

# Memorandum

Nino Chelidze  
Radiation Safety Officer

**Date:** February 4, 2020  
**To:** Matt Quinn, Senior Radiation Safety Officer (SRSO)  
**From:** Nino Chelidze, RSO and Maddie Schoell, RPO Department Head  
**Re:** Summer 2019 Shutdown Post-Shutdown Dose Report

**ESH Section**  
P.O. Box 500, MS 371  
Kirk Road and Pine Street  
Batavia, Illinois 60510-5011  
USA  
Office: 630.840.2995  
Mobile: 208-840-0431  
[chelidze@fnal.gov](mailto:chelidze@fnal.gov)

## Message:

The Fermilab 2019 shutdown began on July 7, 2019, and machines started up between September 27, 2019 and December 4, 2019.

All shutdown jobs in the electronic worklist were reviewed by ESH Radiation Physics Operations (RPO) Department, RSOs & RCTs prior to the start of shutdown, and jobs requiring various levels of RP coverage, described in Table 1, were identified.

RP Coverage Category	Description & Requirements
No Coverage	No restrictions by Radiation Safety. No need to contact RSO/RCT prior to start of work. No job-specific RWP will be issued. General (enclosure) RWPs remain in force. Record pocket dosimeter readings for the week in GetDose on Mondays.
RCT Coverage	Must contact RCT prior to start of work. RCT will determine how much coverage is needed for each part of the job. No job-specific RWP will be issued. General (enclosure) RWPs remain in force. Record pocket dosimeter readings for the job with the RCT, and for the week in GetDose on Mondays.
RCT & RWP	Must contact RCT prior to start of work. RCT will determine how much coverage is needed for each part of the job. Must read and sign applicable job-specific RWP (with the RCT), in addition to the general (enclosure) RWP, prior to start of work. Record pocket dosimeter readings for the job with the RCT, and for the week in GetDose on Mondays.
RCT, RWP & ALARA	Requires SRSO approval. Must contact RCT prior to start of work, may require pre-job briefing with RSO, RCT will determine how much coverage is needed for each part of the job, must read and sign applicable job-specific RWP (with the RCT), in addition to the general (enclosure) RWP, prior to start of work, record pocket dosimeter readings for the job with the RCT, and for the week in GetDose on Mondays, may require post-job briefing with RSO.

Table 1. RP Coverage Categories and Descriptions & Requirements.

Prior to the start of shutdown, there were 138 jobs scheduled, 35 of which were flagged by Radiation Safety for further review. Out of these 35, one was classified as "No Coverage", 19 as "RCT coverage", 5 as "RCT & RWP", and 12 as "RCT, RWP & ALARA". Initially there were 13 such jobs identified. However, two were covered under one RWP and accordingly with one ALARA plan.

Including 25% contingency level, pre-shutdown dose estimate for “RCT & RWP” jobs was 213 person-mrem, and for “RCT, RWP & ALARA” jobs 3,093 person-mrem, totaling 3,306 person-mrem for rad coverage jobs.

The list below summarizes pre-shutdown estimates and the actual dose received for the 12 “RCT, RWP & ALARA” jobs that were performed during 2019 shutdown:

1. Install new NuMI Target. Estimated at 688 person-mrem. Actual dose received was 365 person-mrem.
2. NuMI Target Hall and RAW Room Piping. Estimated at 213 person-mrem. Actual dose received was 327 person-mrem.
3. NuMI Target Move from MI-65 to CZero. Estimated at 31 person-mrem. Actual dose received was 12 person-mrem.
4. NuMI Target Hall pre filter and HEPA filter replacement. Estimated at 75 person-mrem. Actual dose received was 44 person-mrem.
5. AP0 Target Rotation Diagnostics – the target was placed in the alcove inside the AP0 vault and kept on rotating for extended periods of time for diagnostic purposes. Estimated at 98 person-mrem. Actual dose received was 79 person-mrem.
6. RCT Decontamination of MI-30 Collimator Region. Estimated at 124 person-mrem. Actual dose received was 35 person-mrem.
7. RCT Decontamination of MI 8 GeV Collimator Region. Estimated at 128 person-mrem. Actual dose received was 17 person-mrem.
8. Alignment elevation surveys in MI 8 GeV line. Estimated at 164 person-mrem. Actual dose received was 46 person-mrem.
9. Linac Tank 4 Drift Tube Replacement. Estimated at 125 person-mrem. Actual dose received was 5 person-mrem.
10. Ion Pump Cable Pulls in MI-300 Region. Estimated at 1,094 person-mrem. Actual dose received was 548 person-mrem.
11. Ion Pump Cable Replacements in MI 8 GeV line. Estimated at 300 person-mrem. Actual dose received was 361 person-mrem.
12. Ion Pump Replacement in Recycler 308, MI-30 Collimator Region. Estimated at 151 person-mrem. Actual dose received was 121 person-mrem.

Table 2 below summarizes these jobs in tabular format, stating pre-shutdown estimates, pre-job estimates, and actual dose received per job.

No	Task Performed	Pre Shutdown Estimate	Pre Job Estimate	Actual Dose Received
1	Removal and replacement of NuMI Target	688	349	365
2	NuMI RAW Skid and Waterline Upgrade	213	377	327
3	NuMI Target move from MI-65 to C0	31	17	12
4	NuMI HEPA Filter Replacement	75	52	44
5	AP0 Target Rotation Diagnostics	Not available	98	79
6	Decon of MI-30	124	82	35
7	Decon of MI-8	128	85	17
8	Alignment surveys in MI-8	164	72	46
9	Linac Tank 4 Drift Tube	125	50	5
10	Ion Pump Cable Pulls MI-30	1094	875	548
11	Ion Pump Cable Pulls MI-8	300	302	361
12	Ion Pump Replacement in Recycler	151	179	121
	<b>TOTAL</b>	<b>3093</b>	<b>2538</b>	<b>1960</b>

Table 2: Summary of 12 ALARA jobs performed during 2019 summer shutdown: Pre-Shutdown, Pre-Job and Actual Dose Received.

The jobs this year were completed mostly as planned. Pre-job estimate dose usually exceeds the actual dose received for the job, except for 1 and 11. In both cases, the actual dose received is within 25% contingency, however, it should be mentioned that both of the jobs are multi-day jobs, and in case of MI-8 cable pulls, extra time was needed to complete the work.

Here is a breakdown of the job distribution and estimated doses prior to the shutdown and actual dose received during the shutdown:

	Pre-Shutdown		Post-Shutdown, Actual	
	# of jobs	Estimated dose (person-mrem)	# jobs	Actual dose received (person-mrem)
Misc. Dose & RCT – GetDose		4570	19	2093
RCT & RWP		213	5	1960*
RCT, RWP & ALARA		3093	12	
Misc. Dose total		4570		2093
Rad Job total (highlighted)		3306		1960
Total		<b>7874</b>		<b>4053</b>

\*Actual dose received from the all RWP jobs whether they were ALARA jobs.

The actual dose received during the 2019 shutdown, based on Pocket Dosimeter reports from GetDose and/or the pocket dosimeter cards, was 4,053 person-mrem. 154 people reported accumulating some dose (> 0 mrem) during the shutdown. The maximum individual dose received was 156 mrem, and the average individual dose received was 26.32 mrem.

The Misc. Dose total was lower than the pre-shutdown estimate. In fact, the estimated pre-shutdown Misc. Dose was very close to the total actual dose received during 2019 shutdown. The pre-shutdown Misc. Dose is calculated by taking the previous shutdown’s Misc. Dose and normalizing it for the current shutdown based on the number of weeks in each shutdown:

$$2019 \text{ misc. dose} = (2018 \text{ PD report} - 2018 \text{ RP actual dose received}) \times \left( \frac{\# \text{ weeks in 2019 shutdown}}{\# \text{ weeks in 2018 shutdown}} \right)$$

$$2019 \text{ misc. dose} = (6,463 \text{ person} - \text{mrem} - 3,318 \text{ person} - \text{mrem}) \times \left( \frac{13 \text{ weeks}}{10 \text{ weeks}} \right)$$

$$2019 \text{ misc. dose} = 4,089 \text{ person} - \text{mrem}$$

4570 person-mrem is the sum of 481 person-mrem for “no coverage” and “RCT Coverage” jobs and 4089 person-mrem for other jobs that do not warrant a review by RPO (i.e. walkthroughs, etc.).

Overall, all jobs entered into the worklist and performed during the 2019 shutdown were reviewed by RPO. Even with some modifications of scope and reclassifying the radiation safety coverage categories, total dose received was well within the pre-shutdown estimate.

At the end of the memo Table 3 shows the full list of “RCT Coverage”, “RCT & RWP” and “RCT, RWP & ALARA” jobs performed during the shutdown with their pre-shutdown estimated cumulative

dose (where applicable), pre-job estimated cumulative dose (where applicable), and the actual dose received for jobs requiring an RWP and/or ALARA plan.

Cc: R. Madiar      M. Quinn      M. Schoell      M. Lindgren  
C. Gattuso      T. Sullivan      J. Compton      E. McHugh  
A. Kenney      M. Convery      S. McGimpsey      K. Graden

Table 3. Job Review, RP Coverage Categories, Pre-Shutdown Dose Estimate, and Pre-Job Estimates & Actual Dose Received for RWP & ALARA Jobs.

Full post-job writeups for RWP jobs kept in the RWP database – see RSO for details on specific jobs

Job	Pre-Shutdown Estimated person-mrem with 25% contingency	Coverage Type	RWP # (if applicable)	Pre-Job Estimate (person-mrem)	Actual Dose Received (person-mrem)
Sump Installation in Transfer Hall just before the gate to Enclosure B.	0	RCT Coverage			
Open and inspect the Enclosure C magnet drop hatch to determine whether it can be used for magnet replacements.	0	RCT Coverage			
Pull new cables for F11 BPMs.	62.5	RCT & RWP			
Install new NuMI target	687.5	RCT, RWP & ALARA	AD-19-108	349	365
NuMI Absorber RAW Filter Change	0	RCT Coverage			
Switch BNB RAW Chiller	0	No Coverage			
Booster Wide Bore cavity installation	18.75	RCT Coverage			
Find and Fix Booster nitrogen leaks	12.5	RCT Coverage			
Repair Booster capacitor at 6-1	6.25	RCT Coverage			
Booster RF 17 and 18 work	25	RCT Coverage			
Booster L-1 wire inspection	0	RCT Coverage			
Booster L-1 wire repair (if needed)	0	RCT Coverage			
Stripping foil maintenance Booster L-1	0	RCT Coverage			
Booster Alignment of Kicker as founds L-2	25	RCT Coverage			
Check capacitance around booster	175	RCT Coverage			
Booster Vacuum Leak check	12.5	RCT Coverage			
RCT Decon MI-30 collimator floor	123.75	RCT, RWP & ALARA	AD-19-117	82	35
Repair leaks on MI beam valve BV-301	93.75	RCT coverage			
RCT Decon MI-8 collimator region	127.5	RCT, RWP & ALARA	AD-19-116	85	17
MI-8 alignment elevation run	163.75	RCT, RWP & ALARA	AD-19-101	72	46

Test pumps at MI 8 GeV 835 and 840 to see if the feed through/pump is damaged.	75	RCT Coverage			
IERC Com Duct SS Cable Relocate	0	RCT Coverage			
Linac Tank 4 Drift Tube Replacement	125	RCT, RWP & ALARA	AD-19-112	50	5
Ion pump cable pull MI300 region	1094	RCT, RWP & ALARA	AD-19-127	875	548
MI 8 GeV Ion pump cable replacement	300	RCT, RWP & ALARA	AD-19-130	302	361
New water lines for NuMI Horn/Target - Target Hall piping	188	RCT, RWP & ALARA	AD-19-110	377	327
New water lines for NuMI Horn/Target - RAW Room piping	25	RCT, RWP & ALARA	AD-19-110	377	327
NuMI Absorber RAW Filter change	0	RCT Coverage			
NuMI target move from MI-65 to CZero	31.25	RCT, RWP & ALARA	AD-19-107	17	12
Replace Ion pump 308 in recycler	151.25	RCT, RWP & ALARA	AD-19-129	179	121
Inspect QXR Power Connections MI 302 and 304	131.25	RCT Coverage			
NuMI target hall air filter replacement	75	RCT & RWP	AD-19-109	52	44
Replace SwitchYard EPB 201-12	0	RCT Coverage			
Replace SwitchYard A48 Quad	6.25	RCT & RWP	AD-19-118	6.25	0
Remove Proton Line right bends for new SwitchYard septa test stand	50	RCT & RWP	AD-19-125	50	10
APO Target Rotation Diagnostics	Not available	RCT, RWP & ALARA	AD-19-120	98	79