Response of SCK•CEN to the Fukushima Nuclear Accident in the Context of the Protection of Belgian Citizens

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Introduction

- Belgian Nuclear Research Centre = partner of Belgian authorities related to nuclear and radiological emergency preparedness and response, especially related to:
  - Atmospheric dispersion modelling & dose assessment
  - Monitoring (environment, anthropogammametry, …)
- No declaration of emergency plan
  -> ad-hoc organization
- Questions in the aftermath of the accident
  - What’s the impact of the Fukushima accident on Belgian Citizens in Japan
  - Impact on Belgian territory
  - Goods imported from Japan (Food & non-food)
Radiological assessment of situation in Japan
The early phase

High uncertainty, limited information
Our first very basic impact assessment:

- Worst case source term (inventory, accident scenarios)
- Airborne fraction: 10% (I, Cs)
- Variable wind direction over release period

Follow-up of measurements:

<table>
<thead>
<tr>
<th>Distance</th>
<th>Total Effective dose (First week)</th>
<th>Thyroid dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>km</td>
<td>mSv</td>
<td>mSv</td>
</tr>
<tr>
<td>300</td>
<td>1.7</td>
<td>27</td>
</tr>
<tr>
<td>50</td>
<td>5.0</td>
<td>81</td>
</tr>
<tr>
<td>30</td>
<td>6.8</td>
<td>110</td>
</tr>
<tr>
<td>20</td>
<td>7.5</td>
<td>122</td>
</tr>
</tbody>
</table>

→ Need for flexible data assimilation tools/data fusion
Atmospheric dispersion: “later phase” analysis
(Estimation dose first year – ICRP103)

- **Source term**
  - Xe-133 = 1.10E+19 Bq
  - I-131 = 1.60E+17 Bq
  - Cs-134 = 1.80E16 Bq
  - Cs-137 = 1.50E16 Bq

- **Puff releases**

- **Meteorological conditions**
  - Wind direction
  - Wind speed
  - Rain
  - Stability class (cloud cover)

- **Single local data set**
  every 3 hours
Cloud gamma dose rate

Puffs release (1-6 h)
No constant release
Calculation grid 200 km x 200 km
Cesium deposition (Bq/m²)
Long-term impact?
Total effective dose after 1 year

Need for specific improvements of detailed modeling aspects
Contamination control of individuals returning from Japan

Two measurements options were organized:

Voluntary repatriated people (21-25 March 2011)

Military Hospital, close to airport

Worried travellers journalists, employees (March – November 2011)

Laboratories for anthropogammetry, SCK•CEN
Measurement of people returning from Japan

1. External contamination measurement:
   - $\beta\gamma$-contamination monitors

2. Internal contamination: thyroid measurement
   - HPGe detectors
   - Detection limit of 100 Bq I-131 in 1 minute counting time (experience from Fleurus incident)

3. Control of luggage
   - Large volume (4 l) NaI detector to be sensitive to external contamination as well as contaminated goods inside the luggage

Difficult to get detailed info on how measurements are performed in other countries
**Action levels defined**

- **External contamination:**
  - 4 Bq/cm² βγ (around 60 cps on measurement instrument, background 10 cps) → **action:** decontamination and further investigation at SCK•CEN laboratories

- **Internal contamination thyroid:** 5 mSv equivalent thyroid dose (measurement assumed to be 8 d after intake):
  - 150 Bq age 3 month
  - 150 Bq age 1 year
  - 500 Bq age 5 year
  - 700 Bq age 10 year
  - 1100 Bq age 15 year
  - 1600 Bq adults

- **Luggage:** portal monitor calibrated for I-131 (via Ba-133) and Cs-137: exemption levels (10 kBq Cs-137, 1 MBq I-131)
Communication with people to be measured

- Video on measurement procedure
- Posters
- Leaflets

+ Experts from FANC and SCK•CEN

=> reassurance, education, questions & answers
Measurements at laboratories SCK•CEN

- Internal contamination: thyroid (14) + WBC (34)
- Control of external contamination/luggage
Total:

- 33 individuals from 3 - 60 years old

<table>
<thead>
<tr>
<th></th>
<th>Thyroid (I-131)</th>
<th>Whole Body (Cs-137, Cs-134)</th>
</tr>
</thead>
<tbody>
<tr>
<td># measurements</td>
<td>14</td>
<td>34</td>
</tr>
<tr>
<td># positive cases</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>max measured activity (retention)</td>
<td>280 Bq</td>
<td>159 Bq</td>
</tr>
<tr>
<td>max equivalent thyroid dose</td>
<td>592 µSv</td>
<td></td>
</tr>
<tr>
<td>max committed effective dose</td>
<td>29 µSv</td>
<td>5 µSv</td>
</tr>
</tbody>
</table>

First measurement on March 17, Journalist returned from Fukushima (nearest distance to power plant: Fukushima city at around 70 km) Estimated intake of around 500 Bq I-131 $\rightarrow$ TIC $\rightarrow$ deposition of 18000 Bq/m$^2$ (Food countermeasures probably required)

Measurement of contaminated persons $\rightarrow$ environmental information (data fusion)
Impact on Belgian territory
Increased surveillance of radioactivity levels in Belgium

Measurements done by SCK•CEN:

- **FANC (Federal Agency for Nuclear Control):** Increased number of analysis on Belgian territory
  - Air filters
  - Deposition on grass, total deposit
  - Milk

- **FAVV (Food Agency):** Additional program lines for food products imported from Japan

- **External costumers:**
  - Belgian companies importing food and feed stuffs from Japan
  - Belgian manufactures of paramedical equipment with production divisions in Japan asked for radioactivity analysis on their products.
I-131 cloud over Belgium, air-borne activity

Measurements SCK•CEN and IRE on demand of Federal Agency for Nuclear Control (FANC)
Similar over rest of Europe (IMS stations)

Air Concentration (mBq/m$^3$)

Date
IMS Station RN33 (Germany)
IMS Station RN63 (Sweden)
I-131 cloud over Belgium, air-borne activity

Integration $\rightarrow$ TIC
720 Bq.s/m$^3$
$\times$ 5 (charcoal versus paper)
$\rightarrow$ 500 nSv thyroid dose small children (trivial exposure)
I-131 measured in grass (different locations):

- no I-131 activity detected in milk

Surveillance measurements

Can give at maximum around 1 Bq/l I-131 in milk
Contaminated goods

- Companies importing from Japan
  - Large variety in type of products: e.g. demand for measurement of an artificial kidney

- Lack of knowledge in radiation protection/ radiation measurements

- Requests for
  - Training in radiation protection
  - Assistance in setting up monitoring procedures to check radioactive contamination of imported goods
    - Demand for advise on the use of measurement equipment purchased by companies
    - Certification of products

Need for better preparedness → Contaminated goods (ConGoo) workgroup NERIS, WP FP7-project PREPARE
Response at large distance: ad-hoc organization with many challenges:

- How to deal with little information and high uncertainties: uncertainty should be an integral part of an assessment

- Qualitative measurements/model calculations contribute largely to re-assure the population, however still challenge to communicate measureable but trivial exposures

- Better preparedness needed for contaminated food and goods imported
Thanks for your attention. Questions?

Acknowledgements

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- FANC: partner in thyroid measurement campaign
- Military Hospital Neder-over-Heembeek (Belgian Defense): partner in thyroid measurement campaign
- IMS stations RN33 (Bfs, Freiburg) and RN63 (FOI, Stockholm)
- KIT: Wolfgang Raskob (JRODOS patch for world-wide calculations)