D&D OF A PU EXTRACTION FACILITY IN VNIINM

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ABSTRACT

Old Pu extraction facility was decontaminated and decommissioning in VNIINM in 1999- 2000.

This facility is a system of interconnected working areas housing process equipment located in 4 floor building and includes more than 20 laboratories rooms, 2 “hot cells”, few sealed contaminated rooms and two extraction shaft. Industrial separation technologies have been tested on the facility for 20 years since 1947. The first USSR Pu was obtained here. In the mid-1960s the equipment was partially decommissioned and sealed. Some areas were put into prolonged storage. Some areas were adapted for laboratories. Practically all rooms were contaminated with Pu, Cs, Sr etc.

A technology, tools and decontamination and localization polymeric coats has been developed for decontamination and decommissioning process equipment and further rehabilitation of working areas.

Based on laboratory research effective decontamination processes and agents have been developed and selected.

A package of measures has been taken for decommissioning the facility.

As a result of the D&D activities all rooms and “hot cells” was decontaminated, generated waste (more than 10 000 kg of lead, more than 10 000 another solid radioactive waste) sent for disposal.

INTRODUCTION

Since the mid-1940s VNIINM has been deeply involved in developing extraction techniques for the nuclear engineering of the USSR. During operation certain working areas and equipment became radioactive over permissible levels. As VNIINM is currently located within a thickly populated region of Moscow a decision has been made for their decontamination and decommissioning to protect the population against potential hazards. One of the primary D&D objectives was to demolish a facility (U-5) that was the first in the USSR to produce Pu (December 18, 1947). The facility was used to develop a technique for extracting plutonium from irradiated uranium and to optimize it for reducing into an industrial practice at the PA Mayak. In 1965 U-5 was put into a prolonged storage: it was preliminarily decontaminated and isolated by blocking doors and windows with bricks. But a few laboratories and hot cells have been used until recently to collect, store and condition VNIINM's radioactive waste and to perform D&D research. Fig.1 is an external view of the facility building.

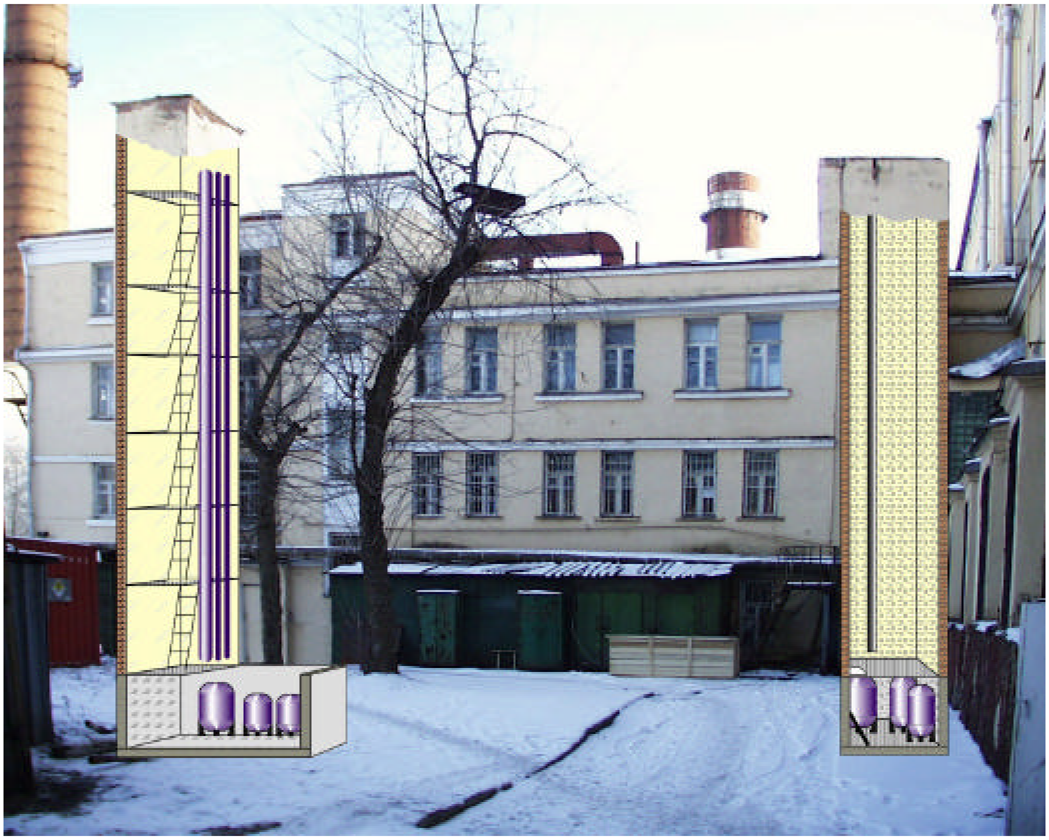

Fig 1. External view of the U-5 building.

Radioactive contaminants of various physical-chemical compositions penetrated structural materials of U-5 sometimes a distance of centimeters. Moreover, by the time the D&D activity had started little was known on the state, layout and contamination of the process equipment. In the initial stage attention was paid to retrieval of archives. The most contaminated and hazardous items of U-5 were shifts housing extraction columns and tanks, a dissolver compartment, a metering tank compartment, hot cells and several laboratory rooms. All glove boxes required decontamination.

PRELIMINARY STAGE

D&D activities were preceded by preliminary stages to monitor:

- radiation safety for personnel;
- effluents;
- environmental quality;
- dose rates;
- surface contamination of equipment and working areas ;
- airborne contamination;

Based on the radiation monitoring, safety precautions to be taken to protect the personnel, routes for movements and waste transportation, permissible occupancy time were identified.

EFFLUENT MONITORING

To meet rigid environmental requirements and standards for a thickly populated region, a special attention was placed on monitoring of:

- Radionuclide content of gaseous effluents;
- radionuclide content of liquid effluents;
- site and stack γ-dose rates;

ENVIRONMENTAL QUALITY MONITORING

The environmental quality monitoring involved the radionuclide content of:

- air near the ground;
- natural basin water;
- ground water;
- plants, bed loads;
- rainfall;

The monitoring covered the VNIINM site and adjacent populated area. No radionuclides in excess of the permissible level was detected during this rehabilitation work.

D&D PROCEDURE AND MEANS

The preliminary stage outlined general D&D approaches based on our experience gained [6,10-14]. The decision was made for a dry decontamination method with strippable PVA coatings. A starting film-forming agent contains aqueous polymer, plasticizer, surfactant and reactive additives and is applied on the surface by spraying, brushing or rolling on a 0.25-0.5 kg/m^2 basis. It takes 4-8 hr. to form a protective layer 100-150 µm thick. as a function of ambient temperature.

In cooperation with the Moscow State University a new IPEC-based amphiphilic polymer has been developed for immobilizing dusty surface contaminants.

Radioactive waste was routinely collected, packed into polyethylene sacks and transferred to a standard container next to the building. Then the container filled was monitored and transported by a special vehicle for disposal. Within the building radwaste transportation followed specified paths.

The floor and stair surfaces along the transportation paths were covered with protective polymeric films with sackcloth or gauze under it to add strength. Prior to removing contaminated equipment and decontaminating glove boxes the room surfaces of 300 m^3 were covered with polymeric coatings. The D&D area was fenced and restricted for 'B' personnel.

U-5 D&D ACTIVITIES

The D&D activity was initiated with the least contaminated laboratory rooms. Contaminated equipment with **a mean equivalent dose** of 0.1 to 1.2 **mR/hr** was withdrawn from exhaust hoods and glove boxes. The most radioactive items weighing 1500 kg were cemented into metallic cans for intermediate storage. Beforehand the floors and walls (150 m^2) were covered with protective polymeric coatings. As a result, 16 rooms decontaminated were accepted and certified by the Sanitary Epidemic Service (SES) for use as laboratory rooms. The table 1 demonstrates results of decontamination activities in lab room.

Table I. Radiation levels for the interior surfaces of the glove boxes of room 27

Glove-box No.	Before decontamination			After decontamination		
	a-part.min/cm^2 (non-fixed)	ß-part.min/cm^2	γ mR/hr	a-part.min/cm^2 (non-fixed)	ß-part.min/cm^2	γ mR/hr
1	As high as 20	As high as 10000	2,4	1	55	0,06
2	As high as 25	As high as 8000	3,0	1	55	0,06
3	As high as 10	As high as 50000	10,0	2	60	0,078

It should be noted that Cs-137, U-235, U-233, Pu-239, Sr-90, Co-60, etc. were responsible for radioactivity. The total area of internal glove box surfaces treated with polymers was 100 m^2. One decontamination cycle resulted in the residual activity satisfying the radiation safety standards. Before treatment the level of a-, ß- and ?-radiation was 500 part.min/cm^2, 11 000 part.min/cm^2 and 100 mR/hr., respectively.

For oil-painted surfaces decontamination solutions with PVA and alkali metal hydroxides were used.

At the second D&D stage the door openings leading to the shafts were unblocked. In shift 1 the surface of the areaway-canyon lined with stainless steel was most contaminated. U-235 and Pu-239 were the main contributors to radioactivity but Np-237, Ra-226, U-234, Am-241, Pu-238, Rn-222 were also detected. Non-fixed smear contamination was as great as 10 a-part/cm^2 min. Three tanks with the total capacity of 700 l and 400 kg of other equipment were decontaminated, dismantled and enclosed in polyethylene. The contamination level was 200-300 000 ß-part.min/cm^2, 5-50 aparticle.min./cm^2**, the mean equivalent** dose being 0.1-10.0 mR/hr. The total amount of collected metallic scrap (stainless steel) to be disposed of was 800 kg. The interior of the shift (above 50 m^2) was decontaminated by easily strippable polymeric coatings.

As for shift 2, U-235, Pu-239, Cs-137 and Sr-90 were major contaminants (60 a-part.min/cm^2, 500 ß-part.min./cm^2**, the mean equivalent dose** being as high as 0.1 mR/hr). The surface of metallic staircases and wall plasters (at a depth of ~3 cm) was contaminated. All plaster contaminated was to be demolished. To suppress dust, beforehand the walls were treated with interpolyelectrolyte complexes (MM-1, MJ-1). The plaster was chopped off by hand-operated electric tools adapted to radioactive operating conditions**. Portable garbage** cans were used to reduce the possibility of secondary contamination.

Fig 2. Application of dust-supressing polymers

Fig 3. Demolishing of contaminated plaster.

As the shafts build on the U-5 building supported its wall they could not be demolished. Therefore they were decontaminated with PVA-based solutions to permissible radiation standards.

D&D OF HOT CELLS, CONTROL AND SERVICE ROOMS

Two hot cells contained autoclaves for research under high pressure and temperature performed since the 60s and were cumbersome. The autoclaves of hot cell #1 were dismantled starting with the less contaminated areas by the following procedure:

- the hot cell was disconnected of electric cables and all utilities;
- water contained inside was sampled and analyzed;
- water was pumped;
- two mechanics dismantled three autoclaves with their connections by means of bench tools (screwdrivers, wrenches, hammers, cutters for low-diameter tubes), electric impact wrenches and hacksaws and packed the resulting solid garbage into polyethylene sacks;

Hot cell #2 of stainless steel and organic glass was decommissioned in view of its contamination by U-235. Before removing autoclaves following the procedure described for hot cell 1.their outer surfaces and the inner surface of hot cell 2 were treated with IPEC to localize the radioactivity.

Service station glove boxes were cleared of glasswork filled with radioactive samples, various reagents and solutions. The glasswork was cemented into metallic containers for safety. According to the regimented procedure **decommissioning** work underneath the hot cells comes before that inside them.

The lead shielding was stripped layer by layer under radiation monitoring. The resulting fractions were packed into Kraft-sacks for further disposal. After withdrawal of garbage the hot cell interior was decontaminated by readily strippable polymeric coatings.

Concurrently, the dissolution and metering tank compartments the control rooms and service rooms were put to D&D.

D&D OF THE METERING TANK COMPARTMENT

The metering tank compartment was located in a basement room measuring 16.8 m^2 (5.8 x 2.9 m). The room also accommodated 4 tanks for collection, storage and transportation of process solutions and liquid waste.

The metering tank and sensors were enclosed in a steel/lead protective box (0.9x0.9x0.9 m) fitted with a batch-metering tube and placed into a stainless steel glove-box surrounded by brick/lead protective casing. The glove box was additionally protected by lead doors weighing 90-100 kg. each. The metering tank was equipped with a system of inlet and outlet stainless steel pipes 12-14 mm in dia at a height of 1.5-1.7 m. There were also two interconnected cylinders jointed to the feeder in the glove box.

The first D&D stage involved measurements of contamination of equipment and room, selection of methods for dismantling the casing and connections, decontaminating and removing the equipment, specifying transportation routes. A team of two workers broke the brick/lead casing and dismantled the equipment while two others classified waste, placed into transportation casks and took them away.

Further the glove box was disconnected from pipelines and isolated by plugging or rolling with a special cutter.

Finally, the inner fittings (doors, pipelines and heavy metering tank elements) were withdrawn to facilitate the removal of the glove-box proper (Fig 4).

Fig. 4. Metering tank casing dismantling

All inner surfaces of the metering tank were treated with our earlier developed decontaminating strippable PVA coatings. Beforehand brickwork was treated with aqueous IPEC-based solutions to suppress dust. Contamination levels inside the metering tank as high as $1*10^5$ ß-part.min/cm^2, 13 mR/hr for γ-radiation and 22-5 a-part.min/cm^2 were caused by Cs-137.

Types and amount of solid radioactive wastes removed from the main U-5 rooms includes in table 2

RESULTS

- The first Soviet semi-commercial Pu-239 extraction facility located within a thickly populated region was decommissioned.
- A multipurpose technology was developed for D&D of U-5, methods and polymeric compositions was created for decontamination and immobilization of contaminated surfaces. A new polymeric agent developed in cooperation with MSU.
- Radiation monitoring showed no abnormal events or radioactive releases into the environment during the D&D work.
- The surface of the shafts (160 m^2) was decontaminated to produce 1 735 kg of solid waste. The shafts decontaminated were certified.

- The experimental equipment of two hot cells was decommissioned. The surface (63 m^2) of hot cells, control and service rooms was decontaminated and certified. The waste amount was 2 226 kg.
- The dissolution equipment was decommissioned and removed to produce above 500 kg of waste.
- The equipment of the metering tank compartment was decommissioned to produce 2 768 kg of solid waste. The compartment room (20 m^2) was rehabilitated.
- 16 laboratory rooms with a total area of 300 m^2 were rehabilitated and certified. The amount of waste removed exceeded 7 000 kg.
- All rooms rehabilitated were certified and accepted by SES for further use.

Table II. Type And Amount Of Radioactive Wastes Removed From U-5

Waste type	***Waste amount, kg***				
	Shafts	**Hot cells**	**Dissolver compartment**	**Metering tank compartment**	**Room #27**
Plaster, cement	**325**				
Wood, paper	**250**	**5**	**31**		**84**
Polyethylene	**115**	**20**	**26**		**70**
Stainless steel	**400**	**650**	**25**	**28**	**25**
Carbon steel	**250**	**16**	**89**		**255**
Electric cable	**105**	**40**	**0**		
Lead		**1250**	**165**	**2280**	**4543**
Class, porcelain		**30**	**17**		**166**
Refuse (brick)	**90**	**0**	**0**	**450**	
Rubber		**15**	**10**		**25**
Other trash	**200**	**200**	**50**	**10**	**200**
Total	**1735**	**2226**	**413**	**2768**	**5368**
			12510		