

APPLICATION OF PROTECTIVE AND DECONTAMINATING POLYMERIC FILMS FOR D&D OF CONTAMINATED SERVICE ROOMS

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ABSTRACTS

Cleanup of incidentally contaminated laboratory equipment and service room remediation are of concern in nuclear engineering. In the past radionuclide contaminated equipment and rooms were put to long storage without resorting to dismantling, which presented potential radiation risk to the personnel. A remediation procedure involving decontamination of equipment to be removed out of service and dismantled has been developed and tested by VNIINM.

A laboratory room in which alpha- emitting nuclides have been handled for 30 years was used for demonstration of the procedure. In the mid-80s an incidental glove-box failure resulted in release of alpha-activity into the room even though the incident was soon brought under control. It was decided to decontaminate and dismount the equipment and to remediate the room using the procedure developed.

Our previous experience suggested that routine cleanup from alpha-contaminants by liquids was inadequate because of large amounts of secondary liquid waste and potential dispersion of radioactivity.

Polymeric coats and pastes developed by our Institute as immobilizing and decontaminating agents are much more attractive for these purposes [1-3].

PRELIMINARY LABORATORY RESEARCH

Materials typical of those present in the room under consideration were used for research (plasticated rubber, stainless steel (12Kh18T10N), carbon steel, oil painted materials). Sheets 20 by 20 mm were used as samples. They were treated with an aqueous soda- surfactant mixture and distilled water, air-dried and rubbed with ethylene alcohol. Then the samples were contaminated with fine powdered mixed U-Pu oxides (20% PuO₂) . Some of them were contaminated drop-wise with Pu nitrate solution. Actual materials sampled from the room were also tested. The total and coherent α -radioactivity was measured by radiometric scintillation detector and smear methods, respectively. During experiments the polymeric compositions and special dopes were specified. Special dopes

are dictated by the function of a coat to be applied: complexing agents and sorbing fillers are needed for a protective immobilizing film and a combination of organic and mineral acids or oxidants for developing a desorbing-etching film (DEF) depending on the nature of material to be decontaminated. For instance, DEF-1 is suitable for decontaminating masticated rubber and steel surfaces while DEF-2 is more advisable for oil-painted materials. The adhesion of coats was preliminary tested on clean surfaces of the above mentioned materials measuring 150 x 80 mm.

Laboratory physical-mechanical experiments show that the time for a polymeric film to be developed is 4 -8 hours at 20 C and a relative humidity of 70%. Under these conditions a film ~100 mkm thick remains its protective properties for more than 100 days, the film-to-surface adhesion being 1 -2 g/cm. It is evident from these data that the polymeric film-application procedure can be used for immobilizing contaminants to prevent their spread during the process of dismounting equipment.

The decontamination efficiency of DEFs has been shown to compare favorably with a commercial cleaning agent «Zashchita» (Table 1 and 2).

Table 1

Mixed U-Pu oxide - contaminated surfaces cleanup

<i>Stainless steel</i>						
<i>Decontaminating agent</i>	<i>Initial contamination, Bq/cm²</i>	<i>1 decontaminating cycle</i>		<i>2 decontaminating cycle</i>		
		<i>Residual contamination Bq/cm²</i>	<i>K_{d1}</i>	<i>Residual contamination Bq/cm²</i>	<i>K_{d2}</i>	<i>K_{d total}</i>
<i>DEF-1</i>	285	4	71	background	-	-
	274	2	134	background	-	-
	301	14	22	background	-	-
<i>Zashchita</i>	260	50	5	33	1,5	8
	196	22	9	5	4	39
	296	25	12	8	3	37
<i>Carbon steel</i>						
<i>DEF-1</i>	299	2	149	background	-	-
	190	1	1290	background	-	-
	216	3	72	background	-	-
<i>Zashchita</i>	173	10	17	8	1	22
	224	45	5	34	1	7
	211	34	7	12	3	18
<i>Oil-painted surface</i>						
<i>DEF-2</i>	209	6	35	background	-	-
	180	4	45	background	-	-
	196	3	65	background	-	-
<i>Zashchita</i>	176	9	20	4	2	44
	146	8	18	4	2	37
	191	12	17	6	2	32

Table 2

Pu-239 nitrate-contaminated surfaces cleanup

<i>Stainless steel</i>						
<i>Decontaminating agent</i>	Initial contamination, Bq/cm ²	1 decontaminating cycle		2 decontaminating cycle		
		Residual contamination Bq/cm ²	K _{d1}	Residual contamination Bq/cm ²	K _{d2}	K _{d total}
<i>DEF-1</i>	140	background	-	background	-	-
	427	background	-	background	-	-
	371	background	-	background	-	-
<i>Zashchita</i>	272	4	68	2	2	136
	312	10	31	8	1,2	40
	264	5	53	2	2,5	132
<i>Carbon steel</i>						
<i>DEF-1</i>	189	background	-	-	-	-
	170	background	-	-	-	-
	177	background	-	-	-	-
<i>Zashchita</i>	201	3	67	1	3	201
	166	2	83	1	2	166
	186	2	93	1	2	186
<i>Oil-painted surface</i>						
<i>DEF-2</i>	119	background	-	-	-	-
	130	background	-	-	-	-
	160	background	-	-	-	-
<i>Zashchita</i>	138	14	10	11	1	12
	124	6	20	5	1	25
	119	5	24	4	1	29

It can be seen that in all cases under study the residual contamination level is within the limits of background radioactivity and of experimental error ($< 0.2 \text{ Bq/cm}^2$) [4]. Besides, the procedure gives no way of producing even small amounts of secondary liquid waste. The practical implementation has confirmed these experimental results.

Relying on these tests detailed regulations for decontaminating equipment dismantled and for remediating service rooms have been developed and demonstrated.

Remediation Procedure Demonstration.

One of VNIINM's laboratory rooms which had been put to prolonged storage after an incidental alpha-radioactivity release was chosen for demonstration. At first, the radioactivity levels inside the room on all the surfaces was measured. On outer surfaces, the alpha-activity was 1-15 α -particles/min.cm², the gamma- activity varied from 720 to 2880 mkrem/s. The room was equipped with instrumentation and apparatuses located in three chains of glove-boxes and hot cells for handling Pu-bearing materials. As far as inner surfaces were concerned, the incoherent radioactivity ranged from 2 10^3 α -particles/min.cm² to 200-800 α -particles/min.cm². Continuous checks of the airborne radioactivity and the personnel residence time inside the room were performed. Solid waste (stucco, equipment etc.) was collected, classified and transported in containers for disposal.

Then the decontamination and remediation procedure was initiated following strict regulations [6]:

- Extensive evacuation of glove-boxes and hot cells to avoid a potential risk of radioactivity dispersion to the environment during the process of dismantling;
- applying of a protective immobilizing coat by brushing or flowing on outer surfaces of the equipment, walls and floor;
- removing the gloves ;
- applying protective polymeric coats inside the boxes;
- disconnecting the chains into separate units;
- dismantling of each box and its support;
- placing the parts dismantled into containers;
- container transporting for disposal;
- decontaminating the surface of walls and floor with DEFs.

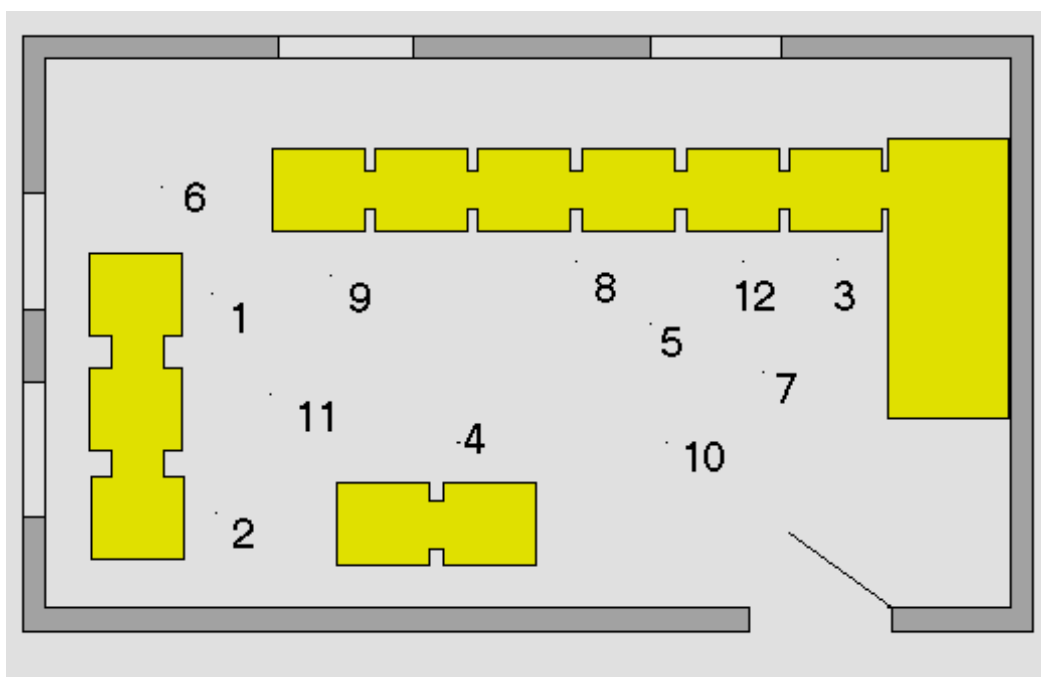


Fig 1. The map of the contaminated room (* - measurement points, see table 3)

The results of decontaminating activity are given in Table 3.

Table 3

Masticated rubber decontamination efficiency by DEFs

N_0^*	<i>Initial coherent contamination, α-particles/min.cm² radiometry/smear</i>	<i>Residual contamination, α-particles/min.cm² radiometry/smear</i>		
		1 cycle	2 cycle	3 cycle
1	50/15	5/1	background	
2	>150/40	25/12	2,5/1	background
3	150/15	5/background	background	
4	150/15	30/5	3/1	1/background
5	150/30	35/12	2/background	2/background
6	150/30	40/13	4,5/2,5	3/0,75
7	150/15	23/12	15/9	4/2
8	70/15	13/9	4/2,5	2/1
9	>150/85**	15/10	12/background	8/background
10	>150/100	20/12	10/background	
11	> 150/75	15/фон		
12	> 150/150	60/5	40/0,5	3/фон

- * contamination map points;
- pre-incidental masticated rubber;

It follows from Table 3 that low coherent (smeared) radioactivity was completely removed for the most part, the residual coherent contamination was within permissible standards (5α -particles/min.cm²) [4].

During the remediation activities the airborne radioactivity was routinely permissible but became twice as great after disclosing glove-boxes and before applying protecting polymeric films. About 600 m² of polymeric materials and seven containers for solid waste (2500 kg) were used.. Characteristics of the room prior to and after remediation are reported in Table 4.

Table 4

Characteristics of the room prior to and after remediation

<i>N^o</i>	<i>Characteristics</i>	<i>Data</i>
1	Room condition prior to remediation	creviced ceiling and walls, contaminated surfaces
2	Area	150 m ²
3	Number of glove-boxes	14
4	Outer surface alpha-radiation before remediation, α -particles/min.cm ²	1-15
5	Exposure dose rate before remediation, mkR /h	720-2880
6	Inner incoherent alpha- radiation before remediation α -particles/min.cm ²	1000-3000
7	Film-coated surface area, (m ²)	600
8	Alpha-radiation of coated surfaces, α -particles/min.cm ²	background
9	Total amount of solid radwaste for disposal , kg	2500
10	Amount of liquid radwaste immobilized, l	10
11	Alpha-radiation after remediation	background

The room remediated was inspected, accepted and prepared for repair and further use.

CONCLUSIONS

Classical decontamination techniques resulting in large amounts of secondary liquid waste are not adequate for remediating alpha-contaminated rooms and equipment. The use of polymeric coats is much more attractive. Polymeric compositions containing special dopes can be applied on a contaminated surface by brushing or flowing. When

dry, a polymerized elastic film developed prevents the radioactivity dispersion in the course of dismounting contaminated equipment.

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