Mixed Isotope Decontamination Using CBI Decon Gel 1101 and 1121 on Multiple Surfaces at ALARON Nuclear Services

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Introduction

Alaron Nuclear Services and Cellular Bioengineering (CBI) conducted a field study to evaluate the use and efficacy of CBI's Decon Gel; both the brush applied and the spray applied versions were employed. The purposes of this field study were to:

- Decontaminate multiple types of equipment, tools, storage containers and a fuel cask in a commercial setting.
- Determine decontamination efficacy of Decon Gel in Department of Energy (DOE) relevant end uses.
- Assess overall operational costs for decontamination using Decon Gel.

Alaron is engaged in nuclear services related to power generation and those that service the industry. One of its services is the decontamination and refurbishment of equipment, tools, storage containers and fuel casks at its NRC-licensed facility in Wampum, PA.



Summary Results

Multiple surfaces and items were decontaminated utilizing Decon Gel with impressive results. With the exception of the Zircaloy-4 Fuel Pellet Tubes, 90-100% reduction in loose activity was achieved in all other tests.

Highlights include:

1. 90% reduction of loose beta contamination on the cylindrical surface of an Nuclear Assurance Corporation (NAC) National Lead Industry (NLI) storage cask.
2. 98% reduction of loose beta contamination on the soiled cap of an NAC NLI storage cask.
3. 99% reduction of loose beta contamination on the bare concrete floor of the heavily used Ronald. J. Macerelli (RJM) containment area.

Overall operational costs, reduction in man-dose exposure and implementation into Alaron's work plan are currently under evaluation.

Summary Results Table

Facility/Equipment Decontaminated	Loose Beta % Activity Removal TOTAL DECON	Fixed Beta % Activity Removal TOTAL DECON	Loose Alpha % Activity Removal TOTAL DECON	Fixed Alpha % Activity Removal TOTAL DECON
NAC NLI Cask	90			
NAC NLI Cask End Cap	98			
NAC Cask Trunion Leg	100	80		
RJM Containment Area	99.1	60.7	93.9	87.1
Braidwood Fuel Rack Chevron	92	59		
Pilgrim Condensate Pump Impeller Shim	100	87		
Zircaloy-4 Fuel Pellet Tubes			72	71
Control Rod Drive Transport Containe	90	96		
Pilgrim Condensate Pump Collar	99.6	92.4		

Experimental Method

Decon Gel 1101 or 1121 was applied via various methods to a variety of surfaces as described in the individual section reports below. The surfaces were assayed before and after decontamination.

Loose contamination was assayed using 47 mm glass fiber smears, over an area of about 100 cm^2. Fixed contamination was assayed by placing the detector directly over the contamination. The results are in CPM/probe area. The same areas were surveyed after the removal of the decon gel.

Surveys were performed with a Ludlem Model 177Alarming Rate Meter equipped with an alpha or beta probe/detector.

The beta probe/detector employed was a Ludlem model 44-9 Geiger Muller "Pancake probe". The detector has an active area of 16 cm^2 with a 2 mg/cm^2 Mica window. Nominal efficiency is 10% for ^{99}Tc betas. The LLD (Lower limit of Detection) is 800 dpm/16 cm^2 or 5000 dpm/100 cm^2 with a maximum background of 140 CPM. Dead time losses are about 5% for 10,000 CPM, correction is not warranted.

The alpha probe/detector employed was a Ludlem model 43-5 ZnS(Ag) scintillation detector. The detector has an active area of 50 cm^2 with a 0.8 mg/cm^2 mylar window. Nominal efficiency is 12% for Pu-239 alphas. The LLD is 200 dpm/100 cm^2 with a maximum background of 3 CPM. Dead time losses in the counting range (100 to 1000 CPM) are non existent.

All efficiencies are in a 2 pie geometry. Both meters were in calibration, and source checked prior to use.

NAC NLI Cask

A NLI cask, used to transport spent fuel, was decontaminated with DeconGel 1101 and 1121. The principal isotopes on the exterior of the cask were Cs-137, Cs-134, Co-60, Mn-54, Ag-110m and Zn-65. The cask exterior was constructed from grade-316 stainless steel.

Decon Gel 1101 was applied to the left portion of the cask (Locations 1-6) with a common paint brush. The middle and right hand portions of the cask (Locations 7-17) were sprayed with Decon Gel 1121 with a GRACO UltraMax 795 airless sprayer equipped with a 0.021" tip at 3300 psi. Both products were allowed to dry for 18-24 hours.

Direct readings with a Geiger meter were not performed due to the background radiation from the contaminated cask interior.

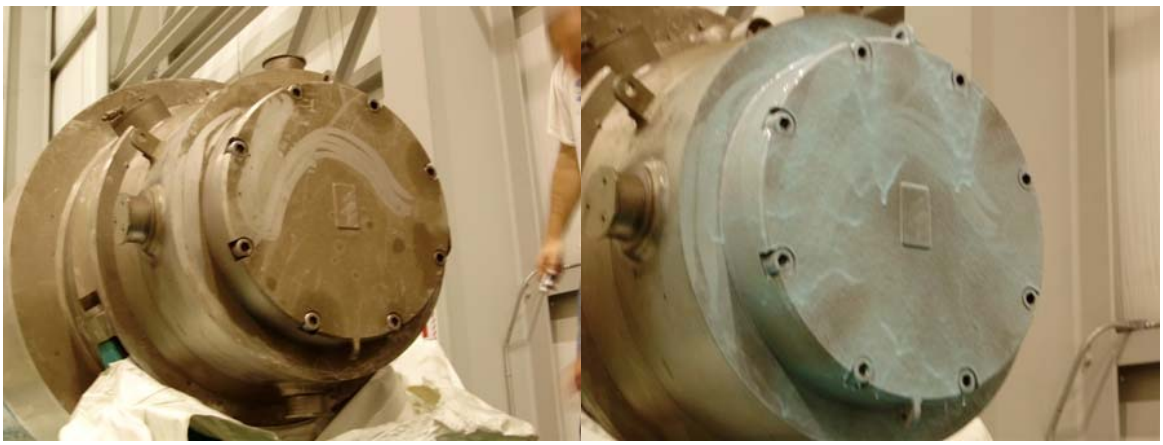
Removal of the dried film yielded an average decrease in the activity of loose contamination of 90%.

Location	Loose beta activity (dpm/100cm^2) PRE-DECON	Loose beta activity (dpm/100cm^2) POST-DECON	Loose beta % Activity Removal TOTAL DECON
1	2,808	55	98
2	1,013	78	92
3	995	75	92
4	745	285	62
5	985	113	89

6	578	40	93
7	385	133	66
8	675	23	97
9	1,945	50	97
10	2,723	35	99
11	1,003	45	96
12	825	80	90
13	728	95	87
14	1,225	73	94
15	1,063	60	94
16	1,100	70	94
17	2,998	35	99
18	1,698	65	96
19	468	208	56
20	1,140	105	91
21	1,360	23	98
22	1,138	95	92
23	585	73	88
24	1,183	28	98
25	678	65	90
26	1,068	95	91
27	2,070	88	96
Average	1,229	**81**	**90**

NAC NLI Cask End Cap

The end of the NAC NLI cask was sprayed with Decon Gel 1121. This differed from the decontamination of the side of the cask in that the surface of the cask end cap had a visible layer of dark oily dirt, whereas the sides initially had a clean appearance. Removal of the dried film yielded an average decrease in activity of loose contamination of 98% and removed the oily dirt layer resulting in a clean surface.



Location	Loose beta activity (dpm/100cm^2) PRE-DECON	Loose beta activity (dpm/100cm^2) POST-DECON	Loose beta % Activity Removal TOTAL DECON
1	30,000	800	97
2	30,000	700	98
3	30,000	700	98
Average	30,000	733	98

NAC Cask Trunion Leg

An aluminum NAC cask trunion leg, used as a part of the lifting yoke to place and remove a cask from the fuel pool, was decontaminated with DeconGel 1101 applied with a common paint brush. The principal isotopes on the support were Cs-137, Cs-134, Co-60, Mn-54, Ag-110m and Zn-65.

Removal of the dried film yielded an average decrease of fixed contamination of 54% and loose contamination of 100%. The gel was reapplied and removal of the dried film yielded an average total decrease of fixed contamination of 80%.

	First application			Second application		
	Fixed beta	**Fixed beta**	**Fixed beta**	**Fixed beta**	**Fixed beta**	**Fixed beta**
Location	activity (cpm/probe) **PRE-DECON**	activity (cpm/probe) **POST- 1st DECON**	% Activity Removal **POST- 1st DECON**	activity (cpm/probe) **POST- 2nd DECON**	% Activity Removal **POST- 2nd DECON**	% Activity Removal **TOTAL DECON**
1A	12,000	4,000	67	2,000	50	**83**
2A	15,000	8,000	47	4,000	50	**73**
3A	40,000	10,000	75	4,000	60	**90**
1B	14,000	8,000	43	4,000	50	**71**
2B	22,000	14,000	36	5,000	64	**77**
3B	22,000	10,000	55	3,000	70	**86**
Average	**20,833**	**9,000**	**54**	**3,667**	**57**	**80**

	First application			Second application		
	Loose beta	**Loose beta**	**Loose beta**	**Loose beta**	**Loose beta**	**Loose beta**
Location	activity (dpm/100cm^2) **PRE-DECON**	activity (dpm/100cm^2) **POST- 1st DECON**	% Activity Removal **POST- 1st DECON**	activity (dpm/100cm^2) **POST- 2nd DECON**	% Activity Removal **POST- 2nd DECON**	% Activity Removal **TOTAL DECON**
1A	280,000	800	100	600	25	**100**
2A	140,000	900	99	700	22	**100**
3A	250,000	700	100	600	14	**100**
1B	160,000	700	100	600	14	**100**
2B	160,000	900	99	800	11	**100**
3B	120,000	700	99	600	14	**100**
Average	**185,000**	**783**	**100**	**650**	**17**	**100**

RJM Containment Area

The RJM containment area at ALARON Nuclear Services, used to process (cut, grind, etc.) highly contaminated materials, was decontaminated with DeconGel 1101 (Locations 1-3, 7-12)

and 1121 (Locations 4-6). The principal isotopes on the unsealed concrete slab were Cs-137, Cs-134, Co-60, Mn-54, Fe-55, Ni-63, Ni-59, Zn-65, Zr-95, U-238, U-234.

Decon Gel 1101, applied with a stand up trowel, peeled from the bare concrete floor very easily. Decon Gel 1121 peeled, but was more difficult due to insufficient film thickness. Removal of the dried film yielded an average decrease of fixed alpha contamination of 87%, fixed beta contamination of 61%, loose alpha contamination of 94% and loose beta of 99%.

Location	Fixed beta activity (cpm/probe) PRE-DECON	Fixed beta activity (cpm/probe) POST-DECON	Fixed beta % Activity Removal TOTAL-DECON	Fixed alpha activity (cpm/probe) PRE-DECON	Fixed alpha activity (cpm/probe) POST-DECON	Fixed alpha % Activity Removal TOTAL DECON
1	3,000	1,000	66.7	100	6	94.0
2	11,000	4,000	63.6	80	6	92.5
3	17,000	1,000	94.1	80	6	92.5
4	7,000	1,000	85.7	240	20	91.7
5	4,000	1,000	75.0	240	50	79.2
6	11,000	6,000	45.5	240	6	97.5
7	24,000	14,000	41.7	300	50	83.3
8	54,000	29,000	46.3	360	80	77.8
9	5,000	2,000	60.0	500	80	84.0
10	3,000	2,000	33.3	150	10	93.3
11	6,000	3,000	50.0	150	50	66.7
12	3,000	1,000	66.7	400	30	92.5
Average	12,333	5,417	60.7	237	33	87.1

Readings were background corrected.

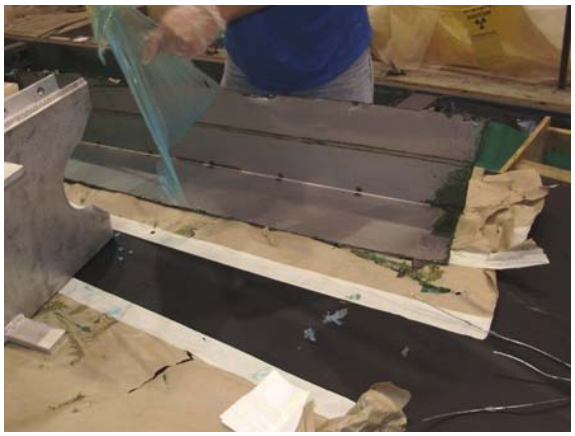
Location	Loose beta activity (dpm/100cm^2) PRE-DECON	Loose beta activity (dpm/100cm^2) POST-DECON	Loose beta % Activity Removal TOTALDECON	Loose alpha activity (dpm/100cm^2) PRE-DECON	Loose alpha activity (dpm/100cm^2) POST-DECON	Loose alpha % Activity Removal TOTAL DECON
1	130,000	800	99.4	500	60	88.0
2	100,000	600	99.4	200	50	75.0
3	120,000	600	99.5	500	60	88.0
4	80,000	700	99.1	800	20	97.5
5	60,000	500	99.2	800	20	97.5

6	120,000	600	99.5	1000	30	97.0
7	70,000	800	98.9	1500	40	97.3
8	80,000	800	99.0	1600	20	98.8
9	80,000	900	98.9	2200	30	98.6
10	50,000	900	98.2	1200	30	97.5
11	50,000	500	99.0	600	40	93.3
12	60,000	600	99.0	1800	30	98.3
Average	83,333	692	99.1	1,058	36	93.9

Braidwood Fuel Rack Chevron

A grade-316 stainless steel Braidwood fuel rack chevron, used to store spent fuel inside of the fuel pool, was decontaminated with DeconGel 1101 applied with a common paint brush. The principal isotopes on the support were Cs-137, Cs-134, Co-60, Mn-54, Fe-55, Ni-63, Ni-59, Zn-65, Zr-95.

Removal of the dried film yielded an average decrease of fixed contamination of 36% and loose contamination of 76%. The gel was reapplied and removal of the dried film yielded an average total decrease of fixed contamination of 59% and loose contamination of 92%.



	First application			Second application		
	Loose beta	**Loose beta**	**Loose beta**	**Loose beta**	**Loose beta**	**Loose beta**
Location	activity (dpm/100cm^2) **PRE-DECON**	activity (dpm/100cm^2) **POST- 1st DECON**	% Activity Removal **POST- 1st DECON**	activity (dpm/100cm^2) **POST- 2nd DECON**	% Activity Removal **POST- 2nd DECON**	% Activity Removal **TOTAL DECON**
1	160,000	3,000	98	1,000	67	99
2	140,000	18,000	87	800	96	99
3	50,000	3,000	94	1,000	67	98
4	70,000	20,000	71	900	96	99
5	100,000	3,000	97	1,000	67	99

6	40,000	15,000	63	900	94	98
7	8,000	2,000	75	700	65	91
8	10,000	2,000	80	800	60	92
9	6,000	2,000	67	900	55	85
10	5,000	1,500	70	700	53	86
11	3,000	1,500	50	700	53	77
12	4,000	1,500	63	700	53	83
Average	49,667	6,042	76	842	69	92

	First application			**Second application**		
	Fixed beta	**Fixed beta**	**Fixed beta**	**Fixed beta**	**Fixed beta**	**Fixed beta**
Location	activity (cpm/probe)	activity (cpm/probe)	% Activity Removal	activity (cpm/probe)	% Activity Removal	% Activity Removal
	PRE-DECON	**POST- 1st DECON**	**POST- 1st DECON**	**POST- 2nd DECON**	**POST- 2nd DECON**	**TOTAL DECON**
1	15,000	3,000	80	1,500	50	90
2	8,000	3,000	63	1,500	50	81
3	4,000	3,000	25	2,500	17	38
4	10,000	6,000	40	2,500	58	75
5	5,000	3,000	40	1,500	50	70
6	4,000	2,000	50	1,300	35	68
7	5,000	5,000	0	4,000	20	20
8	6,000	5,000	17	3,500	30	42
9	6,000	5,000	17	3,000	40	50
10	2,500	1,500	40	600	60	76
11	3,000	2,000	33	1,600	20	47
12	3,000	2,000	33	1,500	25	50
Average	5,958	3,375	36	2,083	38	59

Pilgrim Condensate Pump Impeller Shim

A series 304 stainless steel Pilgrim condensate pump impeller shim, from a condensate pump which heats and supplies water to the steam generator or reactor, was decontaminated with DeconGel 1101 applied with a common paint brush. The principal isotopes on the shim were Cs-137, Cs-134, Co-60, Mn-54, Fe-55, Ni-63, Ni-59, Sr-90, Co-58.

Removal of the dried film yielded an average decrease of fixed contamination of 79% and loose contamination of 96%. The gel was reapplied and removal of the dried film yielded an average total decrease of fixed contamination of 87% and loose contamination of 100%.

	First application			Second application		
	Fixed beta	**Fixed beta**	**Fixed beta**	**Fixed beta**	**Fixed beta**	**Fixed beta**
Location	activity (cpm/probe) **PRE-DECON**	activity (cpm/probe) **POST- 1st DECON**	% Activity Removal **POST- 1st DECON**	activity (cpm/probe) **POST- 2nd DECON**	% Activity Removal **POST- 2nd DECON**	% Activity Removal **TOTAL DECON**
1	10,000	1,800	82	800	56	92
2	24,000	1,000	96	600	40	98
3	10,000	3,800	62	3,000	21	70
4	12,000	3,000	75	1,500	50	88
Average	14,000	2,400	79	1,475	42	87

	First application			Second application		
	Loose beta	**Loose beta**	**Loose beta**	**Loose beta**	**Loose beta**	**Loose beta**
Location	activity (dpm/100cm^2) **PRE-DECON**	activity (dpm/100cm^2) **POST- 1st DECON**	% Activity Removal **POST- 1st DECON**	activity (dpm/100cm^2) **POST- 2nd DECON**	% Activity Removal **POST- 2nd DECON**	% Activity Removal **TOTAL DECON**
1	200,000	8,000	96	700	91	100
2	200,000	6,000	97	800	87	100
3	200,000	8,000	96	800	90	100
4	200,000	8,000	96	900	89	100
Average	200,000	7,500	96	800	89	100

Zircaloy-4 Fuel Pellet Tubes

Zirconium Alloy (Zircaloy-4), used for placement of fuel pellets, was decontaminated with DeconGel 1101 applied with a common paint brush or dipping. The tubes were already split open as the first step in the currently employed sand blasting decontamination method. The principal isotopes on the tubes were U-235, U-234, U-238.

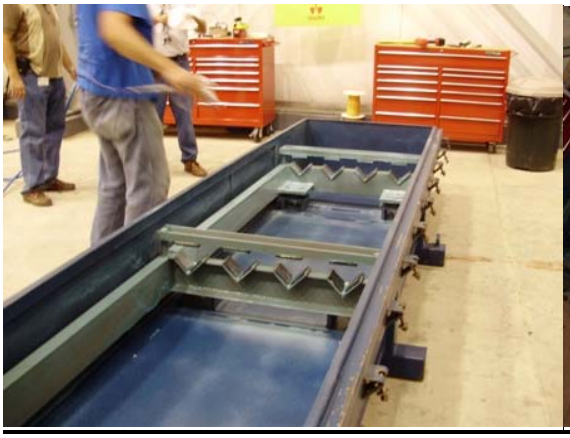
Removal of the dried film yielded an average decrease of fixed contamination of 71% and loose contamination of 72%.

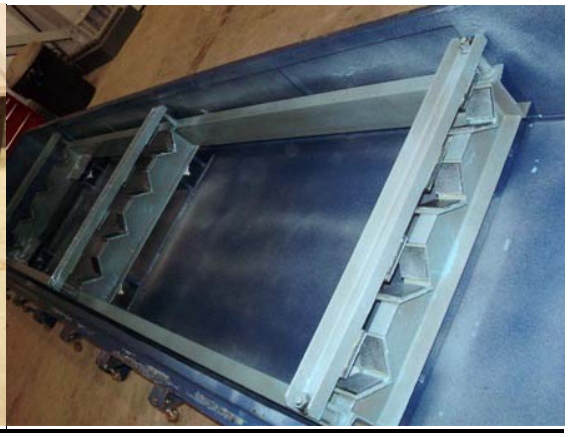
Location	Fixed Alpha activity (dpm/100cm^2) PRE-DECON	Fixed Alpha activity (dpm/100cm^2) POST-DECON	Fixed Alpha % Activity Removal TOTAL DECON	Loose Alpha activity (dpm/100cm^2) PRE-DECON	Loose Alpha activity (dpm/100cm^2) POST-DECON	Loose Alpha % Activity Removal TOTAL DECON
1	500	200	60	300	80	73
2	600	250	58	200	60	70
3	600	100	83	200	60	70
4	800	150	81	200	50	75
Average	625	175	71	225	63	72

Control Rod Drive Transport Container

A control rod drive transport container, used for transportation of CRDM's, was decontaminated with DeconGel 1121 that was spray applied with a GRACO Ultra Max 795 airless sprayer. The container surfaces were composed of painted carbon steel. The principal isotopes on the box were Cs-137, Cs-134, Co-60, Mn-54, Fe-55, Ni-63, Ni-59, Sr-90, Co-58.

Removal of the dried film yielded an average decrease of fixed contamination of 96% and loose contamination of 90%.





Location	Fixed beta activity (dpm/100cm^2) PRE-DECON	Fixed beta activity (dpm/100cm^2) POST-DECON	Fixed beta % Activity Removal TOTAL DECON	Loose beta activity (dpm/100cm^2) PRE-DECON	Loose beta activity (dpm/100cm^2) POST-DECON	Loose beta % Activity Removal TOTAL DECON
1	5000	80	98	10000	800	92
2	5000	70	99	3000	700	77
3	7000	100	99	5000	800	84
4	10000	100	99	8000	800	90
5	800	90	89	5000	600	88
6	5000	800	84	40000	800	98
7	6000	90	99	35000	800	98
8	5000	80	98	25000	700	97
Average	5475	176	96	16375	750	90

Pilgrim Condensate Pump Collar

A series 304 stainless steel Pilgrim condensate pump collar, from a condensate pump which heats and supplies water to the steam generator or reactor, was decontaminated with DeconGel 1101 applied by dipping or a common paint brush. The principal isotopes on the shim were Cs-137, Cs-134, Co-60, Mn-54, Fe-55, Ni-63, Ni-59, Sr-90, Co-58.

Removal of the dried film yielded an average decrease of fixed contamination of 85.2% and loose contamination of 99.6%. The gel was reapplied and removal of the dried film yielded an average total decrease of fixed contamination of 92.4% and loose contamination of 99.6%.

	First application			Second application		
	Fixed beta	**Fixed beta**	**Fixed beta**	**Fixed beta**	**Fixed beta**	**Fixed beta**
Location	activity (cpm/probe) **PRE-DECON**	activity (cpm/probe) **POST- 1st DECON**	% Activity Removal **POST- 1st DECON**	activity (cpm/probe) **POST- 2nd DECON**	% Activity Removal **POST- 2nd DECON**	% Activity Removal **TOTAL DECON**
1	**16,000**	3,500	78.1	2,000	42.9	**87.5**
2	**40,000**	4,000	90.0	1,000	75.0	**97.5**
3	**8,000**	1,500	81.3	1,000	33.3	**87.5**
4	**12,000**	1,500	87.5	800	46.7	**93.3**
5	**12,000**	2,000	83.3	800	60.0	**93.3**
6	**20,000**	1,800	91.0	1,000	44.4	**95.0**
Average	**18,000**	**2,383**	**85.2**	**1,100**	**50.4**	**92.4**

	First application			Second application		
	Loose beta	**Loose beta**	**Loose beta**	**Loose beta**	**Loose beta**	**Loose beta**
Location	activity (dpm/100cm^2) **PRE-DECON**	activity (dpm/100cm^2) **POST- 1st DECON**	% Activity Removal **POST- 1st DECON**	activity (dpm/100cm^2) **POST- 2nd DECON**	% Activity Removal **POST- 2nd DECON**	% Activity Removal **TOTAL DECON**
1	**200,000**	700	99.7	700	0.0	**99.7**
2	**200,000**	800	99.6	800	0.0	**99.6**
3	**200,000**	1,000	99.5	1,000	0.0	**99.5**
4	**200,000**	1,000	99.5	900	10.0	**99.6**
5	**200,000**	1,000	99.5	1,000	0.0	**99.5**
6	**200,000**	900	99.6	900	0.0	**99.6**
Average	**200,000**	**900**	**99.6**	**883**	**1.7**	**99.6**