

Table 2. Summary of Baseline and Residual Risks - Switchyard

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: III
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: *	R: *
2.7*	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: *	R: *
2.8*	Flammable & Combustible Materials – Onsite-2 Co-located worker	R: *	R: *
2.9*	Flammable & Combustible Materials – MOI Offsite	R: *	R: *
2.10*	Electrical Energy – Onsite-1 Facility Worker	R: *	R: *
2.11*	Electrical Energy – Onsite-2 Co-located Worker	R: *	R: *
2.12*	Electrical Energy – MOI Offsite	R: *	R: *
2.13*	Thermal Energy – Onsite-1 Facility Worker	R: *	R: *
2.14*	Thermal Energy – Onsite-2 Co-located Worker	R: *	R: *
2.15*	Thermal Energy – MOI Offsite	R: *	R: *
2.16*	Kinetic Energy – Onsite-1 Facility Worker	R: *	R: *
2.17*	Kinetic Energy – Onsite-2 Co-located Worker	R: *	R: *
2.18*	Kinetic Energy – MOI Offsite	R: *	R: *
2.19*	Potential Energy- Onsite-1 Facility Worker	R: *	R: *
2.20*	Potential Energy – Onsite-2 Co-located Worker	R: *	R: *
2.21*	Potential Energy – MOI Offsite	R: *	R: *
2.22*	Magnetic Fields – Onsite-1 Facility Worker	R: *	R: *
2.23*	Magnetic Fields – Onsite-2 Co-located Worker	R: *	R: *
2.24*	Magnetic Fields – MOI Offsite	R: *	R: *
2.25	Other Hazards – Onsite-1 Facility Worker	R: I	R: IV
2.26	Other Hazards – Onsite-2 Co-located Worker	R: III	R: III
2.27	Other Hazards – MOI Offsite	R: III	R: III
2.28*	Access & Egress – Onsite-1 Facility Worker	R: *	R: *
2.29*	Access & Egress – Onsite-2 Co-located Worker	R: *	R: *
2.30*	Access & Egress – MOI Offsite	R: *	R: *
2.31*	Environmental Hazards	R: *	R: *

* This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis*. Work in the specified areas involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

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).

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)
Prompt Ionizing Radiation	<i>Hazard: Exposure to ionizing radiation.</i>	L: A C: H R: I	<p>P – Radiation Safety Interlock System (RSIS) prevents beam from entering an enclosure when that area is on access.</p> <p>P – Fencing prevents access to areas where beam could be running.</p> <p>P – Training for workers to identify operating enclosures vs. enclosures ready for access.</p> <p>M – Shielding between operating enclosures to minimize exposure to radiation.</p> <p>M – Run Conditions to ensure total radiation levels are within expected parameters.</p> <p>M – Radiation Detectors disable beam to protect personnel.</p>	L: BEU C: N R: IV
Residual Activation	<i>Hazard: Exposure to residual activation.</i>	L: A C: H R: I	<p>P – Radiological Work Permit prevents unauthorized personnel from areas where excessive residual radiation exists.</p> <p>P – Postings intended to caution workers of area hazard.</p> <p>P – Training for workers to identify and respond to the hazard.</p> <p>M – Run Conditions to ensure total radiation levels are within expected parameters.</p> <p>M – Shielding increases distance from the source of residual activation, minimizing exposure.</p>	L: BEU C: L R: IV
Groundwater Activation	<i>Hazard: Potential exposure due to construction activities, (e.g., earthmoving).</i>	L: A C: N R: IV	<p>P – Sump water is evaluated to determine the presence of tritium or other activation products to prevent personnel exposure.</p> <p>P – Sump pits/enclosures capture activated water to prevent releases exceeding allowed discharge limits.</p> <p>M – Facility designs employ shielding to mitigate the production of activation products in groundwater.</p>	L: EU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Surface Water Activation	<i>Hazard: Radionuclides in surface water exceeding regulatory levels.</i>	L: A C: N R: IV	P – Sump Pumps ensure water does not remain in the enclosure for extended periods of time. P – Sump Monitoring Program samples the water discharged by the sump pumps. M – Run Conditions to ensure total radiation levels are within expected parameters. M – Shielding ensures the distance from source to surface is maximized to reduce total dose.	L: EU C: N R: IV
Radioactive Water (RAW) Systems	<i>Hazard: Personnel exposed to radioactive water exceeding regulatory levels.</i>	L: A C: H R: I	P – Postings intended to caution workers of area hazard. P – Radiological Work Permit prevents unauthorized personnel from areas where excessive residual radiation exists. P – Training for workers to identify and respond to the hazard. M – Run Conditions to ensure total radiation levels are within expected parameters.	L: BEU C: M R: IV
Air Activation	<i>Hazard: Radionuclides in air exceeding regulatory levels.</i>	L: A C: H R: I	M – Engineered Air Flow ensures the air activation remains within the enclosure for more than the half-life of radionuclides before exiting. M – Run Conditions to ensure total radiation levels are within expected parameters.	L: A C: L R: III
Soil Interactions	<i>Hazard: Radionuclides are produced, which may contaminate groundwater.</i>	L: A C: H R: I	P – No excavation work allowed without an RWP. M – Engineered Beam Dump designed to contain the radiation produced by absorbing the deposited energy. M – Beamline Design ensures beam is transported through areas without interacting with soil. M – Run Conditions to ensure total radiation levels are within expected parameters.	L: U C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Waste	<i>Hazard: Personnel are exposed to ionizing radiation beyond regulatory levels.</i>	L: A C: H R: I	P – Locked Gates prevent access to areas where radiation waste is stored. P – Key Control Program ensures access to these areas is managed. P – Postings intended to caution workers of area hazard. M – Run Conditions to ensure total radiation levels are within expected parameters. M – Distance to Stored Materials reduces total exposure risk to personnel. M – Material survey and release program ensures radioactive waste is not stored in unauthorized areas.	L: BEU C: N R: IV
Contamination	<i>Hazard: Personnel are exposed to ionizing radiation beyond regulatory levels.</i>	L: A C: H R: I	P – Radiation Survey of areas to measure and detect contamination hazards. P – Postings intended to caution workers of area hazard. M – PPE Specified by the RWP to protect workers in a contamination area. M – Training to ensure workers understand the risks and can prepare for the job accordingly.	L: EU C: L R: IV
⁷ Be	<i>Hazard: Potential radiation exposure to ⁷Be (uptake/committed dose).</i>	L: A C: N R: IV	⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV
Radioactive Sources	<i>Hazard: Personnel are exposed to ionizing radiation beyond regulatory levels.</i>	L: A C: H R: I	P – Training for workers to identify and respond to the hazard. P – Postings intended to caution workers of area hazard. M – Source Handling Storage Requirements ensure radioactive sources are secured when not in use. M – Source Handling "In-Use" Requirements ensure the area where the radioactive source is used is tightly controlled.	L: EU C: L 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)
Prompt Ionizing Radiation	<i>Hazard: Exposure to ionizing radiation.</i>	L: A C: H R: I	P – Radiation Safety Interlock System prevents beam from entering an enclosure when that area is on access. P – Fencing prevents access to areas where beam could be running. P – Training for workers to identify operating enclosures vs. enclosures ready for access. M – Shielding between operating enclosures to minimize exposure to radiation. M – Run Conditions to ensure total radiation levels are within expected parameters. M – Radiation Detectors disable beam to protect personnel.	L: BEU C: N R: IV
Residual Activation	<i>Hazard: Exposure to residual activation.</i>	L: A C: H R: I	P – Radiological Work Permit prevents unauthorized personnel form areas where excessive residual radiation exists. P – Postings intended to caution workers of areas of residual activation. P – Training for workers to identify and respond to the hazard. M – Run Conditions to ensure total radiation levels are within expected parameters. M – Shielding increases distance from the source of residual activation, minimizing exposure.	L: BEU C: M R: IV
Groundwater Activation	<i>Hazard: Radionuclides in groundwater exceeding regulatory levels.</i>	L: A C: H R: I	P – Sump Pumps ensure water does not remain in the enclosure for extended periods of time. P – Sump Monitoring Program samples the water discharged by the sump pumps. M – Run Conditions to ensure total radiation levels are within expected parameters.	L: EU C: M R: III

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Surface Water Activation	<i>Hazard: Radionuclides in surface water exceeding regulatory levels.</i>	L: A C: H R: I	P – Sump Pumps ensure water does not remain in the enclosure for extended periods of time. P – Sump Monitoring Program samples the water discharged by the sump pumps. M – Run Conditions to ensure total radiation levels are within expected parameters. M – Shielding ensures the distance from source to surface is maximized to reduce total dose.	L: EU C: L R: IV
Radioactive Water (RAW) Systems	<i>Hazard: Personnel exposed to radioactive water exceeding regulatory levels.</i>	L: A C: H R: I	P – Postings intended to caution workers of area hazard. P – Radiological Work Permit prevents unauthorized personnel form areas where excessive residual radiation exists. P – Training for workers to identify and respond to the hazard. M – Run Conditions to ensure total radiation levels are within expected parameters.	L: BEU C: M R: IV
Air Activation	<i>Hazard: Radionuclides in air exceeding regulatory levels.</i>	L: A C: H R: I	M – Engineered Air Flow ensures the air activation remains within the enclosure for more than the half-life of radionuclides before exiting. M – Run Conditions to ensure total radiation levels are within expected parameters.	L: A C: L R: III
Soil Interactions	<i>Hazard: Radionuclides are produced, which may contaminate groundwater.</i>	L: A C: H R: I	P – No excavation work allowed without an RWP. M – Engineered Beam Dump designed to contain the radiation produced by absorbing the deposited energy. M – Beamline Design ensures beam is transported through areas without interacting with soil. M – Run Conditions to ensure total radiation levels are within expected parameters.	L: U C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Waste	<i>Hazard: Personnel are exposed to ionizing radiation beyond regulatory levels.</i>	L: A C: H R: I	P – Locked Gates prevent access to areas where radiation waste is stored. P – Key Control Program ensures access to these areas is managed. P – Postings intended to caution workers of area hazard. M – Run Conditions to ensure total radiation levels are within expected parameters. M – Distance to Stored Materials reduces total exposure risk to personnel. M – Material survey and release program ensures radioactive waste is not stored in unauthorized areas.	L: BEU C: N R: IV
Contamination	<i>Hazard: Personnel are exposed to ionizing radiation beyond regulatory levels.</i>	L: A C: H R: I	P – Radiation Survey of areas to measure and detect contamination hazards. P – Postings intended to caution workers of area hazard. M – PPE Specified by the RWP to protect workers in a contamination area. M – Training to ensure workers understand the risks and can prepare for the job accordingly.	L: EU C: L R: IV
⁷ Be	<i>Hazard: Potential radiation exposure to ⁷Be (uptake/committed dose).</i>	L: A C: N R: IV	⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV
Radioactive Sources	<i>Hazard: Personnel are exposed to ionizing radiation beyond regulatory levels.</i>	L: A C: H R: I	P – Training for workers to identify and respond to the hazard. P – Postings intended to caution workers of area hazard. M – Engineered Beam Dump designed to contain the radiation produced by absorbing the deposited energy. M – Engineered Beam Dump designed to contain the radiation produced by absorbing the deposited energy. M – Source Handling Storage Requirements ensure radioactive sources are secured when not in use. M – Source Handling “In-Use” Requirements ensure the area where the radioactive source is used is tightly controlled.	L: EU C: L R: IV

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.

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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)
Prompt Ionizing Radiation	<i>Hazard: Exposure to ionizing radiation.</i>	L: A C: H R: I	P – Locked building prevents unauthorized access by public. P – Interlocked gates prevent unauthorized access by public with beam on. M – Shielding reduces potential for exposure. M – Interlocked Radiation Detectors prevent beam from exceeding predetermined radiation limits.	L: EU C: L R: IV
Residual Activation	<i>Hazard: Exposure to residual activation.</i>	L: A C: H R: I	P – Locked building prevents unauthorized access by public. P – Locked enclosure prevents unauthorized access by public. M – Run Conditions limit total beam through the area to limit the creation of activation.	L: EU C: M R: III
Groundwater Activation	<i>Hazard: Radionuclides in groundwater exceeding regulatory levels.</i>	L: A C: H R: I	P – Sump Pumps ensure water does not remain in the enclosure for extended periods of time. P – Sump Monitoring Program samples the water discharged by the sump pumps. M – Run Conditions to ensure total radiation levels are within expected parameters.	L: EU C: M R: III
Surface Water Activation	<i>Hazard: Radionuclides in surface water exceeding regulatory levels.</i>	L: A C: H R: I	P – Sump Pumps ensure water does not remain in the enclosure for extended periods of time. P – Sump Monitoring Program samples the water discharged by the sump pumps. M – Run Conditions to ensure total radiation levels are within expected parameters. M – Shielding ensures the distance from source to surface is maximized to reduce total dose.	L: EU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Water (RAW) Systems	<i>Hazard: Personnel exposed to radioactive water exceeding regulatory levels.</i>	L: A C: H R: I	P – Locked building prevents unauthorized access by public. P – Locked enclosure gate prevents access to the RAW system. M – Run Conditions limit total beam through the area to limit the creation of activation.	L: EU C: M R: III
Air Activation	<i>Hazard: Radionuclides in air exceeding regulatory levels.</i>	L: A C: H R: I	M – Engineered Air Flow ensures the air activation remains within the enclosure for more than the half-life of radionuclides before exiting. M – Run Conditions to ensure total radiation levels are within expected parameters.	L: A C: L R: III
Soil Interactions	<i>Hazard: Radionuclides are produced, which may contaminate groundwater</i>	L: A C: H R: I	M – Engineered Beam Dump designed to contain the radiation produced by absorbing the deposited energy. M – Beamline Design ensures beam is transported through areas without interacting with soil. M – Run Conditions to ensure total radiation levels are within expected parameters.	L: A C: N R: IV
Radioactive Waste	<i>Hazard: Personnel are exposed to ionizing radiation beyond regulatory levels.</i>	L: A C: H R: I	P – Locked Gates prevent access to areas where radiation waste is stored. P – Key Control Program ensures access to these areas is managed. M – Run Conditions to ensure total radiation levels are within expected parameters. M – Distance to Stored Materials reduces total exposure. M – Material survey and release program ensures radioactive waste is not stored in unauthorized areas.	L: EU C: N R: IV
Contamination	<i>Hazard: Personnel are exposed to ionizing radiation beyond regulatory levels.</i>	L: A C: H R: I	P – Locked building prevents unauthorized access by public. P – Locked enclosure prevents unauthorized access by public. M – Shielding increases distance to stored materials reduces total exposure. M – Material survey and release program ensures radioactive waste is not stored in unauthorized areas.	L: EU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
⁷ Be	<i>Hazard: Potential radiation exposure to ⁷Be (uptake/committed dose).</i>	L: A C: N R: IV	⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV
Radioactive Sources	<i>Hazard: Personnel are exposed to ionizing radiation beyond regulatory levels.</i>	L: A C: H R: I	<p>P – Locked building prevents unauthorized access by public.</p> <p>P – Sources locked and inventoried by ES&H always ensuring positive control of radioactive source.</p> <p>M – Engineered Beam Dump designed to contain the radiation produced by absorbing the deposited energy.</p> <p>M – Engineered Beam Dump designed to contain the radiation produced by absorbing the deposited energy.</p> <p>M – Source Handling Storage Requirements ensure radioactive sources are secured when not in use.</p> <p>M – Source Handling “In-Use” Requirements ensure the area where the radioactive source is used is tightly controlled.</p>	L: EU C: L R: IV

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	N	0.5 rem > C	5 rem > C	5 rem > C																																

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 during manual handling of un-encased lead bricks, lead shot, lead sheets, lead paint, and soldering operations.</i>	L: C: R:	See Section I Chapter 04	L: C: R:

Chemical Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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	L	$PAC-1 > C$	$PAC-2 > C$	PEL or $TLV_c > C$																																
	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 2.5 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 during manual handling of un-encased lead bricks, lead shot, lead sheets, lead paint, and soldering operations.</i>	L: C: R:	See Section I Chapter 04	L: C: R:

Chemical 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		Risk (R, Qualitative Ranking)		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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	H	$C \geq PAC-2$	$C \geq PAC-3$	$C \geq IDLH$																																
	M	$PAC-2 > C \geq PAC-1$	$PAC-3 > C \geq PAC-2$	$IDLH > C \geq PEL$ or TLV_c																																
	L	$PAC-1 > C$	$PAC-2 > C$	PEL or $TLV_c > C$																																
	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 2.6 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.</i>	L: C: R:	See Section I Chapter 04	L: C: R:

Chemical 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		Risk (R, Qualitative Ranking)		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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	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 2.7 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: This hazard is a potential facility fire. The presence of excessive combustible materials can pose a hazard stemming from inadequate housekeeping practices. This hazard can add to the fuel load of a potential facility fire. Poor housekeeping can also lead to life safety concerns, such as egress obstructions and tripping hazards. The exposure of the hazard to the facility worker is of major concern.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Flammable Materials (Flammable gas, cleaning materials, etc.)	<i>Hazard: The presence of flammable gases in cylinders or storage containers pose an inherent hazard due to their flammability/combustibility properties. Exposure to hot work provides a dangerous situation where flammable liquids will ignite. Unmitigated this could lead to an explosion and subsequent fire. The exposure of the hazard to the facility worker is of major concern.</i>	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.

<p>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 ($1.0E-06 > L$)</p>	<p>Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible</p>		<p>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</p>		<p>Risk Matrix</p> <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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<p>Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual</p>	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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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: The presence of excessive combustible materials can pose a hazard stemming from inadequate housekeeping practices. This hazard can add to the fuel load of a potential fire. Poor housekeeping can also lead to life safety concerns, such as egress obstructions and tripping hazards. The exposure of the hazard to the co-located worker is of concern.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Flammable Materials (Flammable gas, cleaning materials, etc.)	<i>Hazard: The presence of flammable gases in cylinders or storage containers pose an inherent hazard due to their flammability/combustibility properties. Exposure to hot work provides a dangerous situation where flammable liquids will ignite. Unmitigated this could lead to an explosion and subsequent fire. The exposure of the hazard to the co-located worker is of concern.</i>	L: C: R:	See Section I Chapter 04	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
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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: The presence of excessive combustible materials can pose a hazard stemming from inadequate housekeeping practices. This hazard can add to the fuel load of a potential fire. Poor housekeeping can also lead to life safety concerns, such as egress obstructions and tripping hazards. The exposure of the hazard to the public is of minimal concern.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Flammable Materials (Flammable gas, cleaning materials, etc.)	<i>Hazard: The presence of flammable gases in cylinders or storage containers pose an inherent hazard due to their flammability/combustibility properties. Exposure to hot work provides a dangerous situation where flammable liquids will ignite. Unmitigated this could lead to an explosion and subsequent fire. The exposure of the hazard to the public is of minor concern.</i>	L: C: R:	See Section I Chapter 04	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
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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 2.10 Electrical Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy	<i>Hazards: Shock Hazard, >50V, Interlocked enclosure area</i> <i>Arc Flash, Interlocked enclosure area</i>	L: C: R: L: C: R:	See Section I Chapter 04	L: C: R: L: C: R:
High Voltage Exposure	<i>Hazards: Shock hazard voltage > 50V, Interlocked enclosures</i> <i>Arc Flash, Interlocked enclosures</i>	L: C: R: L: C: R:	See Section I Chapter 04	L: C: R: L: C: R:
Low Voltage, High Current Exposure	<i>Hazards: Arc Flash, Non-interlocked enclosures</i> <i>Fire hazard from high current causing smoke inhalation and burns.</i>	L: C: R: L: C: R:	See Section I Chapter 04	L: C: R: L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.																																				
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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 2.11 Electrical Energy 1 Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy	<p><i>Hazards:</i> <i>Shock Hazard, >50V, Non-interlocked enclosures</i></p> <p><i>Arc Flash, Non-interlocked enclosures</i></p>	<p>L: C: R:</p> <p>L: C: R:</p>	See Section I Chapter 04	<p>L: C: R:</p> <p>L: C: R:</p>
High Voltage Exposure	<p><i>Hazards:</i> <i>Shock hazard, voltage > 50V, Interlocked enclosures</i></p> <p><i>Arc Flash, Interlocked enclosures</i></p>	<p>L: C: R:</p> <p>L: C: R:</p>	See Section I Chapter 04	<p>L: C: R:</p> <p>L: C: R:</p>
Low Voltage, High Current Exposure	<p><i>Hazards:</i> <i>Arc Flash, Non-interlocked enclosures</i></p> <p><i>Fire hazard from high current causing smoke inhalation and burns.</i></p>	<p>L: C: R:</p> <p>L: C: R:</p>	See Section 1, Chapter 04	<p>L: C: R:</p> <p>L: C: R:</p>

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.

<p>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 ($1.0E-06 > L$)</p>	<p>Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible</p>		<p>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</p>		<p>Risk Matrix</p> <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 2.12 Electrical Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy	<i>Hazard: Shock hazard, >50V, Arc Flash</i>	L: C: R:	See Section I Chapter 04	L: C: R:
High Voltage Exposure	<i>Hazard: Shock Hazard, >50V, Arc Flash outside</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Low Voltage, High Current Exposure	<i>Hazard: N/A</i>	L: C: R:		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
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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 2.13 Thermal Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hot Work	<i>Hazard: Hot work will cause elevated temperatures. If hot work is not supervised, there is a potential for combustibles in the surrounding area to be ignited due to exposure to slag or elevated temperatures. This could lead to excessive heat and burning, which could potentially lead to a fire. The presence of excessive combustible materials can pose a hazard stemming from inadequate housekeeping practices. This hazard can add to the fuel load of a potential fire. The exposure of the hazard to the facility worker is of major concern.</i>	L: C: R:	See Section I Chapter 04	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
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Table 2.14 Thermal Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hot Work	<i>Hazard: Hot work will cause elevated temperatures. If hot work is not supervised, there is a potential for combustibles in the surrounding area to be ignited due to exposure to slag or elevated temperatures. This could lead to excessive heat and burning, which could potentially lead to a fire. The presence of excessive combustible materials can pose a hazard stemming from inadequate housekeeping practices. This hazard can add to the fuel load of a potential fire. The exposure of the hazard to the co-located worker is of minor concern.</i>	L: C: R:	See Section I Chapter 04	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
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Table 2.15 Thermal Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hot Work		L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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Table 2.16 Kinetic Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power Tools	<i>Hazard: Personnel injury due to improper use of power tools.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors	<i>Hazard: Personal injury due to entrapment/entanglement.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Motion Tables	<i>Hazard: Personnel injury due to pinch points, tip-overs, caught in between.</i>	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.

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Table 2.17 Kinetic Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power Tools	<i>Hazard: Personnel injury due to power tool use (flying debris, struck by object).</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors	<i>Hazard: Personal injury due to entrapment/entanglement.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Motion Tables	<i>Hazard: Personnel injury due to tip-overs, caught in between, crushing.</i>	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.																																				
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Table 2.18 Kinetic Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power Tools	<i>N/A</i>	L: C: R:	Public is prevented from having access to work areas.	L: C: R:
Pumps and Motors	<i>N/A</i>	L: C: R:	Public is prevented from having access to work areas.	L: C: R:
Motion Tables	<i>N/A</i>	L: C: R:	Public is prevented from having access to work areas.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.

<p>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 ($1.0E-06 > L$)</p>	<p>Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible</p>		<p>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</p>		<p>Risk Matrix</p> <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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	<p>H</p>	<p>C ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.</p>	<p>C ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.</p>	<p>C ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.</p>																																
	<p>M</p>	<p>C ≥ Mild, transient adverse effects.</p>	<p>C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.</p>	<p>C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.</p>																																
<p>L</p>	<p>Mild, transient adverse effects > C</p>	<p>Minor injuries; no hospitalization > C</p>	<p>Minor injuries; no hospitalization > C</p>																																	

Table 2.19 Potential Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations	<i>Hazard: personnel injury due to improper crane operations.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses	<i>Hazard: Personnel injury due to unexpected release, or unsecure tanks.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	<i>Hazard: Personnel injury due to entrapment/entanglement.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Material Handling	<i>Hazard: Personnel injury due to improper operation of Powered Industrial Trucks and their attachments (rollovers, crush, etc.).</i>	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.																																				
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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 2.20 Potential Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations	<i>Hazard: Struck by falling, swinging loads.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses	<i>Hazard: Collocated personnel injury due to unexpected release, or unsecure tanks.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	<i>Hazard: Personnel injury due to interaction with existing vacuum.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Material Handling	<i>Hazard: Collocated personnel injury due to moving/handing material (rollovers, crush, etc.)</i>	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.

<p>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 ($1.0E-06 > L$)</p>	<p>Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible</p>		<p>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</p>		<p>Risk Matrix</p> <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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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 2.21 Potential Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations	<i>Hazard: N/A</i>	L: C: R:		L: C: R:
Compressed Gasses	<i>Hazard: Injury due to unexpected release, or unsecure tanks outside of buildings.</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	<i>Hazard: N/A</i>	L: C: R:		L: C: R:
Material Handling	<i>Hazard: N/A</i>	L: C: R:		L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.

<p>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 ($1.0E-06 > L$)</p>	<p>Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible</p>		<p>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</p>		<p>Risk Matrix</p> <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 2.22 Magnetic Fields – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	<p><i>Hazards:</i></p> <p><i>Exposure to fringe fields beyond allowable limits (worker with ferromagnetic or electronic medical device(s))</i></p> <p><i>Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic medical device(s))</i></p> <p><i>Exposure to flying metallic objects causing potential injury.</i></p>	<p>L: C: R:</p> <p>L: C: R:</p> <p>L: C: R:</p>	See Section I Chapter 04	<p>L: C: R:</p> <p>L: C: R:</p> <p>L: C: R:</p>

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.

<p>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 ($1.0E-06 > L$)</p>	<p>Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible</p>		<p>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</p>		<p>Risk Matrix</p> <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 2.23 Magnetic Fields – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	<p><i>Hazards:</i></p> <p><i>Exposure to fringe fields beyond allowable limits (worker with ferromagnetic or electronic medical device(s))</i></p> <p><i>Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic medical device(s))</i></p> <p><i>Exposure to flying metallic objects causing potential injury.</i></p>	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.

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Table 2.24 Magnetic Fields – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	<p><i>Hazards:</i></p> <p><i>Exposure to fringe fields beyond allowable limits (worker with ferromagnetic or electronic medical device(s))</i></p> <p><i>Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic medical device(s))</i></p> <p><i>Exposure to flying metallic objects causing potential injury.</i></p>	<p>L:</p> <p>C:</p> <p>R:</p>	See Section I Chapter 04	<p>L:</p> <p>C:</p> <p>R:</p>

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.

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Table 2.25 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: Limited egress</i>	L: A C: H R: I	P – Confined Space training informs workers of hazard and process for working in the confined space. P – Work practice procedure requires use of an attendant, outside of the enclosure. P – “Permit Required Access” and “Reclassification” require ES&H approval on every access. M – Mechanical ventilation active, when required.	L: BEU C: M R: IV
Noise	<i>Hazard:</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Ergonomics	<i>Hazard:</i>	L: C: R:	See Section I Chapter 04	L: C: R:
Working at Heights	<i>Hazard: Falls, dropped items.</i>	L: A C: H R: I	P – Fall protection program P – Training for ladders, scaffolds, mobile elevating work platforms P – Guard Rails or tie off points. M – PPE – PFAS, including approved anchor points, hard hats	L: BEU C: M R: IV

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
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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 2.26 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: Accidental entry</i>	L: BEU C: H R: III	P – Work practice procedure requires use of an attendant, outside of the enclosure to warn of hazard.	L: BEU C: H R: III
Noise		L: C: R:	See Section I Chapter 04	L: C: R:
Ergonomics		L: C: R:	See Section I Chapter 04	L: C: R:
Work from Heights	<i>Hazard: Struck by dropped tool/material.</i>	L: A C: H R: I	P – Fall protection program P – WPC M – PPE-Hard Hats	L: EU C: M R: III

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
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Table 2.27 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: Accidental entry</i>	L: BEU C: H R: III	P – Work practice procedure requires use of an attendant, outside of the enclosure.	L: BEU C: H R: III
Noise		L: C: R:	See Section I Chapter 04	L: C: R:
Ergonomics		L: C: R:	See Section I Chapter 04	L: C: R:
Work from Heights	<i>N/A</i>	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
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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 2.28 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		L: C: R:	See Section I Chapter 04	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																															
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Table 2.29 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		L: C: R:	See Section I Chapter 04	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																																	
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Table 2.30 Access & Egress – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress	N/A	L: C: R:	See Section I Chapter 04	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
	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)	
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	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		

		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

Table 2.31 Environmental

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Airborne	<p><i>Hazards:</i> <i>Airborne release of radionuclides beyond permitted limits.</i></p> <p><i>Discharge of chemicals into onsite surface waters beyond permitted limits.</i></p>	<p>L: C: R:</p>	<p>See Section I Chapter 04</p>	<p>L: C: R:</p>
Water	<p><i>Hazards:</i> <i>Discharge of radionuclides into onsite surface waters beyond permitted limits.</i></p> <p><i>Discharge of chemicals into onsite surface waters beyond permitted limits.</i></p>	<p>L: A C: N R: IV</p>	<p>See Section I Chapter 04</p>	<p>L: C: R:</p>
Soil	<p><i>Hazards:</i> <i>Radioactive soil in beam loss areas beyond allowable concentrations of radionuclides beyond calculated Fermilab limits.</i></p> <p><i>Discharge of chemicals into onsite soils beyond permitted limits.</i></p>	<p>L: C: R:</p>	<p>See Section I Chapter 04</p>	<p>L: C: R:</p>