laboratories

- Confirm the presence of fission and/or activation products

(all Level-5 samples are re-analysed at laboratories)

- Provide more accurate and precise
- Clarify the presence or absence of fission and/or activation products

5. Radionuclide Laboratories

- Re-analyse samples selected for QA/QC (4 samples per year)
- Station back-up samples when a station is down
- Proficiency test exercise samples.





CR Tools: www2.ctbto.org

CR Tools

CR Tools

Formats and protocols – Overview

The IDC, National Data Centres (NDCs), IMS stations, and communicate with each other via e-mail messages.

Exchange Data and Products

Types of messages exchanged

- Request
- Products.
- **Data** (PHD, SOH, MET, Alert)
- Command Request
- Command Response

Formats and protocols – Overview

Message Protocols

Two standard low-level protocols are used for the exchange of messages: electronic mail

- **Email**
- File transfer protocol (FTP)

Message Authentication

- IMS2.0 messages are sent via email using the Secure Multipurpose Internet Mail Extensions (S/MIME)

Formats and protocols – Message Structure

Message consists of a preface, body, and conclusion.

Message preface

- BEGIN,
- MSG_TYPE, MSG_ID,

```
begin ims2.0
msg_type request
msg_id 2002/05/21_0001 ABC_NDC
...
stop
```

Body depends on its type

Conclusion: The STOP line is the last line of an IMS2.0 message.

Formats and protocols – Overview

Data types for Radionuclide Messages from Stations

Pulse height data (PHD)

- SAMPLEPHD : Sample Spectrum.
- BLANKPHD : Calibration Spectrum
- DETBKPHD : Detector background measurement
- GASBKPHD : Noble Gas Background Spectrum
- CALIBPHD : Calibration Spectrum
- QCPHD : Quality Control Spectrum

State of Health Data

RMSSOH State of Health Data

Meteorological Data

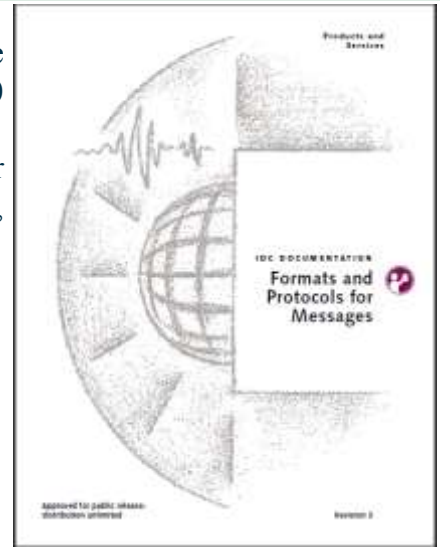
MET meteorological Data

Alerts

Airflow, System, Temperature and UPS Power Supply

Format and Protocols for Messages

This document describes the International Monitoring System 2.0 (**IMS2.0**) version of the formats and protocols used for discrete message exchange, including requests for subscriptions and data messages



Formats and protocols – Message Structure

Message conventions

- Fixed-format field justification
- Case sensitivity
- Blank lines (not allowed)
- Date and Times formats (yyy/mm/dd hh:mm:ss.sss)
- Missing data
- Station naming
- Comment conventions
- Version format number
- File size (less than 100Mb)
- Radionuclide Detector codes KWP_40, DEP_33

Format and Protocol - PHD

DATA BLOCKS FOR PHD FROM SITES SENDING HIGH-RESOLUTION gamma SPECTROMETRY DATA

#Header
#Comment
#Collection
#Acquisition
#Processing
#Sample
#g_Energy
#g_Resolution
g_Efficiency
#TotalEff
#g_Spectrum
#Calibration
#Certificate

Format and Protocol - RMSSOH

DATA BLOCKS RMSSOH MESSAGES

Particulate Data

#Header
#AirSamplerFlow
#AirSamplerEnv2
#Comment
#DetEnv
#NIMBIN
#PowerSupply
#EquipStatus
#TamperEnv

Noble Gas

#Header
#AirSamplerFlow
#Comment
#DetEnv
#NIMBIN
#PowerSupply
#EquipStatus
#TamperEnv
#ProcessSensors2
#Chromatogram2

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