

Memorandum

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Date: July 2, 2019
To: Matt Quinn, Senior Radiation Safety Officer (SRSO)
From: Maddie Schoell, RPO Department Head
Re: Estimated Dose for Summer 2019 Shutdown & SRSO Approval Request for Select ALARA Jobs Per FRCM Article 354.8

Message:

The Fermilab 2019 shutdown begins on July 7, 2019 and will last approximately 13 weeks, with beam operations planned to begin being restored during the week of September 23, 2019. All shutdown jobs in the electronic worklist have been reviewed by ES&H Radiation Physics Operations (RPO) Department RSOs & RCTs, and jobs requiring various levels of RP coverage, described in Table 1, have been identified. All of the jobs that require work in radiologically hotter areas will allow for as much cool-off as possible, taking into account that many tasks are time-dependent within an overall project management completion schedule.

Table 1. RP Coverage Categories and Descriptions & Requirements. These categories were created before the 2018 shutdown to help clarify and disambiguate requirements for specific jobs.

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 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.

At the time of the review, 7/2/2019, there are 138 jobs scheduled for the shutdown, 35 of which were flagged by Radiation Safety for further review. Of these jobs, 1 is classified as "No Coverage", 18 are "RCT Coverage", 5 are "RCT & RWP", and 11 are "RCT, RWP & ALARA". Please see Table 2 below, noting that this list represents the jobs reviewed by Radiation Safety as of 7/2/2019 and may not be inclusive of all jobs occurring during the shutdown. As additional jobs are added into the worklist, they will be reviewed by RPO and covered as needed. Dose estimates are conservative estimates from the RSOs, RCTs and/or machine experts noted in their specific job plans, which may be used for ALARA plans if needed. Dose estimates for specific jobs listed in Table 2 and throughout this memo contain a 25% contingency. Job plans and dose estimates may be added, updated and/or removed as needed as the shutdown progresses.

There are eleven (11) jobs that currently surpass the ALARA trigger levels specified in FRCM Article 354:

1. Install new NuMI Target. Estimated at 688 person-mrem. This job surpasses ALARA Trigger Level #2 – radiation fields in excess of 1,000 mrem/hr.
2. RCT Decontamination of MI-30 Collimator Region. Estimated at 124 person-mrem. This job surpasses ALARA Trigger Level #2 – radiation fields in excess of 1,000 mrem/hr.
3. RCT Decontamination of MI 8 GeV Collimator Region. Estimated at 128 person-mrem. This job surpasses ALARA Trigger Level #2 – radiation fields in excess of 1,000 mrem/hr.
4. Alignment elevation surveys in MI 8 GeV. Estimated at 164 person-mrem. This job surpasses ALARA Trigger Level #2 – radiation fields in excess of 1,000 mrem/hr.
5. Linac Tank 4 Drift Tube Replacement. Estimated at 125 person-mrem. This job does not surpass any explicit ALARA Trigger Levels, however it has the potential for contamination inside the tank, but not expected to be 10 times the value in Table 2-2. Previous drift tube replacements received SRSO approval, so SRSO approval is requested again for consistency.
6. Ion Pump Cable Pulls in MI-300 Region. Estimated at 1,094 person-mrem. This job surpasses ALARA Trigger Levels #1 & 2 – collective doses estimated to be greater than 1,000 person-mrem & radiation fields in excess of 1,000 mrem/hr. Additional controls will be in place to monitor for airborne radioactivity, but not expected to be greater than DAC values in Appendix A of 10 CFR 835 (which would require posting as Airborne Radioactivity Area), details will be attached to the RWP.
7. Ion Pump Cable Replacements in MI 8 GeV. Estimated at 300 person-mrem. This job surpasses ALARA Trigger Level #2 – radiation fields in excess of 1,000 mrem/hr. Additional controls will be in place to monitor for airborne radioactivity, but not expected to be greater than DAC values in Appendix A of 10 CFR 835 (which would require posting as Airborne Radioactivity Area), details will be attached to the RWP.
8. NuMI Target Hall Piping. Estimated at 188 person-mrem. This job surpasses ALARA Trigger Level #2 – radiation fields in excess of 1,000 mrem/hr. This job also has the potential for contamination when cutting into beam pipe, but not expected to be 10 times the value in Table 2-2.
9. NuMI RAW Room Piping. Estimated at 25 person-mrem. This job surpasses ALARA Trigger Level #2 – radiation fields in excess of 1,000 mrem/hr. This job also has the potential for contamination when cutting into beam pipe, but not expected to be 10 times the value in Table 2-2. This job will

be done with job #8 (NuMI Target Hall Piping) under the same RWP, there are two entries in the worklist due to the two locations (Target Hall and RAW Room).

10. NuMI Target Move from MI-65 to CZero. Estimated at 31 person-mrem. This job surpasses ALARA Trigger Level #2 – radiation fields in excess of 1,000 mrem/hr. This job involves movement of Class 3 or higher material, and will also follow requirements laid out in FRCM 423, including obtaining Chief Safety Officer (CSO) approval.
11. Ion Pump Replacement in Recycler 308, MI-30 Collimator Region. Estimated at 151 person-mrem. This job surpasses ALARA Trigger Level #2 – radiation fields in excess of 1,000 mrem/hr. Additional controls will be in place to monitor for airborne radioactivity, but not expected to be greater than DAC values in Appendix A of 10 CFR 835 (which would require posting as Airborne Radioactivity Area), details will be attached to the RWP.

There are several other jobs that currently do not surpass the ALARA trigger levels, and are categorized as “RCT Coverage” or “RCT & RWP”. These jobs involve inspections, and if repairs are found to be needed, the job plans will be developed and these jobs may become either “RCT & RWP” or “RCT, RWP & ALARA” jobs.

1. Booster Nitrogen Leak Inspection. Estimated at 13 person-mrem. Depending on where the leak is at, repairs may be in areas with radiation fields in excess of 1,000 mrem/hr – at which point the job will be paused to generate job plans & RWPs and receive necessary approvals.
2. Booster L-1 Wire Inspection. No estimated dose for wire inspection. If a repair is needed, no dose is expected but there may be a need for an RWP for contamination control – at which point the job will be paused to generate job plan & RWP and receive necessary approvals.
3. Booster Vacuum Leak Check. Estimated 13 person-mrem. Depending on if a leak is found and where it’s at, repairs may be in areas with radiation fields in excess of 1,000 mrem/hr – at which point the job will be paused to generate job plans & RWPs and receive necessary approvals.
4. Main Injector beam valve leak repairs. Estimated 94 person-mrem. If a repair is needed in the MI-30 Collimator region, it may be in an area with radiation fields still in excess of 1,000 mrem/hr – at which point the job will be paused to update job plans & RWPs and receive additional necessary approvals.
5. Main Injector QXR Power Connection Inspections. Estimated 131 person-mrem. If repairs are needed, this may be in an area with radiation fields still in excess of 1,000 mrem/hr – at which point the job will be paused to update job plans & RWPs and receive additional necessary approvals.
6. Main Injector BLM Current Draw Inspection & Repair. This job was entered into the worklist 7/2/2019 and the job plan is still under development. The work will occur in the posted High Radiation Area in MI-30, but not expected to be in radiation fields in excess of 1,000 mrem/hr. There will be an RWP for this job, and once the job plan is finalized and exact scope of work is known, a pre-job dose estimate will be provided and SRSO approval requested if necessary.
7. Muon Campus Modification to Spacers Between Target Vault Modules. This job was entered into the worklist 7/2/2019 and the job plan is still under development. This work will likely involve remote handling of Target Vault modules. There will be an RWP for this job and most likely

require SRSO approval as a formal ALARA job, and once the job plan is finalized and exact scope of work is known, a pre-job dose estimate will be provided and SRSO approval requested.

I request advanced SRSO approval for these specific ALARA jobs per the requirements in FRCM Article 354. As the shutdown progresses, SRSO approval will be requested for specific "RCT, RWP & ALARA" jobs if/when they are added.

The initial total pre-shutdown estimated dose, including 25% contingency, is 7,874 person-mrem:

- 3,304 person-mrem for the Rad Coverage Jobs ("RCT & RWP" and "RCT, RWP & ALARA" jobs). Please see Table 2.
- 4,570 person-mrem for other miscellaneous jobs (including RP reviewed "no coverage" and "RCT Coverage" jobs, which will be tracked in GetDose)
 - 481 person-mrem for "no coverage" and "RCT Coverage" jobs.
 - 4,089 person-mrem for other jobs (i.e., walkthroughs, etc.)*, accounting for additional reduction in residual dose in the enclosure**.

*The estimated miscellaneous dose for the 2019 shutdown is based on the actual dose received for the 2018 shutdown Rad Coverage Jobs, and the final pocket dosimeter (PD) report.

**Collimators were added in the Main Injector before the 2017 shutdown, greatly reducing the residual dose in the enclosure. For the 2017 shutdown, an estimated 20% decrease in miscellaneous dose, but was still much higher than miscellaneous dose received, so an additional 10% decrease was incorporated into the 2018 miscellaneous dose estimate. Also in 2018, the new RP categories were implemented, so ~50% more jobs were classified as "Misc." (with RCT coverage but dose tracked through GetDose rather than on RWPs). No significant changes were made either in the enclosures or with the job categories, so no additional reductions were made for the 2019 shutdown miscellaneous dose estimate.

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


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

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

This estimated total may change as the job plans are adjusted as the jobs proceed, or additional RCT Coverage, RCT & RWP, and/or RCT, RWP & ALARA jobs are added upon discovery of unforeseen problems. The total estimated dose for the current year shutdown is 7,874 person-mrem. Dose to individuals will be managed by work planning, the use of temporary shielding, and distribution of dose among several individuals.

The shutdown is planned to be within the same calendar quarter (3rd quarter, 2019). As such, total effective doses will be limited to the 350 mrem in a calendar quarter limit. In previous shutdowns, individuals received less than 300 mrem for the duration of the shutdown, so there is little chance of exceeding the 350 mrem limit in the calendar quarter during the shutdown.

SRSO approval is requested for all of the 2019 shutdown jobs, in addition to specific jobs noted above, with the described RPO review and coverage throughout the shutdown.

I approve this plan:  Date: 7/2/19
Matt Quinn, Senior Radiation Safety Officer (SRSO)

Cc: M. Quinn D. Cossairt J. Anderson Jr. M. Lindgren M. Convery C. Gattuso
T. Sullivan J. Compton E. McHugh A. Kenney M. Bonkalski
M. Schoell N. Chelidze S. McGimpsey K. Graden J. Fulgham

Table 2. Job Review, RP Coverage Categories, and Pre-Shutdown Dose Estimate

Job	Pre-Shutdown Estimated person-mrem with 25% contingency	Coverage Type	Pre-Job Comments
Sump Installation in Transfer Hall just before the gate to Enclosure B.	0	RCT Coverage	RCT coverage for potential contamination.
Open and inspect the Enclosure C magnet drop hatch to determine whether it can be used for magnet replacements.	0	RCT Coverage	RCT Coverage needed to unlock hatch.
Pull new cables for F11 BPMs.	62.5	RCT & RWP	Depends on dose rates in area, F-13 was a High Radiation Area last shutdown.
Install new NuMI target	687.5	RCT, RWP & ALARA	
NuMI Absorber RAW Filter Change	0	RCT Coverage	RCT coverage needed for work on RAW systems.
Switch BNB RAW Chiller	0	No Coverage	Actually LCW chiller work, not RAW. Requested worklist entry be updated.
Booster Wide Bore cavity installation	18.75	RCT Coverage	Contamination survey and storage of cavity
Find and Fix Booster nitrogen leaks	12.5	RCT Coverage	RWP/ALARA if repairs are in Long 3 or Period 6.
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	Combined with repair for contamination control if needed.
Booster L-1 wire repair (if needed)	0	RCT Coverage	If needed, RWP for contamination control.
Stripping foil maintenance Booster L-1	0	RCT Coverage	Contamination if foil breaks
Booster Alignment of Kicker as founds L-2	25	RCT Coverage	
Check capacitance around booster	175	RCT Coverage	Requires RCT coverage in High Rad areas, period 6 and Long 3.
Booster Vacuum Leak check	12.5	RCT Coverage	RWP/ALARA if repairs are in Long 3 or Period 6.
RCT Decon MI-30 collimator floor	123.75	RCT, RWP & ALARA	
Repair leaks on MI beam valves	93.75	RCT & RWP	ALARA if repairs are in MI-30 collimator region if dose rates > 1 R/hr.
RCT Decon MI-8 collimator region	127.5	RCT, RWP & ALARA	
MI-8 alignment elevation run	163.75	RCT, RWP & ALARA	
Test pumps at MI 8 GeV 835 and 840 to see if the feed through/pump is damaged.	75	RCT Coverage	

Job	Pre-Shutdown Estimated person-mrem with 25% contingency	Coverage Type	Pre-Job Comments
Linac Tank 4 Drift Tube Replacement	125	RCT, RWP & ALARA	
Ion pump cable pull MI300 region	1093.75	RCT, RWP & ALARA	
MI 8 GeV Ion pump cable replacement	300	RCT, RWP & ALARA	
New water lines for NuMI Horn/Target - Target Hall piping	187.5	RCT, RWP & ALARA	
New water lines for NuMI Horn/Target - RAW Room piping	25	RCT, RWP & ALARA	
NuMI Absorber RAW Filter change	0	RCT Coverage	RCT coverage needed for work on RAW systems.
NuMI target move from MI-65 to CZero	31.25	RCT, RWP & ALARA	SRSO and CSO approval for movement of class 5 material
Replace Ion pump 308 in recycler	151.25	RCT, RWP & ALARA	
Inspect QXR Power Connections MI 302 and 304	131.25	RCT Coverage	ALARA if repairs are in MI-30 collimator region if dose rates > 1 R/hr.
NuMI target hall air filter replacement	75	RCT & RWP	
Replace SwitchYard EPB 201-12	0	RCT Coverage	RCT coverage for potential contamination
Replace SwitchYard A48 Quad	6.25	RCT & RWP	
Remove Proton Line right bends for new SwitchYard septa test stand	50	RCT & RWP	
MI 8 GeV Multiwire Inspection	0	RCT Coverage	RCT coverage for potential contamination
MI BLM Inspection & Repair	Unknown*	RCT & RWP	*Job plan still in development, will be in posted High Radiation Area but no work in fields > 1 R/hr.
Muon Campus modify spacers between modules in Target Vault	Unknown*	RCT, RWP & ALARA	*Job plan still in development, will involve work in Target Vault and work on modules.