

Table 2. Summary of Baseline and Residual Risks - CDF Detector

Risk Tables Description		Baseline Risk	Residual Risk
2.1	Radiological – Onsite-1 Facility Worker	R: I	R: IV
2.2	Radiological – Onsite-2 Co-located Worker	R: I	R: IV
2.3	Radiological – MOI Offsite	R: I	R: IV
2.4	Toxic Materials – Onsite 1 Facility Worker	R: *	R: *
2.5	Toxic Materials – Onsite 2 Co-located Worker	R: *	R: *
2.6	Toxic Materials – MOI Offsite	R: *	*
2.7	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: *	R: *
2.8	Flammable & Combustible Materials – Onsite-2 Co-located worker	*	R: *
2.9	Flammable & Combustible Materials – MOI Offsite	R: *	R: *
2.10	Other Hazards – Onsite-1 Facility Worker	R: *	R: *
2.11	Other Hazards – Onsite-2 Co-located Worker	R: *	R: *
2.12	Other Hazards – MOI Offsite	*	R: *
2.13	Access & Egress – Onsite-1 Facility Worker	R: *	R: *
2.14	Access & Egress – Onsite-2 Co-located Worker	R: *	R: *
2.15	Access & Egress – MOI Offsite	R: *	R: *
2.16	Environmental Hazards	R: *	R: *
<p>* This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 <i>Safety Analysis</i>. Work in the specified areas involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.</p> <p>NOTE: Per DOE-HDBK-1163-2020, Appendix C, “Risk Assessment Methodology”: “Events with an unmitigated risk value of III or IV would not require additional control assignments to provide reasonable assurance of adequate protection. Whereas, for events with an unmitigated risk value of I or II, controls would need to be assigned to either reduce the likelihood or the consequence, and therefore the overall mitigated risk. Generally, preventive controls are applied prior to a loss event – reflecting a likelihood reduction and mitigative controls are applied after a loss event – reflecting a consequence reduction. Each control is credited for a single “bin drop” either in likelihood or consequence; not both. Following a standard hierarchy of controls, controls are applied until the residual risk is acceptable – reflecting a mitigated risk value of III or IV. After controls are credited, events with a remaining unacceptable residual risk (i.e., I or II) are candidates for additional analyses and additional controls, often quantitative in nature.” For Fermilab, these controls for accelerator-specific hazards are identified as Credited Controls and further summarized in the Accelerator Safety Envelope (ASE).</p>			

Table 2.1 Radiological – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Sources	<i>Hazard: Radioactive sources for in-situ calibration remain in the detector: Cs-137 and Fe=55.</i>	L: U C: N R: I	P: Access to the area is controlled via a single entrance which is locked. P: Sources are buried deep in the detector and not accessible without specialized tools and knowledge. M: These are low dosage sources and have already decayed at the 50% level.	L: U C: N R: IV

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.																																				
Likelihood (L, of event)/year A = Anticipated ($L > 1.0E-02$) U = Unlikely ($1.0E-02 > L > 1.0E-04$) EU = Extremely Unlikely ($1.0E-04 > L > 1.0E-06$) BEU = Beyond Extremely Unlikely ($1.0E-06 > L$)	Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible		Risk (R, Qualitative Ranking) I = situation (event) of major concern II = situation (event) of concern III = situation (event) of minor concern IV = situation (event) of minimal concern		Risk Matrix <table border="1"> <thead> <tr> <th colspan="2" rowspan="2"></th> <th colspan="4">Likelihood</th> </tr> <tr> <th>A</th> <th>U</th> <th>EU</th> <th>BEU</th> </tr> </thead> <tbody> <tr> <th rowspan="4">Consequences</th> <th>H</th> <td>I</td> <td>I</td> <td>II</td> <td>III</td> </tr> <tr> <th>M</th> <td>II</td> <td>II</td> <td>III</td> <td>IV</td> </tr> <tr> <th>L</th> <td>III</td> <td>III</td> <td>IV</td> <td>IV</td> </tr> <tr> <th>N</th> <td>IV</td> <td>IV</td> <td>IV</td> <td>IV</td> </tr> </tbody> </table>			Likelihood				A	U	EU	BEU	Consequences	H	I	I	II	III	M	II	II	III	IV	L	III	III	IV	IV	N	IV	IV	IV	IV
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Table 2.2 Radiological – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Sources	<i>Hazard: Radioactive sources for in-situ calibration remain in the detector: Cs-137 and Fe=55.</i>	L: U C: N R: I	P: Access to the area is controlled via a single entrance which is locked. P: Sources are buried deep in the detector and not accessible without specialized tools and knowledge. M: These are low dosage sources and have already decayed at the 50% level.	L: U C: N R: IV

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Table 2.3 Radiological – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Sources	<i>Hazard: Radioactive sources for in-situ calibration remain in the detector: Cs-137 and Fe=55.</i>	L: U C: H R: I	P: Access to the building is not available to the public. P: Access to the area is controlled via a single entrance which is locked. P: Sources are buried deep in the detector and not accessible without specialized tools and knowledge. M: These are low dosage sources and have already decayed at the 50% level.	L: BEU C: M R: IV

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Table 2.4 Toxic Materials – Onsite 1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	<i>Hazard: Potential exposure to lead-sheets that are part of the electromatic calorimeters.</i>	L:EU C:H R:II	P – Plates are completely contained within the calorimeter modules and are not exposed. P – Access requires opening up the central detector using special equipment and knowledge so would only be done during final decommissioning. P - Work planning and controls would be required for any access to the plates. M -Access to the area is controlled administratively.	L:BEU C:H R:III

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Table 2.5 Toxic Materials – Onsite 2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	<i>Hazard: Potential exposure to lead-sheets that are part of the electromatic calorimeters.</i>	L:EU C:H R:II	P – Plates are completely contained within the calorimeter modules and are not exposed. P – Access requires opening up the central detector using special equipment and knowledge so would only be done during final decommissioning. P - Work planning and controls would be required for any access to the plates. M -Access to the area is controlled administratively.	L:BEU C:M R:IV

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Table 2.6 Toxic Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	<i>Hazard: Potential exposure to lead-sheets that are part of the electromatic calorimeters.</i>	L:EU C:H R:II	<p>P – Plates are completely contained within the calorimeter modules and are not exposed.</p> <p>P – Access requires opening up the central detector using special equipment and knowledge so would only be done during final decommissioning.</p> <p>P -Work planning and controls would be required for any access to the plates.</p> <p>M – Public access to the building that contains the entrance is not allowed.</p> <p>M - Access to the area is controlled administratively.</p>	L:BEU C:M R:IV

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Table 2.7 Flammable and Combustible Materials – Onsite -1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible materials (cables, Boxes, Paper, wood cribbing, etc.)	<i>Hazard: N/A</i>	L: C: R:	See section 1, Chapter 4.	L: C: R:

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Table 2.8 Flammable and Combustible Materials – Onsite -2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible materials (cables, Boxes, Paper, wood cribbing, etc.)	<i>Hazard: N/A</i>	L: C: R:	See section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																			
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Table 2.9 Flammable and Combustible Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible materials (cables, Boxes, Paper, wood cribbing, etc.)	<i>Hazard: N/A</i>	L: C: R:	See section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																			
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Table 2.10 Other hazards – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined Spaces	<i>Hazard: N/A</i>	L: C: R:	See section 1, Chapter 4.	L: C: R:

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Table 2.11 Other hazards – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined Spaces	<i>Hazard: N/A</i>	L: C: R:	See section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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Table 2.12 Other hazards – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined Spaces	<i>Hazard: N/A</i>	L: C: R:	See section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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Table 2.13 Access & Egress – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress	<i>Hazard: N/A</i>	L: C: R:	See section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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Table 2.14 Access & Egress – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress	<i>Hazard: N/A</i>	L: C: R:	See section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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	N	IV	IV	IV	IV																															
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.																																
	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C																																
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level																																

Table 2.15 Access & Egress – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress	<i>Hazard: N/A</i>	L: C: R:	See section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
Likelihood (L, of event)/year A = Anticipated ($L > 1.0E-02$) U = Unlikely ($1.0E-02 > L > 1.0E-04$) EU = Extremely Unlikely ($1.0E-04 > L > 1.0E-06$) BEU = Beyond Extremely Unlikely ($1.0E-06 > L$)	Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible		Risk (R, Qualitative Ranking) I = situation (event) of major concern II = situation (event) of concern III = situation (event) of minor concern IV = situation (event) of minimal concern		Risk Matrix <table border="1"> <thead> <tr> <th colspan="2" rowspan="2"></th> <th colspan="4">Likelihood</th> </tr> <tr> <th>A</th> <th>U</th> <th>EU</th> <th>BEU</th> </tr> </thead> <tbody> <tr> <th rowspan="4">Consequences</th> <th>H</th> <td>I</td> <td>I</td> <td>II</td> <td>III</td> </tr> <tr> <th>M</th> <td>II</td> <td>II</td> <td>III</td> <td>IV</td> </tr> <tr> <th>L</th> <td>III</td> <td>III</td> <td>IV</td> <td>IV</td> </tr> <tr> <th>N</th> <td>IV</td> <td>IV</td> <td>IV</td> <td>IV</td> </tr> </tbody> </table>			Likelihood				A	U	EU	BEU	Consequences	H	I	I	II	III	M	II	II	III	IV	L	III	III	IV	IV	N	IV	IV	IV	IV
			Likelihood																																	
A			U	EU	BEU																															
Consequences	H	I	I	II	III																															
	M	II	II	III	IV																															
	L	III	III	IV	IV																															
	N	IV	IV	IV	IV																															
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	C Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)																																	
	H C ≥ Irreversible, other serious effects, or symptoms which could impair an individual’s ability to take protective action.	C ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.																																	
	M C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.																																	
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	N Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level																																	

Table 2.16 Environmental

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Airborne	<p><i>Hazard:</i></p> <ul style="list-style-type: none"> • <i>Airborne release of radionuclides beyond permitted limits.</i> • <i>Discharge of chemicals into onsite surface waters beyond permitted limits.</i> 	L: C: R:	See section 1, Chapter 4.	L: C: R:
Water	<p><i>Hazard:</i></p> <ul style="list-style-type: none"> • <i>Discharge of radionuclides into onsite surface waters beyond permitted limits.</i> • <i>Discharge of chemicals into onsite surface waters beyond permitted limits.</i> 	L: C: R:	See section 1, Chapter 4.	L: C: R:
Soil	<p><i>Hazard:</i></p> <ul style="list-style-type: none"> • <i>Radioactive soil in beam loss areas beyond allowable concentrations of radionuclides beyond calculated Fermilab limits.</i> • <i>Discharge of chemicals into onsite soils beyond permitted limits.</i> 	L: C: R:	See section 1, Chapter 4.	L: C: R: