

INTERNAL ASSESSMENT REPORT

Contamination Areas at Fermilab – Area Postings, Control, Work & Response to Incidents

Start Date	End Date	Area Assessed
March 2019	May 2020	Beamline Enclosures & Service Buildings w/ Posted Contamination Areas

Assessment Team

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¹ Role on assessment team: L=Lead, A=Assessor, O=Observer

Interviewees

Name	Title
n/a	

Assessment Type

- | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> QA Assessment
<input checked="" type="checkbox"/> Line Organization Self-assessment
<input type="checkbox"/> Management System Assessment | <input type="checkbox"/> Tripartite Assessment
<input type="checkbox"/> Triennial Assessment
<input type="checkbox"/> FESHCom Assessment
<input type="checkbox"/> Other: |
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Report

Title

Contamination Areas at Fermilab – Area Postings, Control, Work & Response to Incidents Self-Assessment

Scope

This assessment is being conducted by the Environment, Safety & Health (ES&H) Section Radiation Physics Operations (RPO) Department in response to Beryllium-7 (Be-7) contamination found in March 2019 in the aisleway in the MI-30 collimator region of the MI-20—MI-62 enclosure, where historically contamination had not been seen.

This assessment was initially intended to investigate the extent of the contamination in the specific area (the MI-30 collimator region), and other enclosure areas, to better understand Be-7 contamination and potential contamination in aisleways. However, throughout the course of the assessment, the scope expanded to include review of how Contamination Areas are posted, controlled and monitored by RPO, how work is authorized to occur & conducted in the areas, how contamination is controlled, and the response to potential personnel contamination (especially when there is potential contamination from Be-7 and other isotopes not easily detected with Friskers).

Criteria

1. Understand extent of Be-7 contamination, and contamination in aisles, in beamline enclosures.
2. Understand current postings, and evaluate modifications to properly post actual Contamination Areas as well as warn personnel of potential contamination beyond known areas.
3. Evaluate communication of known contamination hazards as well as potential contamination hazards to personnel (i.e., verbal communication, general enclosures RWPs, job-specific RWPs, etc.) and identify ways to improve and standardize.
4. Review ESH/RPO documents/training related to controlling contamination, performing work in Contamination Areas, etc. and identify areas of improvement and standardization.
5. Review response procedures for contamination events (RPO Department, AD Operations Department, Fire Department, Security) and identify areas of improvement and standardization. Specify roles and responsibilities for all individuals involved. Update to include specifics for Be-7, tritium, etc.

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Report (Summarize what took place. How was the assessment performed? Where were items found?)

This assessment was performed over a number of months, in conjunction with continued contamination build-up studies and response to operational issues. Below is a summary timeline of major events that occurred during the course of this assessment and a list of current areas posted as Contamination Areas. Items found during the course of the assessment and any non-conformances, recommendations, opportunities for improvement, and best practices are listed in the “Results” section of this report.

Timeline of Major Events

- 1/23/2019 RCT discovered detectible contamination on shoecovers of an individual performing a beam loss point survey in the MI-30 collimator region. Contamination on PPE was found while still in the area, PPE was removed & bagged by RCT, and new PPE was worn by individual.
- 2/20/2019 On the next access day, extensive dose rate and contamination wipe survey was conducted in the MI-30 collimator region on the beamline elements, on the floor beneath the beamline elements, and in the adjacent aisles. Results from Radionuclide Analysis Facility (RAF) showed surface contamination in the aisles above surface contamination limits [1] in multiple locations, with a maximum reading of 3,108 dpm/100cm² [2]. A few wipes showed surface contamination just outside of the roped and posted Contamination Area, in the direction of the air flow. *As an interim corrective action, Radiological Work Permits (RWPs) for MI-20—MI-62 enclosure were updated to restrict cart access and require double shoe covers when passing through the MI-30 collimator region. Contamination Area posting relocated to extend the boundary of the posted area (see Recommendation 1), and local postings with new restriction & requirements, PPE & rad waste bags put in place during next enclosure access opportunity (3/5/2019).*
- 3/5/2019 Additional wipe surveys performed in the MI-30 collimator region in the aisles. Results from RAF again showed surface contamination in the aisle, with a maximum reading of 3,831 dpm/100cm² [3]. All areas where surface contamination was found was already within a roped and posted Contamination Area.
- 3/13-19/2019 Multiple methods of decontamination discussed & tested. The most effective method was found to be a dry mop without floor sweeping compound.

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- 3/20/2019
- Additional wipe survey performed in the aisles throughout the remainder of the MI-10 and MI-20—MI-62 enclosures, in areas with dose rates > 500 mrem/hr. Results from RAF showed surface contamination in the aisle in the 300 region, with a maximum reading of 4,926 dpm/100cm² [4]. All areas where surface contamination was found was already within a roped and posted Contamination Area.
 - Additional wipe survey performed in the aisles in the MI 8 GeV enclosure in areas with dose rates > 500 mrem/hr. Results from RAF showed surface contamination in the aisle in the 836-841 region, with a maximum reading of 5,114 dpm/100cm² [5]. All areas where surface contamination was found was already within a roped and posted Contamination Area.
 - Decontamination attempt in the MI-30 collimator region between 307-308 using the dry mop, no sweeping compound method. Post-decontamination wipes still showed surface contamination, with a maximum reading of 1,687 dpm/100cm² [6].
- 3/27/2019 RPO decides to purchase floor scrubber/cleaner.
- 4/3/2019 Additional wipe survey performed in the aisles throughout MI-10 and MI-20—MI-62 enclosures, with wipes taken in each section of the enclosure regardless of dose rates. Results from RAF showed no surface contamination found outside of the MI-30 collimator region [7].
- 4/9-18/2019 RPO floor cleaner arrives, tests performed at TSB.
- 4/22/2019 ESH-RPO-003 “Decontamination Using RPO Floor Cleaner” Created [8].
- 4/24/2019
- Decontamination of the MI-30 collimator region with the RPO floor scrubber. Results from RAF showed all areas below surface contamination values, with the maximum reading of 399 dpm/100cm² (all Be-7) [9]. Decontamination considered a success.
 - Additional wipe surveys performed near the MI-40 Absorber (inside MI-20—MI-62 enclosure) and the SwitchYard Absorber (inside Enclosure C). Results from RAF showed surface contamination below the Table 2-2 limits [1] near the MI-40 Absorber (maximum reading of 488 dpm/100cm²) [10], and no detectable contamination near the Switchyard absorber [11].
 - Additional wipe survey performed in MI-10. Results from RAF showed surface contamination below the Table 2-2 limits [1] (maximum reading of 333 dpm/100cm²) [12].

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5/13/2019	First build-up wipe survey in the MI-30 collimator region. Results from RAF showed that the contamination did build up, but remained below Table 2-2 limits [1], with a maximum reading of 688 dpm/100cm ² [13].
05/11/2019	Wipe Survey of Booster*
6/19/2019	2 nd floor scrubber purchased
6/24/2019	2 nd floor scrubber received
7/6/2019	Shutdown begins, decon of the aisle at MI-30* and 8 GeV*
7/7/2019	Decon of 8 GeV collimator aisle
9/24/2019	Purchase of multi-cell wipe counter
10/2/2019	End of shutdown survey of Booster* aisle, beamline components & floor beneath beamline – no decon, informational only
10/10/2019	End of shutdown decon of 8 GeV* beam line, floor beneath and aisle
10/14/2019	End of shutdown decon of MI-30* beam line, floor beneath and aisle
10/17/2019	Wipe survey of walls at MI-30
10/17/2019	Receipt of multi-cell wipe counter
10/30/2019	MI-40 sump flood*
12/11/2019	MI-30 Build-up survey*
01/07/2020	Collected first beam on air sample at MI-30 21000 pCi of Be-7, 480 pCi Na-24
01/14/2020	Collected beam on air sample at MI-30, 11000 pCi of Be-7, 700 pCi Na-24
1/22/2020	MI-30 Build-up survey* (showed results above 1,000 dpm/100cm ²)
2/5/2020	Collected airborne settling sample at MI30. Beam off at 6:00 sample taken at 7:17 showed 38,000 pCi Be-7, 25 pCi Mn-52, 38 pCi V-48. Next sample at 13:48 no activity. Final sample 1500 no activity.
2/5/2020	MI-8 Buildup study survey* (showed above 3000 dpm/100cm ²)
2/7/2020	MI-30 Build-up survey*
3/23/2020	Fermilab enters COVID-Safe mode
3/20/2020	Receipt of multi-cell wipe counter sources
4/1/2020	MI-40 sump flood, water reaching the bottom of the absorber*
4/13/2020	Decontamination of MI-30*
5/11/2020	Decontamination of 8 GeV*
5/19/2020	Begin procurement process for purchasing additional stanchions & chains for locally posting beamline components in Booster, 8 GeV & MI-30

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**Indicates surveys and/or decontamination performed, but survey maps and wipe results not readily available at the time of writing the report.*

Contamination Areas

The following table shows Contamination Areas at Fermilab, their posting, boundary, etc.

Area	Enclosure/ Service Building	Nature of Contamination	Area Boundary	Posting Text
MI-30 Collimator Region (230- 304)	MI-20—MI-62 Enclosure	Removable. On Beamline elements, floor beneath beamline, aisle. Includes Be-7.	Ropes across the aisle at 230 and 304	Danger, High Radiation Area, Contamination Area, No work without RSO approval, Pass Through Quickly
MI-30 Collimator Region (305- 313)	MI-20—MI-62 Enclosure	Removable. On Beamline elements, floor beneath beamline, aisle. Includes Be-7.	Ropes across the aisle at 305 and 313	Danger, High Radiation Area, Contamination Area, No work without RSO approval, Pass Through Quickly
MI-40 Absorber Room	MI-20—MI-62 Enclosure	Removable. On Beamline elements, floor beneath beamline, aisle. Includes Be-7.	Chain link gate locked with an MI40 Absorber key, obtained from MCR.	Caution, Contamination Area. Upstream pipe Posted High Radiation Area
8 GeV Collimators Region 836 to 841	MI 8 GeV Enclosure	Removable. On Beamline elements, floor beneath beamline, aisle. Includes Be-7.	Ropes across the aisle at 836 and 841	Danger, High Radiation Area, Contamination Area, No work without RSO approval, Pass Through Quickly

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Booster (Periods 3 and 6-7)	Booster Enclosure	Removable. On Beamline elements, floor beneath beamline, aisle. Includes Be-7.	Ropes across the aisle at 2/4 and 3/1	Danger, High Radiation Area, Contamination Area, No work without RSO approval, Pass Through Quickly
AP-0 Target Vault	AP-0 Service Building	Removable & fixed. This area contains primarily hot particles from component change outs. No Be-7 identified.	AP-0 Vault is a caged area. The entry side is also roped off. Locked with AP-0 Vault key	Danger, High Radiation Area, Keep Out, Contamination Area, Contact RSO Prior to Entry
AP0 Water Cage	AP-0 Service Building	Contains RAW system that can cause surface contamination, so it is treated as a Contamination Area.	East side of the vault entrance North of the vault. Locked with AP-0 water cage key,	Danger, High Radiation Area, Keep Out, Contamination Area, Contact RSO Prior to Entry
CZero Hot Cell	CZero Service Building	Removable. On components and floor & walls within hot cell. Likely contains Be-7 among other readily detectable API.	Within hot cell, kept closed and locked with M- 13 key unless being worked on.	Caution High Radiation and Contamination Area Contact AD RSO via MCR x3721 For Entry
CZero HEPA Filters	CZero Service Building	Removable. On HEPA filters within system. Used primarily for Radon control.	Within HEPA filter system, kept closed not locked.	Caution Potential Contamination Area. Contact Radiation Safety prior to

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				working on this system x3721
CZero storage bays	CZero Service Building	Removable contamination. Contains Be-7.	Used for hot component storage. Locked with M-13	Danger Keep out High Radiation Area Contamination Area Contact RSO prior to entry
CZero Long term storage	CZero Service Building	Contamination is contained in the containers	Long term storage of containers with used NuMI targets and horns. Locked with M-13	Danger High Radiation Area Personnel Dosimetry Supplemental Dosimetry & RWP required for entry
NuMI HEPA Filters	NuMI Target Hall	Removable. On HEPA filters within system. Contains Be-7.	Within HEPA filter system, kept closed and locked with M13 key unless being worked on.	Caution Contamination Area. Keep Out. Contact RSO for entry.
Gollum's Cave	NuMI Target Hall	Access to the lower chase area, ventilation and drains. Historically have had contamination and air activation. Contains Be-7.	Area locked with an M-13	Caution Do not attempt to open or otherwise disturb ventilation system! Prior RSO authorization and Radiation Safety coverage of this process is required-No

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				exceptions! Call Radiation Safety to request authorization. Gary Lauten or M. Gerardi.
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Results

(Describe items found and categorize according to definitions below.)

Item Types

Non-conformance - The nonfulfillment of a specified requirement. This is limited to substantive issues that are worthy of being addressed. Word them as **statements of fact** rather than instructions.

Management Concern - An issue that management has identified as a concern requiring action to be taken to mitigate associated risk.

Recommendation - A suggestion or proposal for the best course of action to take on the identified topic.

Opportunity for Improvement - Suggestion on how to improve the identified topic.

Best Practice - A positive example of a work process or innovative approach with the potential to be the basis for significant operational improvements or cost savings.

Lesson Learned - A best practice that is captured and shared to promote repeat application, or an adverse work practice or experience that is captured and shared to prevent recurrence.

Description of Items found

- Be-7 contamination found in the MI-30 collimator region, inside a posted Contamination Area, but in the aisleway where historically contamination was localized to the beamline components and the floor beneath. (See Recommendations 2, 4, 6 and 13)
- Be-7 contamination found just outside of the posted Contamination Area in MI-30. (See Recommendation 1)
- Contamination Area Postings in Booster, MI 8 GeV and MI-20—MI-62 are across the aisle, yet additional controls (beyond the general RWP requirements), such as cart restrictions and additional PPE requirements, are not implemented when individuals remain in the aisle. (See Management Concern 1 and Recommendation 13)
- Wipe results & survey maps for surveys after 5/13/2019 not readily available, as indicated by (*) in the above timeline. (See Opportunity for Improvement 2)
- FRCM glossary definition for “Radioactive Contamination” and sub-definitions not consistent with definitions found in DOE-STD-1098-2017 and DOE G 441.1c. (See Recommendations 8 and 9)
- Inconsistencies in contamination response procedures between RPO, FD, Security & MCR. Procedures did not mention information for Be-7. (See Recommendation 10)
- No RPO procedure specific for control of contamination. (See Recommendation 6)

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- Language on area postings inconsistent. Some postings do not meet 10 CFR 835 requirements (e.g., CZero Hot Cell says “Caution” instead of “Danger”).
- Historical knowledge of hazards and appropriate PPE for mitigating hazards not properly documented (e.g., access into Gollum’s cave should have additional PPE, but it’s not noted on the posting or RWP).

Non-Conformances

none

Management Concerns

1. Personnel being permitted to access posted Contamination Areas without additional PPE, particularly during Supervised Access modes, along with use of carts through posted Contamination Areas, is of particular management concern. (See Recommendations 13)
2. Water being permitted to flow into/out of posted Contamination Areas causes concern about potentially spreading contamination out of posted areas. (See Recommendations 6 and 14.)

Recommendations

1. Move posting in MI-30 to contain areas with Be-7 above 10 CFR 835 Appendix D values.
 - a. *Completed 2/20/2019*
2. Develop procedure for decontamination of aiseways inside beamline enclosures.
 - a. *Completed 5/9/2019 RPO-RPO-003 Decontamination Using RPO Floor Cleaner*
3. Investigate potential internal uptake due to the removable surface contamination and water activity.
 - a. *Inhalation: Completed 7/16/2019 Memo “Working on Contaminated Beamline Components in the Main Injector”*
4. Perform continuous contamination build-up studies in and adjacent to posted Contamination Areas within beamline enclosure.
5. Update RP technical basis’ for air monitoring and internal dosimetry (RP Note 7 and RP Note 165).
6. Develop a “Control of Contamination” procedure to describe how Fermilab monitors & controls contamination at Fermilab. This procedure should clearly define what contamination is, to be consistent with FRCM definitions (see Action Item #9 below). This procedure should clearly and specifically reference regulatory references within the text to demonstrate clear connection between regulatory requirements and controls/monitoring put in place. This procedure should describe how Contamination Areas are posted (see Action Item #11 below).

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7. Establish a list of Contamination Areas.
8. Update FRCM Glossary definition for “radioactive contamination” to be consistent with DOE-STD-1098-2017 and DOE-G-441.1c.
9. Clarify in all documents (i.e., FRCM glossary and Chapter(s), Control of Contamination procedure, and other relevant documents) what Fermilab considers to be “loose surface or removable radioactive contamination”.
10. Update all procedures related to contamination response (i.e., RPO, Site 39, FD, Security, MCR) to ensure consistency and clearly specify roles and responsibilities for all individuals involved. Update to include specifics for Be-7, tritium, etc.
11. Establish a Posting Procedure to standardize how areas are posted at Fermilab, consistent with 10 CFR 835. Specifically, this procedure should describe how Contamination Areas in beamline enclosures should be posted.
12. Update any postings to meet standards in developed Posting Procedure.
13. Investigate strategies to downpost enclosure aiseways and locally post beamline elements when the aisle has been decontaminated.
14. Investigate need and method for ensuring water doesn’t flow into/out of posted Contamination Areas within beamline enclosures.
15. Update RWP and/or posting for access into Gollum’s cave to identify appropriate levels of PPE for access.

Opportunities for Improvement

1. Investigate alternatives to routine cart use (i.e., personnel travel, point loss (aka DALE) surveys, alignment carts, etc.) to continue performing tasks without the need for carts for when aisles need to be posted as Contamination Areas and carts are not allowed (i.e., during Controlled Access or during Supervised Accesses when decontamination has not been performed).
2. Investigate solutions to have survey information (maps, wipes, etc.) more readily available.

Best Practices

1. Wipe surveys routinely taken outside of beamline enclosures to monitor for contamination during snoop surveys.
2. Routine monitoring verifies no spread of removable contamination outside of radiological areas.
3. Routine monitoring shows no transfer of removable contamination onto personnel skin or street clothing.
4. General enclosure RWPs do not allow work in posted Contamination Areas, requiring additional RSO review & approval, RWPs and/or RCT coverage.

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Documents Reviewed

(List procedures, manuals, forms, etc. reviewed.)

Procedures

- AD Ops Contamination & Beam On Incident response procedures
- ESH Floor Scrubber Decontamination
 - a. & technical basis

Manual Chapters

- Fermilab Radiological Control Manual (FRCM)
 - a. Glossary
 - b. Article 334

Regulatory

- 10 CFR 835
 - a. 10 CFR 835.1102
- DOE-STD-1098-2017
 - a. Glossary
- DOE-G-441.1c
 - a. Glossary
 - b. Section 11.1
 - c. Section 11.4

HPIs/iTrack Reviews

- MI40 Sump Replacement Event (HPI Review #261, iTrack ID #51426)

Other Documents

- RP Note 7
- RP Note 165

Distribution

Management of Assessed Area

Assessment Team

Interviewees

Quality Section Liaison

Other Stakeholders

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References

- [1] "Fermilab Radiological Control Manual (FRCM) Table 2-2 Summary of Contamination Values," [Online]. Available: <https://esh-docdb.fnal.gov/cgi-bin/ShowDocument?docid=444>
- [2] "20190220 MI-30 Contamination Informational Wipe Survey," [Online]. Available: <https://fermipoint.fnal.gov/org/eshq/rp/Snoop%20Survey%20Program/Survey%20Archive/Misc.%200Surveys/20190220%20MI-30%20Contamination%20Informational%20Wipe%20Survey.pdf>
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- [9] "20190424 MI-30 Floor Scrubber Decon Wipe Survey," [Online]. Available: <https://fermipoint.fnal.gov/org/eshq/rp/Snoop%20Survey%20Program/Survey%20Archive/Misc.%200Surveys/20190424%20MI-30%20Floor%20Scrubber%20Decon%20Wipe%20Survey.pdf>
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- [12] "20190424 MI-10 Contamination Informational Wipe Survey," [Online]. Available: <https://fermipoint.fnal.gov/org/eshq/rp/Snoop%20Survey%20Program/Survey%20Archive/Misc.%200Surveys/20190424%20MI-10%20Contamination%20Informational%20Wipe%20Survey.pdf>
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