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Optimisation in air transportof radioactive materials

A case study from Switzerland

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Content

- The incidents and dose estimates
- Lessons learnt and measured prescribed by the Swiss authorities
- Conclusion and discussion

Part of the material in this presentation comes from colleagues at SFOPH and Suva

Preamble

Radiation protection authorities in Switzerland

	Medicine, (non-nuclear) industry, research and education		Nuclear energy
Licensing authorities	Swiss Federal Office of Public Health (SFOPH)		Swiss Federal Office of Energy
Supervisory authorities	Swiss Federal Office of Public Health (SFOPH) + environmental monitoring	Swiss National Accident Insurance Fund (Suva)	Swiss Federal Nuclear Safety Inspectorate (ENSI)
License holders	Hospitals and clinics, universities, research centers, etc.	Industry, private companies	Nuclear facilities

The incidents and dose estimates

Some statistics

Source: https://swiss.newsmarket.com/

- Swiss International Airline performs airborne radioactive transport (unlike many other airlines).
- About 7’500 radioactive transports per year (about 20 per day).
- Fraction of incidents for radioactive transports: 0.4% (mostly for minor reasons)

Incident of July 2017
CAI-ZRH-BRU

Source: https://swiss.newsmarket.com/

- On 26.07.2017, SFOPH was informed by the Belgian radiation protection authority FANC/AFCN of an incident during the transport of a package containing a 30 GBq Ir-192 radioactive source (industrial radiography source).
- On receipt of the package in Belgium, it was found that the radioactive source was incorrectly placed inside the shielding.
- The package was transported on 13 July 2017 from Cairo to Zurich, then from Zurich to Brussels, in two passenger flights from the Swiss International Airline company.
- The FANC/AFCN classified this event as level 2 on the INES scale.

Dose estimates

Source: https://swiss.newsmarket.com/

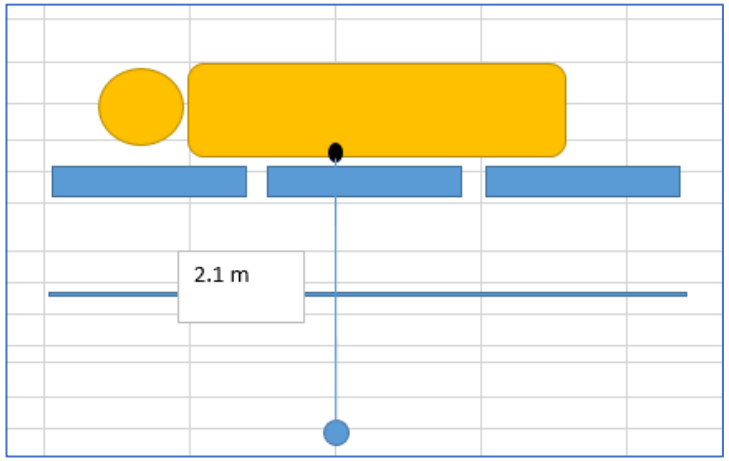
- Measured dose rate at 1 m distance: 2.6 mSv/h.
- 26 passagers overall were exposed to doses above 1 mSv.
- Max. 6.6 mSv from Cairo to Zurich, max. 3.1 mSv from Zurich to Brussels.
- No dose limit exceedance for the ground staff.
- All the Swiss passengers with doses > 1 mSv were informed by SFOPH.

Incident of April 2021
JNB-ZRH-AMS

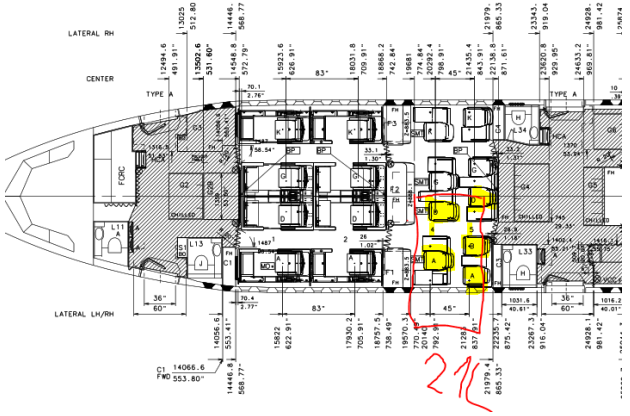
- On 27.04.2021, Swiss International Airline informed SFOPH on an incident that occurred during the transport of a 10 GBq Ir-192 sealed source from South Africa to Switzerland and then from Switzerland to the Netherlands.
- The source was not in the foreseen position inside the shielded transport container.
- First flight: cargo flight from Johannesburg to Zurich on 09.04.2021.
- Second flight: passenger flight from Zurich to Amsterdam on 10.04.2021.
- 26.04.2021: Report by Swiss Air Lines on the finding of a package with an increased dose rate in Amsterdam. The high dose rate of the package was only detected about two weeks after the flight upon arrival at the recipient company.

Dose estimates

First flight: dose to the crew

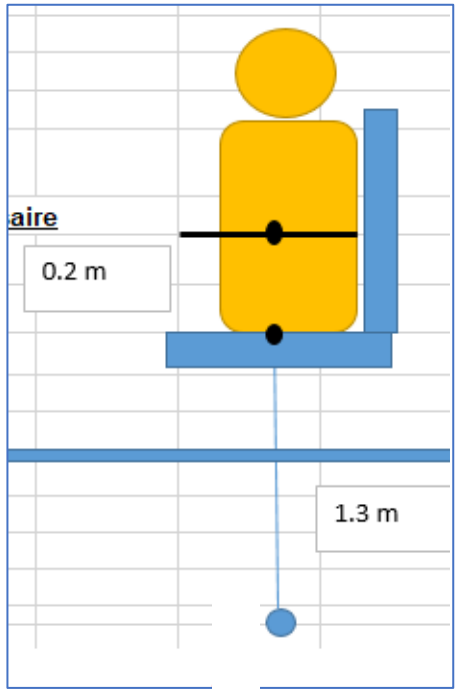


- Measured dose rate at 1 m distance: about 1 mSv/h.
- Cargo flight from Johannesburg to Zurich, without passengers.
- Distance from source to person, duration of exposure, nominal source activity, and dose rate of package are known.
- Conservative scenario: crew member lying above the source during 3 hours.
- Resulting dose: < 1 mSv. The flight crew was informed of this incident.



Dose estimates

Second flight: dose to the passengers



- Passenger flight from Zurich to Amsterdam.
- Distance from source to person, duration of exposure, nominal source activity, and dose rate of package are known.
- Scenario: adult passenger sitting above the source.
- Two-compartment model was considered: pelvis-abdominal region and upper body. For the latter, attenuation by the lower region and increased distance were considered.
- Resulting dose (Microshield): < 1 mSv.
- Passengers were **not informed** (low health risk and no dose limit exceedance). The flight crew and ground staff were directly informed of this incident.

Dose estimates

Dose to the ground staff

- Hypothesis: all organs exposed in an identical way during the handling, loading and stowing of the source.
- Four scenarios with different distances and exposure durations, representing the different manipulations by the ground staff. Based on investigation and information from the staff.
- Unloading of the plane from Johannesburg: source was in a cargo container → < 1 mSv.

Person 1

Scenario				
Time [min]	3.5	3.0	5.0	40.0
Distance [cm]	Contact	30	100	200
Dose rate [mSv/h]	36.00	11.00	1.00	0.25
H*(10) dose [mSv]	2.10	0.55	0.08	0.17
Total effective dose [mSv] [1)]				**2.9**

Person 2, 3

Time [min]	-	2.0	5.0	40.0
Distance [cm]	-	30	100	200
Dose rate [mSv/h]	-	11.00	1.00	0.25
H*(10) Dose [mSv]	-	0.37	0.08	0.17
Total effective dose [mSv] [1)]				**0.6**

Person 4, 5, 6, 7, 8

Time [min]	-	-	-	40.0
Distance [cm]	-	-	-	200
Dose rate [mSv/h]	-	-	-	0.25
H*(10) Dose [mSv]	-	-	-	0.17
Total effective dose [mSv] [1)]				**0.2**

[1)] Sum of the effective dose resulting from all relevant scenario for a given person.

- Loading in the plane to Amsterdam: maximum dose about 2.9 mSv for one person, below 1 mSv for all the others. The ground staff was informed of this incident.

Lessons learnt and measures prescribed by the Swiss authorities

Lessons learnt

- The high dose rates have not been detected at the airports involved in those transports.
- At the Dangerous Good (DG) check, the paperwork, the condition of the package and the labelling are checked. Dose rate measurement or transport index (TI) determination is possible at DG check. However, it is not required by the international regulations. TI was 260 for CAI-ZRH-BRU incident, and 100 for JNB-ZRH-AMS one.
- Further checks during the transport are usually not possible (package cannot be opened).
- Class 7 is the only DG class showing risk even if the package is closed and intact (direct radiation).
- At ZRH airport, there is no DG check for transit.

Optimisation measures

Requested by the Swiss radiation authorities

- **Radiation monitoring** for import and transit of class 7 packages
  - Have to be performed by logistics companies that handle packages.
  - Measurement has to be done before the package leaves the airport.
  - Definition of two dose rate thresholds of 50 µSv/h and 500 µSv/h at 1 m distance (might be adjusted according to experience).
  - Measurements of individual packages, trolleys, unit load devices (ULDs). If threshold exceeded, measurement on individual package.
  - Most packages with TI well above 10 should be detected.
  - Legal basis: employer's obligation to protect employees. **No legal basis for TI measurement!**
  - Implementation is ongoing.

Optimisation measures

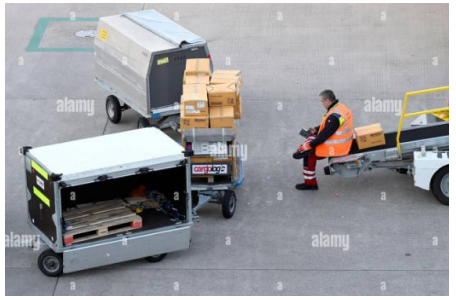
Requested by the Swiss radiation authorities

- Green no measures needed (still, TI might be too high).
- Yellow package stored at predefined location; clarification needed; implementation details still pending.
- Red stop working; DG-alarm; firefighters take over; national emergency operations centre is alerted.

The procedure is about to be finalised in an internal guideline.

Optimisation measures

Difficulties and next steps



- All the involved stakeholders (airport, airline, logistics companies) could not agree on single automatic detection system or measurement portal (financing, responsibility, …).
- Several other options were evaluated: one of the companies performs the measurements with a hand-held device and shares the data with the other companies; the companies mandate a third-party company; the companies make separate measurements; … but were not retained.
- The following solution has been tested for one year (test period just finished): the main unloading company performs measurements with a hand-held measuring device during unloading, near the arriving plane, on three planes per day. Test phase successful, will now be generalized to all planes.
- Once everything is in place, it is foreseen to introduce similar measurements in the other international airports in Switzerland. Difficulty for Basel: binational airport!

Conclusion and discussion

Conclusion and discussion

- To protect staff and passengers, it is not enough to rely on the shipper to package the radioactive sources correctly and to determine and declare the transport index.
- Introduction of an international prescription of TI measurements during DG checks?
- ICAO would be the right international organisation for the implementation of such a requirement.
- In civil aviation, consignors can be certified for certain tasks. Such certified consignors are inspected regularly by the authorities and/or the airlines. Certification of interested consignors for TI measurement? An additional radiation measurement at the DG check would not be necessary for class 7 packages from these consignors.
- Are there regulations on radiation measurements for class 7 packages at the airports in your countries?

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Thank you for your attention.
Any questions?