Idaho National Laboratory
MFC Manipulator Decontamination Improvement Program
Permanent Decontamination Facility Modifications

Background

The primary area of concern is the repair of slave arms in the Fuel Conditioning Facility and to a lesser extent the Hot Fuels Examination Facility. Both of these facilities use two types of manipulators which are resulting in elevated radiation levels during repairs of the slave arms.

The primary manipulator at this facility is a Model J manufactured by Central Research Laboratory. The manipulator is a 3 piece unit with a master arm, seal tube, and slave arm. The slave arm, located in the cell, is a high repair rate item, removed from the cell, and repaired in a glove box specifically designed for slave repair. Prior to repairs the manipulator is decontaminated in the decontamination spray chamber (DSC) using a high pressure wash system. The manipulator is staged for repair in a room adjacent to the repair glove box called the FCF Suited Entry Repair Area (SERA) or HFEF Hot Repair Area (HRA) The model J manipulator is manufactured from aluminum and stainless steel. This manipulator type represents approximately ¾ of the manipulators in use at these facilities.

The second manipulator used and repaired in the glove boxes is the System 50 also manufactured by Central Research Laboratory. The manipulator is again a three piece manipulator and is similar in construction and is currently decontaminated as discussed above.

In addition to the master slave manipulators, these facilities have overhead electro mechanical manipulators (EMMs) and cranes. Components from the overhead EMMs and cranes are remotely removed from the bridges and wiped down in cell to remove gross contamination. These components are then transferred into the SERA or HRA and contact decontaminated via suited entry. The EMM and crane components are not designed for high pressure spray and are primarily painted carbon steel.

Currently, hot spot dose rates are approximately 300 – 1,200 mr/hr gamma and 25-41 R/hr beta on contact with general area around 2-10 mr/hr. The principal beta emitting radionuclides are comprised of Sr 89,90;Y 90,91;Cs 134,136,137;La140; Ce 144; Pr 144; Pm 147; and Sm 151.

Improvements in existing decontamination processes at Idaho National Laboratory's (INL) Materials and Fuels Complex (MFC) is necessary for lower worker whole body and extremity dose. The improvements will be carried out under the Manipulator Decontamination Improvement Program (MDIP). Idaho National Laboratory has contracted Environmental Alternatives, Inc. (EAI) to furnish the recently developed and licensed Rad-Release decontamination technology and technical expertise to support the MDIP.

The purpose of the Manipulator Decontamination Improvement Program (MDIP) is to identify a more effective technology that can quickly reduce the contamination levels and subsequently the dose rates of the manipulators prior to personnel coming in contact with the equipment during

repair operations. Ultimately, it is desired by INL to have a remote decontamination process incorporated into the existing decontamination spray chamber (DSC) to eliminate the need for personnel to perform manual (hands-on) decontamination prior to repair operations and provide a better decontamination efficacy than what is yielded by the currently-used high pressure water wash system.

The current area of interest is in manipulator maintenance. However, during the discussions leading up to the recent testing that was performed at INL, the same permanent decontamination facility improvements will have a broader range of applicability to other operations at the facility. The permanent decontamination system that will be designed and recommended to INL will incorporate provisions to allow other equipment and materials to be processed through the DSC. If these other waste streams are processed through the DSC, lower personnel exposure can be achieved. Additionally, the elimination of size reduction activities using the DOE surface contaminated object (SCO) protocol for disposal of items being removed from the cell that no longer have any reuse value could be achieved.

Recent testing

Environmental Alternatives, Inc., working under contract number 00118076 during the month of September 2011, performed several demonstrations using their Rad-Release decontamination agent to remove contamination from master/slave manipulator parts. These tests removed a significant amount of contamination and lowered the radiological beta activity dose rate from about 40 Rad/hr to about 0.5 Rad/hr. Only minor corrosion was discovered after the manipulator cleaning tests and disassembly of the wrist sections. This is a substantial improvement in dose reduction for the manipulator repair group when working on the highly contaminated manipulators, reducing the extremity dose rates by about 100 fold (from almost 10 R to 150 mR, assuming 15 minutes working time in high field area. This renders these highly contaminated manipulators repairable, forgoing replacement, at a cost of over $200,000 per manipulator. The Rad-Release application also greatly reduced the time spent decontaminating the manipulator, saving several days over the typical water cleanup and resurvey cycles, and reduced the overall amount of waste generated.

The first use of the technology for manipulator decontamination came in 2010 when EAI introduced the technology at Argonne National Laboratories. EAI achieved 94% removal in a single, 90 minute application compared to 4–5 days when conventional (far less effective) decontamination techniques were employed. Rad-Release is no stranger to the INL though, since it was invented and patented by an INL team for use in urban “dirty bomb” decontamination and licensed to EAI. The INL Rad-Release research team was recently awarded a 2011 R&D 100 Award for this development. Other successful decontamination projects using Rad-Release include hot cells at West Valley Demonstration Project and the Canadian “Little House on the Prairie” urban decontamination contest. These highlights led the MFC engineers to conclude that Rad-Release might also be successful at reducing the radiation dose on manipulators.

The MFC Rad-Release trials began with a non-radioactive test to determine the potential degradation of fine manipulator parts. An uncontaminated manipulator wrist was immersed in Rad-Release in an ultrasonic bath at elevated temperature (~ 50 degrees C) for ten minutes, then placed in an ultrasonic bath with deionized water for another five minutes. At the end of that test the wrist was disassembled and checked for corrosion. While some parts were discolored, no significant degradation was discovered.

Following the "cold" test, a contaminated wrist was cleaned at the Fuel Cycle Facility (FCF) Suited Entry Repair Area (SERA) manipulator repair glovebox. An ultrasonic bath was again used, and the conditions were similar to those for the previous test. The results of the ultrasonic and later tests are summarized in Table 1, below. The significant point is that the beta dose readings fell from about 6 R/hr down to about 50 mr/hr. Again, this allows much more time to work on these parts while maintaining ALARA principles. When the wrist was disassembled for repair, only minor corrosion was noted. There was no substantial corrosion of fine, critical tolerance parts. Pictures of the wrist and ultrasonic in the glovebox are shown in Figure 1.

Table 1, Rad-Release Manipulator Test Results

Location and Activity	**Date**	**Conditions**	**Gamma Dose (mr/hr)**	**Corrected Beta Dose (mr/hr)**
Manipulator Tong (Mod J spare) Before	9/14/2011	previously water rinsed	6	2982
Manipulator Wrist (Mod J spare) Before	9/14/2011	previously water rinsed	12	5964
Manipulator Tong (Mod J spare) After	9/14/2011	Rad-Release Ultrasonic	6	27
Manipulator Wrist (Mod J spare) After	9/14/2011	Rad-Release Ultrasonic	8	25
Manipulator Slave Arm (top) Before	9/22/2011	previously water rinsed	500	1500
Manipulator Slave Arm (middle) Before	9/22/2011	previously water rinsed	100	2700
Manipulator Slave Wrist Before	9/22/2011	previously water rinsed	1200	41400
Manipulator Slave Arm (top) After	9/22/2011	Rad-Release Mist/Rinse	50	450
Manipulator Slave Arm (middle) After	9/22/2011	Rad-Release Mist/Rinse	50	450
Manipulator Slave Wrist After	9/22/2011	Rad-Release Mist/Rinse	50	450

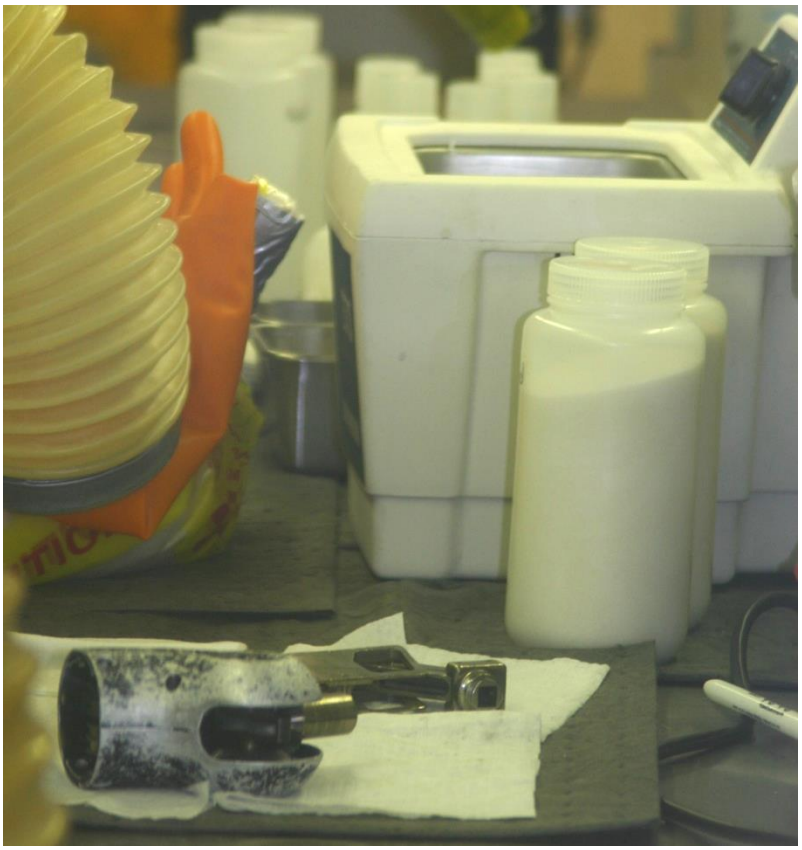

Figure 1, Ultrasonic, Manipulator Wrist and Tongs

The final test of Rad-Release on a manipulator was to decontaminate an entire "slave" arm in the SERA main cell area. The results of the test proved the method very successful, rapidly reducing the radiation levels on the wrist of slave arm #7168 from 41 R/hr to 450 mr/hr. This manipulator was very contaminated, having been cleaned twice with water and still reading 41 R/hr beta dose. Previous cleaning of the manipulator with water jetting had taken a substantial amount of time and generated about 20 gallons of waste. Accounting for radiation dose readings (entries) and processing the wastes, probably 20 hours had been spent cleaning the manipulator to that point and it remained very contaminated. The Rad-Release entry began at about 1:30 pm on 9/22 and concluded at 3:45 pm the same afternoon (including all radiation surveys). The total amount of waste (both solution and rinse) totaled less than 2 gallons. That waste was solidified with Acid-Bond A660 solidification agent and disposed of as low-level waste. We estimate that the savings was about $20,000 for operations, analysis and waste treatment and perhaps $2000 for operator entry time in the SERA versus two entries for water wash down (which were far less effective). A picture of the slave arm being cleaned is shown in Figure 2. The arm was attached to an overhead crane with a plastic shower curtain controlling overspray and a small barrel collecting the waste. The solution and rinse were applied with garden type sprayers.

Figure 2, Slave Arm 7168 being cleaned with Rad-Release