Fermilab	ES&H Section Procedures	
Procedure Number/Name ESH-RPO-003 – Decontamination Using RPO Floor Cleaner		**Original Date:** 4/22/2019
Written by: Joel Fulgham	**Reviewed and Updated By:** Joel Fulgham	**Date:** 5/8/2019

Decontamination Using RPO Floor Cleaner

Approvals

Reviewed By: N. Chelidze Date: 5/9/19

Nino Chelidze, Radiation Safety Officer (RSO)

Reviewed By: Date: 5/9/19

Tony Busch, Radiological Control Technician (RCT)

Reviewed By: Dale White Date: 5/9/19

Dale White, Radiological Control Technician (RCT)

Approved By: Maddelyn Schoell Date: 5/9/2019

Maddie Schoell, Radiation Physics Operations (RPO) Department Head

Approved By: Date: 5/9/19

Matt Quinn, Senior Radiation Safety Officer (SRSO)

Revision History

Author	Description of Change	Revision Date
Joel Fulgham	Initial Release	4/22/2019
Joel Fulgham	Updated following initial decon, including lessons learned. Also expanding to include specifics for the 8 GeV Line.	5/8/2019

Table of Contents

Standard Operating Procedure

1.0 Purpose

The purpose of this procedure is to describe the general process for decontamination of enclosure aisles and other floors using the floor scrubber machine owned by the ES&H RPO Department. This applies to areas with average contamination values of 2,000 pCi/100cm^2 and below. (See attached Technical Basis for more details.) More detailed descriptions of each individual decontamination job will be reflected in individual RWPs and associated ALARA plans.

2.0 Qualifications & Authorizations

Environment, Safety & Health (ES&H) Section Radiation Safety Officers (RSOs) and Radiological Control Technicians (RCTs), either within the Radiation Physics Operations (RPO) Department or Hazard Control Technology Team (HCTT), may perform this procedure. Additional personnel outside of these organizations may receive approval from the RPO Department Head and Senior Radiation Safety Officer (SRSO) to perform this procedure. All personnel must have all required training in Section 2.1 up-to-date.

Final authorization to perform this procedure is awarded to qualified individuals upon signing the Standard Operating Procedure (SOP) Signature Page and obtaining Group Leader and Department Head approval. Final authorization, along with this written procedure, constitutes written authorization to perform the work described herein. Any work that goes beyond the general procedure/process description may warrant additional authorizations, please contact the RPO Department Head. Any work in areas that present additional hazards not described in the general procedure/process description may warrant additional Hazard Analysis (HAs), please contact the Division Safety Officer (DSO) for the location.

2.1 Additional Training Requirements

- Radiological Control Technician Qualifications
    - OR Radiological Worker Training
- Fermilab Controlled Access Training
- Use the cleaner prior to attempting decontamination

3.0 Regulatory Drivers, Basis, References

Fermilab Radiological Control Manual (FRCM)

- Chapter 2 Part 2: Contamination Control and Control Levels
- Article 235: Posting Contamination, High Contamination and Airborne Radioactivity Areas
- Article 354: ALARA Trigger Levels and Required Approvals

10 CFR 835

- 835.402(c)(1): Basis for requiring internal dosimetry

4.0 Procedure

This section describes the general processes for the various aspects involved in decontaminating an area using the floor cleaner. This process is mainly written for decontamination in the MI-30 collimator

region of the MI-20—MI-62 Enclosure and in the 8-GeV Line collimator region, and can be modified if decontamination is needed elsewhere.

4.1 Required Equipment

- Floor cleaner
- 5 Carboys with extra water
- Boundary ribbon
- Contamination Area Signs
- Herculite
- Rad Waste labels
- Wipes and envelopes
- 2 copies of area maps
- Extension cord
- Extra gloves
- Bag for waste tank cleanup
- R.W. Form 31 "Radioactive Waste Certification and Pickup Request Form"
    - Won't need in the enclosure, only afterwards if determined to be radioactive waste
- 250 ml sample bottles
    - Won't need in the enclosure, only afterwards if determined to be radioactive waste

4.2 Required PPE

- Coveralls
- Shoe covers
    - May need multiple pairs depending on area postings
- Rubber Boots (optional)
    - If wearing rubber boots, ensure that coveralls fit outside of the boot top.
- Personal Air Monitors (PAMs) if average contamination levels are above 2,000 pCi/100cm^2 (See attached Technical Basis for more details.)
- Extra Gloves
- Face Shield (optional)

4.3 Potential Hazards and their Mitigation(s)

Hazard	Mitigation
Losing control of cleaner	OJT, practice
Personnel contamination	PPE
Tripping over electrical cord	2nd person to monitor cord location
Overflowing the reservoir (dirty) tank	Built-in float to shut off

4.4 Decontamination of Area

- Read and sign any appropriate RWPs/HAs.
- Transport the cleaner (if not already stored in the area requiring decontamination), 5 full carboys to the area

    - Down at MI60 elevator and trailer everything to the boundary at MI313 via MI50 and MI40.
    - Down the MI8 elevators into the 8 GeV line
- Remove the cleaner from the cart, fill the supply tank.
    - This now empty carboy will be used later in the procedure.
- Setup Herculite in an out of the way location (i.e., in the alcove at MI30 for the MI-20—MI-62 Enclosure, in the MI-8 labyrinth for MI-8 line), for the cleaner to sit on when decontamination work is complete.
- Take pre-decontamination wipes from just outside the posted area all the way through to just beyond the opposite boundary.
- Run the floor cleaner all the way down the aisle on the beam line side from the downstream boundary to the upstream boundary. Check the water level in the supply and waste tanks before making the return trip. Add or drain water as required, using emptied carboys to drain the water into.
- With a slight overlap with the previously cleaned area make the return trip. Check water level in the supply tank, add or drain water if necessary. Continue this process until the complete width of the aisle has been cleaned. (This should be approximately 4 trips.) For the MI-8 collimators contamination extends into the alcove and it should also be decontaminated.
    - *NOTE: take caution when turning the floor cleaner around.*
- Clean your way back to the storage location (i.e., MI30 Alcove or MI-8 labyrinth) and place the cleaner on the prepared Herculite area.
    - Post the area around the floor cleaner as a Contamination Area.
- Drain the waste water into empty carboys and obtain a sample of the water for gamma/tritium analysis. Seal the carboys and label them, location and date.
- Clean the sludge out of the waste tank.
- Once the floor is dry take post-decontamination wipes.
- Transport waste water and empty carboys out of the tunnel.
- Submit the waste water sample and pre- and post-decontamination wipes to Radionuclide Analysis Facility (RAF) for analysis.

NOTE: Monitor personnel dose throughout decontamination, swap personnel using the floor cleaner as needed to evenly distribute dose.

4.5 Decontamination of Equipment

- Post the area around the cleaner as a Contamination Area.
    - When in the MI-20—MI-62 enclosure, the cleaner should be stored in the MI30 alcove.
    - When in the MI-8 enclosure the cleaner should be stored in the MI-8 labyrinth.
- If reservoir tank needs cleaning, use new carboy water to rinse the tank out. Drain water back into carboy as waste.

4.6 Waste

Sampling/Analysis

- Once the analysis results are received determine the effectiveness of the decontamination. (See below)

Disposal

- Using the results of the sample, dispose of the waste water as radioactive waste if required.

4.7 Post-Job

Any in-the-field modifications to the ALARA plan will be noted in the comments section of the ALARA plan. A full post-job writeup, including the total accumulated person-mrem, will be added in the appropriate section of the RWP.

Once results from the post-decontamination wipes are received:

- Determine if contaminations levels are below 450 pCi/100cm^2 (1000 dpm/100cm^2).
- If the decontamination was successful (below specified levels), during the next access take another set of wipes. Analyze them for accelerator produced isotopes to check the buildup rate.

Any Lessons Learned will be documented on the Radiation Protection SharePoint page, and may be used to update this procedure. Lessons Learned may also be distributed to other groups at the Lab if and when appropriate.

5.0 Program Documentation & Records

An RWP and ALARA Plan will be generated for each decontamination job. They should detail the location of the decontamination and the maximum dose rate. The ALARA plan can be broken down into smaller sub-areas and use average dose rates in each sub-area in an effort to be as accurate as possible in the dose estimate. The RWPs will be reviewed and approved by the assigned RSO and SRSO.

RWPs and associated ALARA plans will be uploaded into the RWP database in FileMaker Pro, PDFs will be saved on the shared drive and/or the Radiological Protection SharePoint Site, and the original paper copy will be stored with other RWPs and eventually stored at Archive.

If a decontamination job involves others hazards not specified in this procedure, a separate Hazard Analysis (HA) will be generated, in consultation with the Division Safety Officer (DSO).

SOP Signature Page

This table indicates all qualified personnel, and documents that they have read and understood this procedure and completed necessary On-the-Job Training (OJT). By signing below, the qualified individual agrees to follow this procedure along with the applicable RWP & ALARA plan for each specific decontamination. ES&H RPO Group Leader and Department Head approvals authorize the qualified individuals to perform this decontamination procedure.

Name	OJT Completion Date	Signature	ID #	Date	Approvals & Date	
					Group Leader	Dept. Head
Joel Fulgham	5/9/19		9634	5/9/19	~~[illegible]~~	MS
Tony Busch	5/9/19		10068	5/9/19	[illegible]	MS
Paul Sedory	5/9/19		12630	5/9/19	[illegible]	MS
Dale White	5/9/19		10017	5/9/19	[illegible]	MS
Jose DeLaO	5/9/2019		4175	5/9/19	[illegible]	MS

Enclosure Aisle Decontamination Technical Basis Document
M. Quinn
5/9/2019

Updated to indicate that this technical basis is also applicable to other portions of the Main Injector such as the MI-8 section.

Additionally, this technical basis provides an upper bound of 5,000 pCi/ 100 cm^2 but it was decided to use 2,000 pCi/ 100 cm^2 as a limit in ESH-RPO-003 because the nature of aisle contamination in enclosures is still being investigated. A limit of 2,000 pCi/ 100 cm^2 provides some allowance above the average of ~1000 pCi/ 100 cm^2 seen in the MI-30 region, but is a good trigger for re-examining the SOP requirements before reaching the limit of this technical basis.

MI-30 Aisle Decontamination Technical Basis Document
M. Quinn
4/23/2019

Results on floor indicate levels between 400 - 3000 pCi/ 100cm2, with an average of about 1,000 pCi / 100 cm2. (7Be and 24Na)

Gamma spec results indicate 5-10x 7Be vs 24Na at the time the wipes were taken, which were approximately

1000 E -12 Ci / 100 cm2 = 1 E -11 Ci/cm2

Enclosure size 4' x 8' x 1000' (122 cm x 245 cm x 30500 cm)

Total activity represented in this removable material 1E-11 Ci/cm2 x 122cm x 30500cm / 0.1 wipe efficiency = 3.7 E -4 Ci = 370 uCi

To estimate the airborne radioactivity hazard, we start with the extremely conservative assumption that all of the removable activation is resuspended in air. Given that we are cleaning with a wet method, we suspect this value will be very low in practice, perhaps 1% or lower. While the calculation below provides a bounding case, we will employ personal air monitors to help determine what the resuspension factor is.

If all is suspended in air: 370 uCi/ (122 cm x 245 cm x 30500 cm) = 4 E-13 Ci/ml = 4 E -7 uCi/ml
- 7Be: 0.83 x 4E-7 uCi/ml = 3.3E-7 uCi/ml
- 24Na: 0.17 x 4E-7 uCi/ml = 6.8 E-8 uCi/ml

DAC values
- 7Be: 1E-5 uCi/ml
- 24Na: 4E-7 uCi/ml

DAC fractions
- 7Be: 3.3E-7/1E-5 = 0.033
- 24Na: 6.8E-8/4E-7 = 0.17

1 DAC: 5000 mrem/2000 hr = 2.5 mrem/hr
At 20% of a DAC, 2 hour decon work is 2.5 mrem/hr * 0.2 DAC Fraction * 2 hr = 1 mrem

Wet cleaning should mitigate resuspension significantly, lowering the expected DAC fraction and dose received well below 1% of a DAC and less than 1 mrem.

At 100 % resuspension, average removable contamination values of 5000 pCi/100 cm2 would approach 1 DAC. Even in this case, the received dose would be 5 mrem, which is much lower than the external dose that is expected. An ALARA calculation (ala NUREG/CR-0041, Section 2) would indicate against specifying respiratory PPE due to the worker inefficiency factor of wearing PPE (~15%).

Estimated exposure rate from 370 uCi of removable activity:

7Be: 0.83 x 370 = 307 uCI

$X = 5.263E\text{-}6\ A\ yE(\mu/\rho)/r^2$

$= 5.263E\text{-}6(1.14E7\ Bq)(0.1)(0.477\ MeV)(2.96E\text{-}2\ cm^2/g) / (30\ cm)^2$

= 9.4E-5 R/hr = 0.09 mR/hr

24Na: 0.17 x 370 = 63 uCi

$X = 5.263E\text{-}6\ A\ yE(\mu/\rho)/r^2$

$= 5.263E\text{-}6(2.33E6\ Bq)(1)((2.754\ MeV\ (2.06E\text{-}2\ cm^2/g) + 1.369\ MeV(2.40E\text{-}2\ cm^2/g)) / (30\ cm)^2$

= 1.22E-3 R/hr = 1.22 mR/hr

Check with RadProCalculator: 1.28 mR/hr

Therefore, the exposure rate of the collected activity is estimated to be ~1.3 mR/hr. This ignores the self-shielding that the water the activity is contained in will provide.