

STUK's threat analysis of a nuclear submarine accident

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NKS-B NORCOP COAST Workshop

14.10.2015, Tromsø, Norway

STUK's work 1(4)

In 1993 STUK carried out a threat study that included deterministic analyses on the consequences of severe accidents at near-by NPPs and on a nuclear submarine.

The inventory (100 MW_{th} reactor, full-power operation for 600 days) and total release fractions used in the submarine study were based mainly on the following two references:

1. Eriksen V.O. *Sunken nuclear submarines*. Norway; 1990.
2. U.S. Atomic Energy Commission. *NS 'Savannah' Safety Assessment, Vol. III*. U.S.A.E.C; 1961.

STUK's work 2(4)

It was assumed that half of the total release takes place (immediately after the reactor shutdown) during the first hour and the latter half – depending on the nuclide group – in the following 5, 11 or 23 hours. The release was “ a close-to-the-sea-level release”.

Radionuclide	Release fraction
Xe, Kr	1
I, Br	1
Cs, Rb	1
Te, Sb, Se	0,17
Sr, Ba	0,01
Mo	0,024
Muut	0,01

STUK's work 3(4)

Weather situation was defined by the Finnish Meteorological Institute: wind speed 2.5 m/s and stability between E and F (Pasquill categories).

The submarine was assumed to be in the middle of the Gulf of Finland, i.e. at a distance of 40 km from Helsinki.

Calculations were performed with the late code OIVA which contained a Gaussian plume model.

STUK's work 4(4)

Results of STUK's study (target site Helsinki):

<u>Dose during two days</u> (mSv)	
Inhalation	380
Cloud	17
Deposition	230
Total	630
<u>Maksimum dose rate</u> (mSv h ⁻¹)	
Inhalation	430
Cloud	20
Deposition	7,1
<u>Maximum deposition</u> (MBq m ⁻²)	
¹³⁷ Cs	52
¹³¹ I	630

About weather scenario

- Deterministic approach (“worst case scenario”)
- The aim was to find weather conditions with most unfavourable radiological consequences but still realistic
 - Still rare (0.5-1-0 times a year)
 - Avoid overestimation of bad weather conditions
- Vertical dilution
 - 300 – 400 m: mixing reaches the ground surface with level that corresponds evenly distributed concentration
- Horizontal dilution
 - To get high ground concentrations Pasquill atmospheric stability class D and E were chosen (neutral and slightly stable)

Some conclusions

- Ship reactors located near Murmansk
 - “In practice it is impossible that nuclear submarine accident in this area would cause any protective actions due to radioactive release in Finland”
- However very consequence assessment of scenario nuclear submarine accident near Helsinki was carried out with following conclusions
 - “Due to short distance (40 km) there’s is not much time to implement protective actions”
 - “During first 10-20 hours the inhalation dose is dominant”
 - “Iodine isotopes cause most of the effective dose”
 - “The significance of transuranium isotopes is smaller than in the case of NPPs”