



Underground nuclear explosions and release of radioactive noble gases

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One of the main methods for detection of clandestine nuclear explosions is a radionuclide method based on the monitoring of elevated Xe radionuclides background concentration in atmospheric air.

Over a period of 1961-1990 in the Soviet Union about 500 underground nuclear tests and explosions of different purpose and in different rocks were conducted.

In all, at the Semipalatinsk Test Site 340 tests were conducted: 209 in tunnels and 131 in shaft (vertical holes). Among these explosions 179 (52,6 %) were classed as complete containment, 145 explosions (42,6 %) as explosions with weak release of radioactive noble gases (RNG) and 12 explosions (3,5 %) as explosions with nonstandard radiation situation.

39 nuclear tests had been conducted at the Novaya Zemlya Test Site, 6 from them - in shafts. In 14 tests (36%) there were no RNG release. 23 tests have been accompanied by RNG release into the atmosphere without residual contamination. In 2 tests accidental radiation situation occurred.

In incomplete containment explosions both early-time RNG release (up to ~ 1 h) and late-time release from 1 to 28 h after explosion were observed. Sometimes gas release lasted for several days, and it occurred in turn through tunnel portal or epicentral zone depending on atmospheric air temperature. In tunnel tests radioactive gas release occurred through cracks in epicentral zone, seldom through tunnel portal stemming; in shaft tests - through the hole head of test shaft, , the space between metallic casing,

radiological sampling pipeline, cracks in epicentral zone.

In the Novaya Zemlya Test Site tests a RNG seepage beyond the boundary of the Test Site (offsite) was observed in 11 tests, total activity of RNG released being higher than 10^{14} Bq. Maximum total activity did not exceed 10^{17} Bq (1 test). Total activity of RNG being lower than $3.7 \cdot 10^{13}$ Bq were not registered beyond the Test Site boundary. Nearly in a half of tests noble gases release began in time interval of 5-20 minutes. RNG spreading beyond this Test Site boundaries is considered.

Sometimes the release of radioactive noble gases took place after peaceful nuclear explosions. 39 from them with a yield ranging from 2 to 23 kt in vertical holes (shaft) at the depth of 400-1000 m had been conducted in accordance with core seismic sounding program . No release of radioactive substances (gases) at the day surface was observed in 22 explosions. Complete containment of explosions had been observed here. The composition of RNG depended on the time when their seepage began.