Table 11. Summary of Baseline and Residual Risks Main Injector / Recycler

11.1Radiological – Onsite-1 Facility WorkerR: I*11.2Radiological – Onsite-2 Co-located WorkerR: I*11.3Radiological – MOI OffsiteR: NA*11.4Toxic Materials – Onsite 1 Facility WorkerR: *11.5Toxic Materials – Onsite 2 Co-located WorkerR: *11.6Toxic Materials – MOI OffsiteR:NA *11.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: *11.8Flammable & Combustible Materials – Onsite-2 Co-located workerR: *11.9Flammable & Combustible Materials – MOI OffsiteR: NA*11.10Electrical Energy – Onsite-1 Facility WorkerR: *11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	
11.3Radiological – MOI OffsiteR: NA*11.4Toxic Materials – Onsite 1 Facility WorkerR: *11.5Toxic Materials – Onsite 2 Co-located WorkerR: *11.6Toxic Materials – MOI OffsiteR:NA *11.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: *11.8Flammable & Combustible Materials – Onsite-2 Co-located workerR: *11.9Flammable & Combustible Materials – MOI OffsiteR: NA*11.10Electrical Energy – Onsite-1 Facility WorkerR: *11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	R: IV, *
11.4Toxic Materials – Onsite 1 Facility WorkerR: *11.5Toxic Materials – Onsite 2 Co-located WorkerR: *11.6Toxic Materials – MOI OffsiteR:NA *11.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: *11.8Flammable & Combustible Materials – Onsite-2 Co-located workerR: *11.9Flammable & Combustible Materials – MOI OffsiteR: NA*11.10Electrical Energy – Onsite-1 Facility WorkerR: *11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	R: IV, *
11.5Toxic Materials – Onsite 2 Co-located WorkerR: *11.6Toxic Materials – MOI OffsiteR:NA *11.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: *11.8Flammable & Combustible Materials – Onsite-2 Co-located workerR: *11.9Flammable & Combustible Materials – MOI OffsiteR: NA*11.10Electrical Energy – Onsite-1 Facility WorkerR: *11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	R: NA, *
11.6Toxic Materials – MOI OffsiteR:NA *11.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: *11.8Flammable & Combustible Materials – Onsite-2 Co-located workerR: *11.9Flammable & Combustible Materials – MOI OffsiteR: NA*11.10Electrical Energy – Onsite-1 Facility WorkerR: *11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	R: *
11.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: *11.8Flammable & Combustible Materials – Onsite-2 Co-located workerR: *11.9Flammable & Combustible Materials – MOI OffsiteR: NA*11.10Electrical Energy – Onsite-1 Facility WorkerR: *11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	R: *
11.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: *11.8Flammable & Combustible Materials – Onsite-2 Co-located workerR: *11.9Flammable & Combustible Materials – MOI OffsiteR: NA*11.10Electrical Energy – Onsite-1 Facility WorkerR: *11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	R: NA*
11.9Flammable & Combustible Materials – MOI OffsiteR: NA*11.10Electrical Energy – Onsite-1 Facility WorkerR: *11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	R: *
11.10Electrical Energy – Onsite-1 Facility WorkerR: *11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	R: *
11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	R: NA*
11.11Electrical Energy – Onsite-2 Co-located WorkerR: *11.12Electrical Energy – MOI OffsiteR: NA*	R: *
11.12 Electrical Energy – MOI Offsite R: NA*	R: *
	R: NA*
11.13 Thermal Energy – Onsite-1 Facility Worker R: *	R: *
11.14 Thermal Energy – Onsite-2 Co-located Worker R: *	R: *
11.15 Thermal Energy – MOI Offsite R: NA*	R: NA*
11.16 Kinetic Energy – Onsite-1 Facility Worker R: *	R: *
11.17 Kinetic Energy – Onsite-2 Co-located Worker R: *	R: *
11.18 Kinetic Energy – MOI Offsite R: NA*	R: NA*
11.19 Potential Energy- Onsite-1 Facility Worker R: *	R: *
11.20 Potential Energy – Onsite-2 Co-located Worker R: *	R: *
11.21 Potential Energy – MOI Offsite R: NA*	R: NA*
11.22 Magnetic Fields – Onsite-1 Facility Worker R: *	R: *
11.23 Magnetic Fields – Onsite-2 Co-located Worker R: *	R: *
11.24 Magnetic Fields – MOI Offsite R: NA*	R: NA*
11.25 Other Hazards – Onsite-1 Facility Worker R: *	R: *
11.26 Other Hazards – Onsite-2 Co-located Worker R: *	R: *
11.27 Other Hazards – MOI Offsite R: NA*	R: NA*
11.28 Access & Egress – Onsite-1 Facility Worker R: *	R: *
11.29 Access & Egress – Onsite-2 Co-located Worker R: *	R: *
11.30 Access & Egress – MOI Offsite R: NA*	R: NA*
11.31 Environmental Hazards R: *	R: *

<sup>\*</sup> 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 11.1 Radiological – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Residual	Hazard: exposure to residual	L: A	P – Locked Gates: Barriers to entrances of areas that contain radioactive	L: BEU
activation	activation	C: H	material. Keys are required to open these gates.	C: N
		R: I	<ul> <li>P – Key Control Program: A program that checks the worker's training prior to issuing them a key to the accelerator enclosure. Also keeps track of worker accountability.</li> <li>P – Radiological Work Permit: A permit written by Safety that specifies the</li> </ul>	R: IV
			work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure.	
			P – Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions.	
			P – Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing.	
			P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components.	
			<ul> <li>M – Machine Protection System: An accelerator system that monitors devices such as beam loss monitors, power supplies, vacuum valves, etc. If these devices are not within their specified limits, the beam is aborted and further injections into the accelerator are inhibited until the system is reset by an operator.</li> <li>M – Local Component Shielding: Material placed between the local component and the area to be protected. The material is used to attenuate the radiation flux by a factor related to the radiation length of the material.</li> </ul>	

			M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	
Groundwater Activation	Hazard: radionuclides in ground water exceed regulatory levels	L: A C: H R: I	<ul> <li>P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated prior to removing the water from the enclosure.</li> <li>P – Sump Monitoring Program; Sump water samples are periodically collected and measured for radiological activation. If activation is</li> </ul>	L: BEU C: N R: IV
			found in the sump sample, we have the ability to look for the root cause before additional water is pumped to the surface.	
			P—Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated whit adjustment to the accelerators to prevent activation of tunnel components.	
			<ul> <li>M – Pond Monitoring program: Samples taken from the ponds and measured for activation. Sump water from the tunnel is discharged into these ponds</li> <li>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered</li> </ul>	
Surface Water Activation	Hazard: radionuclides in surface water exceed regulatory levels	L: A C: H R: I	P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated prior to removing the water from the enclosure.	L: BEU C: N R: IV

			<ul> <li>P – Sump Monitoring Program; Sump water samples are periodically collected and measured for radiological activation. If activation is found in the sump sample, we have the ability to look for the root cause before additional water is pumped to the surface.</li> <li>P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated whit adjustment to the accelerators to prevent activation of tunnel components.</li> <li>M – Pond Monitoring program: Samples taken from the ponds and</li> </ul>	
			measured for activation. Sump water from the tunnel is discharged into these ponds  M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered	
Radioactive Water (RAW) Systems	Hazard: Exposure to activated water	L: A C: H R: I	<ul> <li>P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates.</li> <li>P – Key Control Program: A program that checks the worker's training prior to issuing them a key to the accelerator enclosure. Also keeps track of worker accountability.</li> <li>P – Radiological Work Permit: A permit written by Safety that specifies the work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure</li> <li>P – Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions.</li> <li>P – Training: An educational system managed by ES&amp;H that establishes basic worker knowledge through presentations and testing.</li> <li>M – Volume Monitoring: Reservoir of closed loop water is monitored for the total volume. When a leak occurs in this closed loop system, the system will report an alarm and shut down if the volume becomes too low.</li> <li>M – Engineered Containment: Containment in the area around the RAW</li> </ul>	L: BEU C: L R: IV
			system to prevent the RAW from spreading in the case of a leak.	

Air Activation	Hazard: radionuclides in air exceed	L: A	P – Air Monitoring: Air sampled from the enclosure for activation	L: EU
	regulatory levels	C: H	M – Run Conditions: Operating parameters that reduce residual activation	C: N
	R: I	by limiting the total amount of beam that could be delivered.	R: IV	
			P– Beam loss Monitoring: Electronic Beam Loss Monitors are used to	
			convert radiation created by prompt dose due to beam loss into	
			electrical signals. This information is then made available to the	
			accelerator control system where the data can be logged and	
			monitored with alarms and limits. Losses can be reduced or	
			eliminated with adjustment to the accelerators to prevent activation of	
			tunnel components.	
			M – Machine Protection System: An accelerator system that monitors	
			devices such as beam loss monitors, power supplies, vacuum valves,	
			etc. If these devices are not within their specified limits, the beam is	
			aborted and further injections into the accelerator are inhibited until	
			the system is reset by an operator.	
			M – Engineered Air Flow: Enclosure air flow design to give the activated	
			air time to decay before exiting the enclosure.	
Soil Interactions	Hazard: radionuclides are produced	L: A	P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to	L: U
Boll interactions	which may contaminate ground water	C: H	convert radiation created by prompt dose due to beam loss into	C: N
	which hay contaminate ground water	R: I	electrical signals. This information is then made available to the	R: IV
		IX. I	accelerator control system where the data can be logged and	Κ. 1 γ
			monitored with alarms and limits. Losses can be reduced or	
			eliminated with adjustment to the accelerators to prevent activation of	
			tunnel components.	
			M – Machine Protection System: An accelerator system that monitors	
			devices such as beam loss monitors, power supplies, vacuum valves,	
			etc. If these devices are not within their specified limits, the beam is	
			aborted and further injections into the accelerator are inhibited until	
			the system is reset by an operator.	
			M – Engineered Beam Dump: Design of a beam absorber that minimizes	
			the radiological leakage through the used of shielding.	
			M – Beamline Design: Design of beamline optics to ensure that the actual	
			beam size is smaller than the beam pipe to prevent scraping, beam	
			loss, prompt dose, and residual activation.	
			M – Run Conditions: Operating parameters that reduce residual activation	
			by limiting the total amount of beam that could be delivered	

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Radioactive	Hazard: persons are exposed to	L: A	P – Locked Gates: Barriers to entrances of areas that contain radioactive	L: BEU
waste	ionizing radiation beyond regulatory	C: H	material. Keys are required to open these gates.	C: N
	levels	R: I	P – Key Control Program: A program that checks the worker's training	R: IV
			prior to issuing them a key to the accelerator enclosure. Also keeps	
			track of worker accountability.	
			P – Postings: Signs located in various places throughout the accelerator	
			warning of various hazards and occupancy restrictions	
			M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	
			M – Distance to Stored Material: Barriers, such as ropes, that are used to	
			increase the distance between the activated material and personnel.	
			-	
			M – Material survey and release process	
Contamination	Hazard: persons are exposed to	L: A	P – Locked Gates: Barriers to entrances of areas that contain radioactive	L:EU
	ionizing radiation beyond regulatory	C: H	material. Keys are required to open these gates.	C: L
	levels	R: I	P – Key Control Program: A program that checks the worker's training	R: IV
			prior to issuing them a key to the accelerator enclosure. Also keeps	
			track of worker accountability.	
			M – Radiological Work Permit: A permit written by Safety that specifies	
			the work that is permitted to be performed, requirements to perform	
			the work, and limitations of radiological exposure.	
			M – Training: An educational system managed by ES&H that establishes	
<sup>7</sup> Be	Hazard, Potential radiation company	L: A	basic worker knowledge through presentations and testing.  Not Applicable. No prevention or mitigation is required. <sup>7</sup> Be isn't	L: A
De	Hazard: Potential radiation exposure to 7Be (uptake/committed dose).	C: N	hazardous in this pattern of use by facility.	C: N
	io /Be (upiake/committea aose).	R: IV	nazardous in this pattern of use by facility.	R: IV
		K. IV		IX. IV
Non-ionizing	Hazard: Exposure to high power RF	L:	See section I Chapter IV	L:
Radiation	and Lasers	C:	Class 1 and 2 lasers only	C:
Hazards		R:		R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year		Risk (R, Qualitative Ranking)		Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0\text{E}-02)$		$\mathbf{H} = \text{High}$		I = situation (event	I = situation (event) of major concern			Likelihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (even)	nt) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (even)	ent) of minor concern	જ	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		<b>IV</b> = situation (eve	ent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	nbə	_				
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	<b>C</b> ≥ 25.0 rem		<b>C</b> ≥ 100 rem	<b>C</b> ≥ 100 rem	ons	L	III	III	IV	IV
<b>M</b> = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	00 rem > C ≥ 25 rem	100 rem > C ≥ 25 rem	C	N	IV	IV	IV	IV
Acronyms  MOI - Movimelly, averaged Offsite Individual	L	5 rem > <b>C</b>		25 rem > C	25 rem > C						
MOI = Maximally-exposed Offsite Individual rem = Roentgen equivalent man	N	0.5 rem > <b>C</b>		5 rem > C	5 rem > <b>C</b>						

Table 11.2 Radiological – Onsite-2 Co-located Worker

Hazard	d Hazard Description Risk (without controls)		Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Residual activation	Hazard: exposure to residual activation	L: A C: H R: I	<ul> <li>P - Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates.</li> <li>P - Key Control Program: A program that checks the worker's training prior to issuing them a key to the accelerator enclosure. Also keeps track of worker accountability.</li> <li>P - Radiological Work Permit: A permit written by Safety that specifies the work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure.</li> <li>P - Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions.</li> <li>P - Training: An educational system managed by ES&amp;H that establishes basic worker knowledge through presentations and testing.</li> <li>P - Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components.</li> <li>M - Machine Protection System: An accelerator system that monitors devices such as beam loss monitors, power supplies, vacuum valves, etc. If these devices are not within their specified limits, the beam is aborted and further injections into the accelerator are inhibited until the system is reset by an operator.</li> <li>M - Local Component Shielding: Material placed between the local component and the area to be protected. The material is used to attenuate the radiation flux by a factor related to the radiation length of the material.</li> </ul>	L: BEU C: N R: IV

			M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	
Groundwater Activation	Hazard: radionuclides in ground water exceed regulatory levels	L: A C: H R: I	P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated prior to removing the water from the enclosure.	L: BEU C: N R: IV
			P – Sump Monitoring Program; Sump water samples are periodically collected and measured for radiological activation. If activation is found in the sump sample, we have the ability to look for the root cause before additional water is pumped to the surface.	
			P– Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated whit adjustment to the accelerators to prevent activation of tunnel components.	
			<ul> <li>M – Pond Monitoring program: Samples taken from the ponds and measured for activation. Sump water from the tunnel is discharged into these ponds</li> <li>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered</li> </ul>	
Surface Water Activation	Hazard: radionuclides in surface water exceed regulatory levels	L: A C: H R: I	P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated prior to removing the water from the enclosure.	L: BEU C: N R: IV
			P – Sump Monitoring Program; Sump water samples are periodically collected and measured for radiological activation. If activation is found in the sump sample, we have the ability to look for the root cause before additional water is pumped to the surface.	
			P– Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss. This	

			information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated whit adjustment to the accelerators to prevent activation of tunnel components.  M – Pond Monitoring program: Samples taken from the ponds and measured for activation. Sump water from the tunnel is discharged into these ponds  M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered	
Radioactive Water (RAW) Systems	Hazard: Exposure to activated water	L: A C: H R: I	<ul> <li>P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates.</li> <li>P – Key Control Program: A program that checks the worker's training prior to issuing them a key to the accelerator enclosure. Also keeps track of worker accountability.</li> <li>P – Radiological Work Permit: A permit written by Safety that specifies the work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure</li> <li>P – Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions.</li> <li>P – Training: An educational system managed by ES&amp;H that establishes basic worker knowledge through presentations and testing.</li> <li>M – Volume Monitoring: Reservoir of closed loop water is monitored for the total volume. When a leak occurs in this closed loop system, the system will report an alarm and shut down if the volume becomes too low.</li> <li>M – Engineered Containment: Containment in the area around the RAW system to prevent the RAW from spreading in the case of a leak</li> </ul>	L: BEU C: L R: IV
Air Activation	Hazard: radionuclides in air exceed regulatory levels	L: A C: H R: I	<ul> <li>P – Air Monitoring: Air sampled from the enclosure for activation</li> <li>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.</li> <li>P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits.</li> </ul>	L: EU C: N R: IV

			Losses can be reduced or eliminated whit adjustment to the accelerators to prevent activation of tunnel components.  M – Machine Protection System: An accelerator system that monitors devices such as beam loss monitors, power supplies, vacuum valves, etc. If these devices are not within their specified limits, the beam is	
			aborted and further injections into the accelerator are inhibited until the system is reset by an operator.	
			<ul> <li>M – Engineered Air Flow: Enclosure air flow design to give the activated air time to decay before exiting the enclosure.</li> </ul>	
Soil Interactions	Hazard: radionuclides are produced which may contaminate ground water	L: A C: H R: I	<ul> <li>P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated whit adjustment to the accelerators to prevent activation of tunnel components.</li> <li>M – Machine Protection System: An accelerator system that monitors devices such as beam loss monitors, power supplies, vacuum valves, etc. If these devices are not within their specified limits, the beam is aborted and further injections into the accelerator are inhibited until the system is reset by an operator.</li> <li>M – Engineered Beam Dump: Design of a beam absorber that minimizes the radiological leakage through the used of shielding.</li> <li>M – Beamline Design: Design of beamline optics to ensure that the actual beam size is smaller than the beam pipe to prevent scraping, beam loss, prompt dose, and residual activation.</li> <li>M – Run conditions: Operating parameters that reduce residual activation</li> </ul>	L: U C: N R: IV
Radioactive	Hazard: persons are exposed to	L: A	by limiting the total amount of beam that could be delivered  P – Locked Gates: Barriers to entrances of areas that contain radioactive	L: BEU
waste	ionizing radiation beyond regulatory levels	C: H R: I	<ul> <li>material. Keys are required to open these gates.</li> <li>P – Key Control Program: A program that checks the worker's training prior to issuing them a key to the accelerator enclosure. Also keeps track of worker accountability.</li> <li>P – Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions</li> <li>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.</li> </ul>	C: L R: IV

Non-ionizing Radiation Hazards	Hazard: Exposure to high power RF and Lasers	L: C: R:	See section I Chapter IV. Class 1 and 2 lasers only	L: BEU C: M R: IV
<sup>7</sup> Be	Hazard: Potential radiation exposure to 7Be (uptake/committed dose).	L: A C: N R: IV	Not Applicable. No prevention or mitigation is required. <sup>7</sup> Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV
Contamination	Hazard: persons are exposed to ionizing radiation beyond regulatory levels	L: A C: H R: I	<ul> <li>M – Distance to Stored Material: Barriers, such as ropes, that are used to increase the distance between the activated material and personnel.</li> <li>P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates.</li> <li>P – Key Control Program: A program that checks the worker's training prior to issuing them a key to the accelerator enclosure. Also keeps track of worker accountability.</li> <li>M – Radiological Work Permit: A permit written by Safety that specifies the work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure.</li> <li>M – Training: An educational system managed by ES&amp;H that establishes basic worker knowledge through presentations and testing.</li> </ul>	L:EU C: L R: IV

Radiological Hazard Consequences, derived from Figu	ire C	-1, "Example Qualitativ	e Con	sequence Matrix", DOI	E-HDBK-1163-2020.									
Likelihood (L, of event)/year	Cor	nsequence (C, of event)/y	year	Risk (R, Qualitative Ranking)			Risk Matrix							
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathrm{High}$		I = situation (event) of major concern					Like	lihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = \text{situation (even}$	nt) of concern			Α	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		<b>III</b> = situation (eve	ent) of minor concern	es	Н	I	I	II	III			
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \text{Negligible}$		<b>IV</b> = situation (eve	ent) of minimal concern	ences	M	II	II	III	IV			
Control(s) Type	C	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	edn		TTT	TIT	IV	IV			
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	<b>C</b> ≥ 25.0 rem		<b>C</b> ≥ 100 rem	<b>C</b> ≥ 100 rem	ons	L	III	III					
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	$00 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	100 rem > C ≥ 25 rem		N	IV	IV	IV	IV			
Acronyms  MOI - Mayimally, avposed Offsite Individual	L	5 rem > <b>C</b>		25 rem > <b>C</b>	25 rem > C									
MOI = Maximally-exposed Offsite Individual rem = Roentgen equivalent man	N	0.5 rem > <b>C</b>		5 rem > C	5 rem > C									

**Table 11.3 Radiological – MOI Offsite** 

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Residual activation	Hazard: exposure to residual activation	L: BEU C: N R: IV	Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate.	L: BEU C: N R: IV
Groundwater Activation	Hazard: radionuclides in ground water exceed regulatory levels	L: A C: H R: I	<ul> <li>P – Monitoring Wells: Wells that are drilled near accelerator enclosures in areas that are sensitive to potential aquifer contamination. These wells are periodically sampled and analyzed by ES&amp;H to ensure the aquifer is not becoming contaminated from accelerator operations.</li> <li>P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated.</li> </ul>	L: BEU C: L R: IV
			P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated whit adjustment to the accelerators to prevent activation of tunnel components.	
			M – Machine Protection System: An accelerator system that monitors devices such as beam loss monitors, power supplies, vacuum valves, etc. If these devices are not within their specified limits, the beam is aborted and further injections into the accelerator are inhibited until the system is reset by an operator.	
			M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	

Surface Water Activation	Hazard: radionuclides in surface water exceed regulatory levels	L: A C: H R: I	<ul> <li>P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated prior to removing the water from the enclosure.</li> <li>P – Sump Monitoring Program; Sump water samples are periodically collected and measured for radiological activation. If activation is found in the sump sample, we have the ability to look for the root cause before additional water is pumped to the surface.</li> <li>P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated whit adjustment to the accelerators to prevent activation of tunnel components.</li> <li>M – Pond Monitoring program: Samples taken from the ponds and measured for activation. Sump water from the tunnel is discharged into these ponds</li> <li>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered</li> </ul>	L: BEU C: L R: IV
Radioactive Water (RAW) Systems	Hazard: Exposure to activated water	L: BEU C: N R: IV	Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate.	L: BEU C: N R: IV
Air Activation	Hazard: radionuclides in air exceed regulatory levels	L: BEU C: N R: IV	Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate.	L: BEU C: N R: IV
Soil Interactions	Hazard: radionuclides are produced which may contaminate ground water	L: BEU C: N R: IV	Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate.	L: BEU C: N R: IV
Radioactive waste	Hazard: persons are exposed to ionizing radiation beyond regulatory levels	L: BEU C: N R: IV	Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate.	L: BEU C: N R: IV

Contamination	Hazard: persons are exposed to ionizing radiation beyond regulatory levels	L: BEU C: N R: IV	Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate.	L: BEU C: N R: IV
<sup>7</sup> Be	Hazard: Potential radiation exposure to 7Be (uptake/committed dose).	L: BEU C: N R: IV	Not Applicable. No prevention or mitigation is required. <sup>7</sup> Be isn't hazardous in this pattern of use by facility.	L: BEU C: N R: IV
Non-ionizing Radiation Hazards	Hazard: Exposure to high power RF	L: BEU C: N R: IV	Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate.	L: BEU C: N R: IV

Radiological Hazard Consequences, derived from Figu	ire C	-1, "Example Qualitativ	e Con	sequence Matrix", DOI	E-HDBK-1163-2020.								
Likelihood (L, of event)/year	Co	nsequence (C, of event)/	year	Risk (R, Qualitative Ranking)			Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (event) of major concern					Like	lihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (even)	nt) of concern			Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		<b>III</b> = situation (eve	ent) of minor concern	es	Н	I	I	II	III		
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (even)	ent) of minimal concern	ences	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	n ba		TTT	TIT	13.7	13.7		
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		<b>C</b> ≥ 100 rem	C ≥ 100 rem	ons	L	III	III	IV	IV		
$\mathbf{M} = \mathbf{M}$ itigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	00 rem > C ≥ 25 rem	100 rem > C ≥ 25 rem	C	N	IV	IV	IV	IV		
Acronyms  MOI - Movimelly, avenued Offsite Individual	L	5 rem > <b>C</b>		25 rem > C	25 rem > <b>C</b>								
MOI = Maximally-exposed Offsite Individual rem = Roentgen equivalent man	N	0.5 rem > <b>C</b>		5 rem > <b>C</b>	5 rem > C								

**Table 11.4 Toxic Materials – Onsite 1 Facility Worker** 

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	Hazard: Potential exposure to lead dust during manual handling of unencased lead bricks, lead shot, and lead sheets.	L: C: R:	See section I Chapter IV	L: C: R:
Beryllium *	Hazard: Potential exposure to beryllium dust during manual handling of un-encased, or machining dusts from fabrication shop activities.	L: C: R:	See section I Chapter IV	L: C: R:
Fluorinert byproducts	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

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

Likelihood (L, of event)/year	C	onsequence (C, of event)	)/year	Risk (R, Qualitative	Ranking)	Risk	Matri	X			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathrm{High}$		<b>I</b> = situation (event) of major concern					Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		<b>II</b> = situation (event) of concern				Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		<b>III</b> = situation (event) of minor concern			Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		<b>IV</b> = situation (event) of minimal concern		ences	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn	-		***	***	***
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C≥IDLH	ons	L	III	III	IV	IV
<b>M</b> = Mitigative (reduces event consequences)	М	$PAC-2 > C \ge PAC-1$	P/	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$	C	N	IV	IV	IV	IV
Acronyms	L	$PAC-1 > \mathbf{C}$		$\frac{\text{PAC-2} > \mathbf{C}}{\text{PAC-2} > \mathbf{C}}$	PEL or $TLV_c > C$						
IDLH = Immediately Dangerous to Life and Health MOI = Maximally-exposed Offsite Individual PAC = Protective Action Criteria PEL = Permissible Exposure Limit TLV <sub>c</sub> = Threshold Limit Value (ceiling)	N	Consequences less than those for Low Consequence Level		nsequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level						

**Table 11.5 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 *	Hazard: Potential exposure to lead dust during manual handling of unencased lead bricks, lead shot, and lead sheets.	L: C: R:	See section I Chapter IV	L: C: R:
Beryllium *	Hazard: Potential exposure to beryllium dust during manual handling of un-encased, or machining dusts from fabrication shop activities.	L: C: R:	See section I Chapter IV	L: C: R:
Fluorinert byproducts	Hazard: Potential exposure to fluorinert decomposition products (HF, PFIB).	L: A C: H R: I	See section I Chapter IV	L: EU C: L R: IV

Chemical Hazard Consequences, derived from Figure	C-1	, "Example Qualitative	Conseq	quence Matrix", DOE-	HDBK-1163-2020.							
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Risk (R, Qualitative Ranking)			atrix	ζ			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	$\mathbf{H} = \mathbf{High}$		<b>I</b> = situation (event) of major concern					Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		<b>II</b> = situation (ev	ent) of concern				A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	L = Low		<b>III</b> = situation (event) of minor concern		5	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	$\mathbf{N} = $ Negligible		vent) of minimal concern	bu d		M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)		;   -	.	Ш	III	IV	IV
<b>P</b> = Preventive (reduce event occurrence likelihood)	H	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	8	<u> </u>	L	111	Ш	1 V	1 V
M = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P.A	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$		) ]	N	IV	IV	IV	IV
Acronyms	L	PAC-1 > C		PAC-2 > C	PEL or TLV <sub>c</sub> > C							

<b>IDLH</b> = Immediately Dangerous to Life and Health	N	Consequences less	Consequences less than	Consequences less than	
MOI = Maximally-exposed Offsite Individual		than those for Low	those for Low Consequence	those for Low	
<b>PAC</b> = Protective Action Criteria		Consequence Level	Level	Consequence Level	
<b>PEL</b> = Permissible Exposure Limit					
TLV <sub>c</sub> = Threshold Limit Value (ceiling)					

**Table 11.6 Toxic Materials – MOI Offsite** 

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	Hazard: Potential exposure to lead dust during manual handling of unencased lead bricks, lead shot, and lead sheets.	L: C: R:	See section I Chapter IV	L: C: R:
Beryllium *	Hazard: Potential exposure to beryllium dust during manual handling of un-encased, or machining dusts from fabrication shop activities.	L: C: R:	See section I Chapter IV	L: C: R:
Fluorinert byproducts	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Chemical Hazard Consequences, derived from Figure	C-1	, "Example Qualitative	Conseq	quence Matrix", DOE-	HDBK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Ris	k Matr	ix			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{H} = \mathbf{High}$		I = situation (event) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = \text{situation (ev}$	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	L = Low		<b>III</b> = situation (event) of minor concern		Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	N = Negligible		vent) of minimal concern	ences	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn		TIT	III	IV	IV
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C≥PAC-3	C ≥ IDLH	ons	L	III	1111	1 V	1 V
M = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	PA	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$	၁	N	IV	IV	IV	IV
Acronyms	L	PAC-1 > <b>C</b>		PAC-2 > C	PEL or TLV <sub>c</sub> > C						

<b>IDLH</b> = Immediately Dangerous to Life and Health	N	Consequences less	Consequences less than	Consequences less than	
MOI = Maximally-exposed Offsite Individual		than those for Low	those for Low Consequence	those for Low	
<b>PAC</b> = Protective Action Criteria		Consequence Level	Level	Consequence Level	
<b>PEL</b> = Permissible Exposure Limit					
$TLV_c$ = Threshold Limit Value (ceiling)					

Table 11.7 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	Hazard: N/A	L:	See section I Chapter IV	L:
materials		C:		C:
(cables, Boxes,		R:		R:
Paper, wood				
cribbing, etc.)				
Flammable	Hazard: N/A	L:	See section I Chapter IV	L:
Materials		C:		C:
(Flammable gas,		R:		R:
cleaning				
materials, etc.)				

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event)	)/year	Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (eve	ent) of concern		1	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		<b>III</b> = situation (ex	vent) of minor concern	ences	Н	I	I	II	III	
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		<b>IV</b> = situation (ev	vent) of minimal concern		M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbəş	T	III	III	IV	IV	
<ul> <li>P = Preventive (reduce event occurrence likelihood)</li> <li>M = Mitigative (reduces event consequences)</li> <li>Acronyms</li> <li>MOI = Maximally-exposed Offsite Individual</li> </ul>	other serious effects, or a or symptoms which		Prompt worker fatality acute injury that is immediately life- tening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately lifethreatening or permanently disabling.	Consequ	N	IV	IV	IV	IV		
	M	C ≥ Mild, transient	C	≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	imm	nediate loss of life no	immediate loss of life no							

		permanent disabilities;	permanent disabilities;
		hospitalization required.	hospitalization required.
L	Mild, transient	Minor injuries; no	Minor injuries; no
	adverse effects > C	hospitalization $> C$	hospitalization $> \mathbf{C}$
N	Consequences less	Consequences less than	Consequences less than
	than those for Low	those for Low Consequence	those for Low
	Consequence Level	Level	Consequence Level

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	Hazard: N/A	L:	See section I Chapter IV	L:
materials		C:		C:
(cables, Boxes,		R:		R:
Paper, wood				
cribbing, etc.)				
Flammable	Hazard: N/A	L:	See section I Chapter IV	L:
Materials		C:		C:
(Flammable gas,		R:		R:
cleaning				
materials, etc.)				

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event)	)/year	Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern			Likelihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern		1	A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		<b>III</b> = situation (ex	vent) of minor concern	ences	Н	I	I	II	III	
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern		M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbəş	ı	III	III	IV	IV	
<ul> <li>P = Preventive (reduce event occurrence likelihood)</li> <li>M = Mitigative (reduces event consequences)</li> <li>Acronyms</li> <li>MOI = Maximally-exposed Offsite Individual</li> </ul>	gative (reduces event consequences)  other serious effects, or symptoms which		or i	Prompt worker fatality acute injury that is immediately life-tening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately lifethreatening or permanently disabling.	Consequ	N	IV	IV	IV	IV	
	M	C ≥ Mild, transient	C	≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	imm	nediate loss of life no	immediate loss of life no							

		permanent disabilities;	permanent disabilities;
		hospitalization required.	hospitalization required.
L	Mild, transient	Minor injuries; no	Minor injuries; no
	adverse effects > C	hospitalization $> C$	hospitalization $> \mathbf{C}$
N	Consequences less	Consequences less than	Consequences less than
	than those for Low	those for Low Consequence	those for Low
	Consequence Level	Level	Consequence Level

**Table 11.9 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.)	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Flammable Materials (Flammable gas, cleaning materials, etc.)	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event)	)/year	Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \text{High}$		I = situation (eve	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern		1	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		<b>III</b> = situation (ex	vent) of minor concern	ences	Н	I	I	II	III	
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern		M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbəş	1	III	III	IV	IV	
<ul> <li>P = Preventive (reduce event occurrence likelihood)</li> <li>M = Mitigative (reduces event consequences)</li> <li>Acronyms</li> <li>MOI = Maximally-exposed Offsite Individual</li> </ul>	event consequences) other serious effects, or symptoms which		or i	Prompt worker fatality acute injury that is immediately life-tening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately lifethreatening or permanently disabling.	Consequ	N	IV	IV	IV	IV	
	M	C ≥ Mild, transient	C	≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	imm	nediate loss of life no	immediate loss of life no							

		permanent disabilities;	permanent disabilities;
		hospitalization required.	hospitalization required.
L	Mild, transient	Minor injuries; no	Minor injuries; no
	adverse effects > C	hospitalization $> C$	hospitalization $> \mathbf{C}$
N	Consequences less	Consequences less than	Consequences less than
	than those for Low	those for Low Consequence	those for Low
	Consequence Level	Level	Consequence Level

Table 11.10 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 Exposure	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
High Voltage Exposure	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Low Voltage, High Current Exposure.	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Co	onsequence (C, of event)/y	year	Risk (R, Qualitative	sk (R, Qualitative Ranking)			x				
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (even	ent) of concern			A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (evaluation	vent) of minor concern	es	Н	I	I	II	III	
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \text{Negligible}$		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2	2 (co-located worker)	Onsite-1 (facility worker)	Consequences		III	III	IV	IV	
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality or acute injury that is		C ≥ Prompt worker	ous	L	111	111	1 V	1 V	
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,			fatality or acute injury that	0	N	IV	IV	IV	IV	
Acronyms		or symptoms which		nmediately life-	is immediately life-							
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an	threatening or permanently		threatening or							
		individual's ability to		disabling.	permanently disabling.							
		take protective										
		action.										
	M	C ≥ Mild, transient	<b>C</b> ≥	Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	imme	ediate loss of life no	immediate loss of life no							
			perm	nanent disabilities;	permanent disabilities;							
			hospi	italization required.	hospitalization required.							

L	,	Mild, transient	Minor injuries; no	Minor injuries; no	
		adverse effects $> C$	hospitalization $> \mathbf{C}$	hospitalization $> \mathbf{C}$	
N		Consequences less	Consequences less than	Consequences less than	
		than those for Low	those for Low Consequence	those for Low	
		Consequence Level	Level	Consequence Level	

Table 11.11 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	Hazard: N/A	L:	See section I Chapter IV	L:
Exposure		C:		C:
		R:		R:
High Voltage	Hazard: N/A	L:	See section I Chapter IV	L:
Exposure		C:		C:
		R:		R:
Low Voltage,	Hazard: N/A	L:	See section I Chapter IV	L:
High Current		C:		C:
Exposure.		R:		R:

Other Hazard Consequences, derived from Figure C-1	l, "E	xample Qualitative Cons	equence Matrix", DOI	E-HD	BK-1163-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)/y	year   Risk (R, Qualit	ative :	Ranking)	Risk	Matri	X			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \text{High}$	I = situation	ı (eve	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation}$	n (eve	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	<b>III</b> = situati	on (ev	vent) of minor concern	S	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situati	on (ev	vent) of minimal concern	ences	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located work	ker)	Onsite-1 (facility worker)	edn		TTT	TIT	IV	137
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible.	C ≥ Prompt worker fata	ality	C ≥ Prompt worker	ons	L	III	III	1 V	IV
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	or acute injury that i	•	fatality or acute injury that	Ď	N	IV	IV	IV	IV
Acronyms		or symptoms which	immediately life-		is immediately life-						
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an	threatening or permane	ntly	threatening or						
		individual's ability to	disabling.	•	permanently disabling.						
		take protective									
		action.									
	M	$C \ge Mild$ , transient	C ≥ Serious injury, n	10	C ≥ Serious injury, no						
		adverse effects.	immediate loss of life	no	immediate loss of life no						
			permanent disabilitie	s;	permanent disabilities;						
			hospitalization require	ed.	hospitalization required.						

L	,	Mild, transient	Minor injuries; no	Minor injuries; no	
		adverse effects $> C$	hospitalization $> \mathbf{C}$	hospitalization $> \mathbf{C}$	
N		Consequences less	Consequences less than	Consequences less than	
		than those for Low	those for Low Consequence	those for Low	
		Consequence Level	Level	Consequence Level	

Table 11.12 Electrical Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy Exposure	Hazard: NA	L: C: R:	See section I Chapter IV	L: C: R:
High Voltage Exposure	Hazard: NA	L: C: R:	See section I Chapter IV	L: C: R:
Low Voltage, High Current Exposure.	Hazard: NA	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "E	xample Qualitative Conse	equence Ma	atrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)/y	year Risk	(R, Qualitative	Ranking)	Risk	Matri	x			
$\mathbf{A} = \text{Anticipated (L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$	]	I = situation (even)	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	]	II = situation (even	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	]	<b>III</b> = situation (ev	vent) of minor concern	es	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \text{Negligible}$	]	IV = situation (ev	vent) of minimal concern	ences	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-l	located worker)	Onsite-1 (facility worker)	sedno	Ι.	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood)  M = Mitigative (reduces event consequences)	H	•	•	t worker fatality	$C \ge Prompt worker$	Con					
Acronyms		other serious effects,		injury that is	fatality or acute injury that		N	IV	IV	IV	IV
MOI = Maximally-exposed Offsite Individual		or symptoms which		liately life-	is immediately life-						
Wilds = Waximany-exposed Offsite individual		_	_	or permanently	threatening or						
		individual's ability to	disa	abling.	permanently disabling.						
		take protective									
		action.									
	M	$C \ge Mild$ , transient	$\mathbf{C} \geq \mathbf{Serio}$	ous injury, no	C ≥ Serious injury, no						
		adverse effects.	immediate	loss of life no	immediate loss of life no						
			permanen	nt disabilities;	permanent disabilities;						
			hospitaliza	ation required.	hospitalization required.						

L	,	Mild, transient	Minor injuries; no	Minor injuries; no	
		adverse effects $> C$	hospitalization $> \mathbf{C}$	hospitalization $> \mathbf{C}$	
N		Consequences less	Consequences less than	Consequences less than	
		than those for Low	those for Low Consequence	those for Low	
		Consequence Level	Level	Consequence Level	

Table 11.13 Thermal Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Magnet Bakeouts	Hazard: N/A	L: C:	See section I Chapter IV	L: C:
Dakeouts		R:		R:
Hot Work	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Cons	sequen	ce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/	/year	Risk (R, Qualitative	Ranking)	Risk	Matri	X			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \text{High}$		I = situation (eve	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (expression)	vent) of minor concern	nces	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	47	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	edne	т.	III	III	IV	IV
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	$C \ge P$	rompt worker fatality	C ≥ Prompt worker	Cons	L	111	111	1 V	1 V
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that	0	N	IV	IV	IV	IV
Acronyms		or symptoms which		mmediately life-	is immediately life-	-					
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		ening or permanently	threatening or						
		individual's ability to		disabling.	permanently disabling.						
		take protective		<i>8</i> .	r · · · · · · · · · · · · · · · · · · ·						
		action.									
	M	C ≥ Mild, transient	<b>C</b> ≥	Serious injury, no	C ≥ Serious injury, no						
		adverse effects.	imm	ediate loss of life no	immediate loss of life no						
			peri	manent disabilities;	permanent disabilities;						
			hosp	oitalization required.	hospitalization required.						
	L	Mild, transient	N	Inor injuries; no	Minor injuries; no						
		adverse effects > C	ho	ospitalization > C	hospitalization $> \mathbf{C}$						

N	Consequences less	Consequences less than	Consequences less than
	than those for Low	those for Low Consequence	those for Low
	Consequence Level	Level	Consequence Level

Table 11.14 Thermal Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Magnet Bakeouts	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Hot Work	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "E	Example Qualitative Con	sequen	nce Matrix", DOE-HD	BK-1163-2020.						·
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk	Matr	x			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	ent) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (expression of the state o	vent) of minor concern	es	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	ences	M	II	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	edne		TIT	Ш	IV	IV
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	$C \ge P$	Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	1 V	1 V
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that	S	N	IV	IV	IV	IV
Acronyms		or symptoms which		mmediately life-	is immediately life-					•	
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		tening or permanently	threatening or						
		individual's ability to		disabling.	permanently disabling.						
		take protective		uisuomig.	permanently unsucoming.						
		action.									
	M	C ≥ Mild, transient	C ≥	≥ Serious injury, no	C ≥ Serious injury, no						
		adverse effects.	imm	nediate loss of life no	immediate loss of life no						
			per	manent disabilities;	permanent disabilities;						
			hosp	pitalization required.	hospitalization required.						
	L	Mild, transient	N	Minor injuries; no	Minor injuries; no						
		adverse effects > C	h	ospitalization > C	hospitalization $> \mathbf{C}$						

N	N	Consequences less	Consequences less than	Consequences less than
		than those for Low	those for Low Consequence	those for Low
		Consequence Level	Level	Consequence Level

**Table 11.15 Thermal Energy – MOI Offsite** 

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Magnet Bakeouts	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Hot Work	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "E	Example Qualitative Con	sequen	nce Matrix", DOE-HD	BK-1163-2020.						·
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk	Matr	x			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	ent) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (expression)	vent) of minor concern	es	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	ences	M	II	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	edne		TIT	III	IV	IV
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	$C \ge P$	Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	1 V	1 V
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that	S	N	IV	IV	IV	IV
Acronyms		or symptoms which		mmediately life-	is immediately life-					•	
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		tening or permanently	threatening or						
		individual's ability to		disabling.	permanently disabling.						
		take protective		uisuoiiig.	permanently unsucoming.						
		action.									
	M	C ≥ Mild, transient	C ≥	≥ Serious injury, no	C ≥ Serious injury, no						
		adverse effects.	imm	nediate loss of life no	immediate loss of life no						
			per	manent disabilities;	permanent disabilities;						
			hosp	pitalization required.	hospitalization required.						
	L	Mild, transient	N	Minor injuries; no	Minor injuries; no						
		adverse effects > C	h	ospitalization > C	hospitalization > C						

N	N	Consequences less	Consequences less than	Consequences less than
		than those for Low	those for Low Consequence	those for Low
		Consequence Level	Level	Consequence Level

**Table 11.16 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	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Pumps and Motors	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Motion Tables	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Mobile Shielding	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-1	1, "E	Example Qualitative Cor	sequei	nce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Ris	k Matri	X			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		<b>II</b> = situation (even	ent) of concern	l —		Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		<b>III</b> = situation (ex	vent) of minor concern	s	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		<b>IV</b> = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn	-				
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible.	C > I	Prompt worker fatality	C ≥ Prompt worker	S	L	III	III	IV	IV
<b>M</b> = Mitigative (reduces event consequences)		other serious effects.		acute injury that is	fatality or acute injury that	Ű	N	IV	IV	IV	IV
Acronyms		or symptoms which		immediately life-	is immediately life-						
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		tening or permanently	threatening or						
		individual's ability to		disabling.	permanently disabling.						
		take protective									
		action.									

M	[	$C \ge Mild$ , transient	C ≥ Serious injury, no	C ≥ Serious injury, no
		adverse effects.	immediate loss of life no	immediate loss of life no
			permanent disabilities;	permanent disabilities;
			hospitalization required.	hospitalization required.
L		Mild, transient	Minor injuries; no	Minor injuries; no
		adverse effects $> C$	hospitalization $> \mathbf{C}$	hospitalization $> \mathbf{C}$
N		Consequences less	Consequences less than	Consequences less than
		than those for Low	those for Low Consequence	those for Low
		Consequence Level	Level	Consequence Level

**Table 11.17 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	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Pumps and Motors	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Motion Tables	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Mobile Shielding	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-1	1, "E	Example Qualitative Cor	sequei	nce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Ris	k Matri	X			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		<b>II</b> = situation (even	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		<b>III</b> = situation (ex	vent) of minor concern	ន	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		<b>IV</b> = situation (ev	vent) of minimal concern	enco	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn	-				
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible.	C > I	Prompt worker fatality	C ≥ Prompt worker	S	L	III	III	IV	IV
<b>M</b> = Mitigative (reduces event consequences)		other serious effects.		acute injury that is	fatality or acute injury that	S	N	IV	IV	IV	IV
Acronyms		or symptoms which		immediately life-	is immediately life-						
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		tening or permanently	threatening or						
		individual's ability to		disabling.	permanently disabling.						
		take protective									
		action.									

M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no
	adverse effects.	immediate loss of life no	immediate loss of life no
		permanent disabilities;	permanent disabilities;
		hospitalization required.	hospitalization required.
L	Mild, transient	Minor injuries; no	Minor injuries; no
	adverse effects $> \mathbf{C}$	hospitalization $> \mathbf{C}$	hospitalization $> \mathbf{C}$

**Table 11.18 Kinetic Energy – MOI Offsite** 

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power tools	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Pumps and Motors	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Motion Tables	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Mobile Shielding	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.													
Likelihood (L, of event)/year	Co	onsequence (C, of event)	/year	Risk (R, Qualitative	Risk (R, Qualitative Ranking)			Risk Matrix					
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \text{High}$		I = situation (eve	nt) of major concern				Likelihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		<b>II</b> = situation (even	ent) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low $N = Negligible$		<b>III</b> = situation (ex	vent) of minor concern	ક	Н	I	I	II	III		
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)				<b>IV</b> = situation (ev	vent) of minimal concern	Consequences	M	П	II	III	IV		
Control(s) Type	$\mathbf{C}$	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nba	-						
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible.	C > F	Prompt worker fatality	C ≥ Prompt worker	ons	L	III	III	IV	IV		
<b>M</b> = Mitigative (reduces event consequences)		other serious effects.		acute injury that is	fatality or acute injury that	ت	N	IV	IV	IV	IV		
Acronyms		or symptoms which		immediately life-	is immediately life-								
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an	* *		threatening or								
		individual's ability to		disabling.	permanently disabling.								
		take protective											
		action.											

M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no
	adverse effects.	immediate loss of life no	immediate loss of life no
		permanent disabilities;	permanent disabilities;
		hospitalization required.	hospitalization required.
L	Mild, transient	Minor injuries; no	Minor injuries; no
	adverse effects $> \mathbf{C}$	hospitalization $> \mathbf{C}$	hospitalization $> \mathbf{C}$

Table 11.19 Potential Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane	Hazard: N/A	L: C:	See section I Chapter IV	L: C:
Operations		R:		R:
Compressed Gasses	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Vacuum/ Pressure Vessels	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Vacuum Pumps	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Material Handling	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	Consequence (C, of event)/year		Risk (R, Qualitative Ranking)			Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern								
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern		1	Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		<b>III</b> = situation (ex	vent) of minor concern	ses	Н	I	I	II	III		
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern			M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn	_	TTT	111	13.7	13.7		
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible.	C > F	Prompt worker fatality	C ≥ Prompt worker	ons	L	III	III	IV	IV		
<b>M</b> = Mitigative (reduces event consequences)				acute injury that is	fatality or acute injury that	2	N	IV	IV	IV	IV		
Acronyms		or symptoms which		immediately life-	is immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an											

		individual's ability to take protective	threatening or permanently disabling.	threatening or permanently disabling.
		action.	disdomig.	permanentry disability.
r	M	$C \ge Mild$ , transient	$C \ge Serious injury, no$	C ≥ Serious injury, no
		adverse effects.	immediate loss of life no	immediate loss of life no
			permanent disabilities;	permanent disabilities;
			hospitalization required.	hospitalization required.
	L	Mild, transient	Minor injuries; no	Minor injuries; no
		adverse effects $> \mathbf{C}$	hospitalization > C	hospitalization $> \mathbf{C}$
	N	Consequences less	Consequences less than	Consequences less than
		than those for Low	those for Low Consequence	those for Low
		Consequence Level	Level	Consequence Level

Table 11.20 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	Hazard: N/A	L:	See section I Chapter IV	L:
Operations		C: R:		C: R:
Compressed Gasses	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Vacuum/ Pressure Vessels	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Vacuum Pumps	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Material Handling	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.													
Likelihood (L, of event)/year	C	onsequence (C, of event)/	year	Risk (R, Qualitative Ranking)			Risk Matrix							
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Likelihood					
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		<b>II</b> = situation (even	ent) of concern			Α	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		<b>III</b> = situation (ex	vent) of minor concern	ces	Н	I	I	II	III			
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern			M	II	II	III	IV			
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn		III	ш	IV	IV			
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible.	C > F	Prompt worker fatality	C ≥ Prompt worker	ons	L	111	III	1 V	1 V			
$\mathbf{M} = \mathbf{Mitigative}$ (reduces event consequences)				acute injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV			
Acronyms		or symptoms which		immediately life-	is immediately life-		•	•		•				
MOI = Maximally-exposed Offsite Individual		could impair an												

		individual's ability to take protective	threatening or permanently disabling.	threatening or permanently disabling.
		action.	disdomig.	permanentry disability.
r	M	$C \ge Mild$ , transient	$C \ge Serious injury, no$	C ≥ Serious injury, no
		adverse effects.	immediate loss of life no	immediate loss of life no
			permanent disabilities;	permanent disabilities;
			hospitalization required.	hospitalization required.
	L	Mild, transient	Minor injuries; no	Minor injuries; no
		adverse effects $> \mathbf{C}$	hospitalization > C	hospitalization $> \mathbf{C}$
	N	Consequences less	Consequences less than	Consequences less than
		than those for Low	those for Low Consequence	those for Low
		Consequence Level	Level	Consequence Level

**Table 11.21 Potential Energy – MOI Offsite** 

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane	Hazard: N/A	L: C:	See section I Chapter IV	L: C:
Operations		R:		R:
Compressed Gasses	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Vacuum/ Pressure Vessels	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Vacuum Pumps	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Material Handling	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.													
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative Ranking)			Risk Matrix							
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (event) of major concern										
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern		_	Α	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		<b>III</b> = situation (ex	vent) of minor concern	es	Н	I	I	II	III			
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		<b>IV</b> = situation (event) of minimal concern		ences	M	II	II	III	IV			
Control(s) Type	$\mathbf{C}$	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn	<b>—</b>		***	***	TX 7			
<b>P</b> = Preventive (reduce event occurrence likelihood)	H	C ≥ Irreversible.	C > F	Prompt worker fatality	C ≥ Prompt worker	ons	L	III	III	IV	IV			
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that	ت	N	IV	IV	IV	IV			
Acronyms		or symptoms which		immediately life-	is immediately life-		1							
MOI = Maximally-exposed Offsite Individual		could impair an		ininicalately life	is miniculately life									

		individual's ability to take protective	threatening or permanently disabling.	threatening or permanently disabling.
		action.	uisuomig.	permanenty disacring.
N	M	$C \ge Mild$ , transient	C ≥ Serious injury, no	C ≥ Serious injury, no
		adverse effects.	immediate loss of life no	immediate loss of life no
			permanent disabilities;	permanent disabilities;
			hospitalization required.	hospitalization required.
]	L	Mild, transient	Minor injuries; no	Minor injuries; no
		adverse effects > C	hospitalization $> \mathbf{C}$	hospitalization $> \mathbf{C}$
	N	Consequences less	Consequences less than	Consequences less than
		than those for Low	those for Low Consequence	those for Low
		Consequence Level	Level	Consequence Level

Table 11.22 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	Hazard: Personnel with implanted medical devices	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year R	lisk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated (L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (evolution)	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		<b>III</b> = situation (ev	vent) of minor concern	seou	Н	I	I	II	III	
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (	(co-located worker)	er) Onsite-1 (facility worker)	nba						
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C > Pror	mpt worker fatality	C ≥ Prompt worker	suo	L	III	III	IV	IV	
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,		ate injury that is	fatality or acute injury that	ر ر	N	IV	IV	IV	IV	
Acronyms		or symptoms which		nediately life-	is immediately life-							
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		ing or permanently	threatening or							
		individual's ability to		disabling.	permanently disabling.							
		take protective		· ·								
		action.										
	M	C ≥ Mild, transient	C≥Se	erious injury, no	C ≥ Serious injury, no							
		adverse effects.	immedi	iate loss of life no	immediate loss of life no							
			perma	nent disabilities;	permanent disabilities;							
			hospita	dization required.	hospitalization required.							
	L	Mild, transient	Min	or injuries; no	Minor injuries; no							
				oitalization > C	hospitalization > C							
	N			quences less than	Consequences less than							
		than those for Low	those for	Low Consequence	those for Low							
		Consequence Level		Level	Consequence Level							

**Table 11.23 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	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Co	onsequence (C, of event)	/year Ris	sk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = situation (evolution (evolution for evolution $	ent) of concern			A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (ev	vent) of minor concern	s	Н	I	I	II	III	
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co	o-located worker)	Onsite-1 (facility worker)	Consequences	т	III	III	IV	IV	
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	$C \ge Irreversible$ ,	C ≥ Promp	pt worker fatality	C ≥ Prompt worker	ons	L	111	III	1 V	1 V	
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	•	e injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV	
Acronyms		or symptoms which		ediately life-	is immediately life-	-					·	
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an	threatening	g or permanently	threatening or							
		individual's ability to	di	isabling.	permanently disabling.							
		take protective										
		action.										
	M	$C \ge Mild$ , transient	$C \ge Ser$	ious injury, no	C ≥ Serious injury, no							
		adverse effects.	immediat	te loss of life no	immediate loss of life no							
			permane	ent disabilities;	permanent disabilities;							
			hospitali	zation required.	hospitalization required.							
	L	Mild, transient	Minor	r injuries; no	Minor injuries; no							
		adverse effects > C	hospita	alization > C	hospitalization > C							
	N	Consequences less	Consequ	iences less than	Consequences less than							
	than those for Low those			ow Consequence	those for Low							
		Consequence Level		Level	Consequence Level							

**Table 11.24 Magnetic Fields – MOI Offsite** 

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year   Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (ev	ent) of major concern							
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (e}$	vent) of concern	l		A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		event) of minor concern	seou	Н	I	I	II	III	
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N}$ = Negligible	IV = situation (e	event) of minimal concern	enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	edne		ш	TIT	13.7	IV	
<b>P</b> = Preventive (reduce event occurrence likelihood)	H	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	1 V	
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	၁	N	IV	IV	IV	IV	
Acronyms		or symptoms which	immediately life-	is immediately life-							
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an	threatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective	G								
		action.									
	M	$C \ge Mild$ , transient	C ≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects > C	hospitalization > C	hospitalization > C							
	N	Consequences less	Consequences less than	Consequences less than							
		than those for Low	those for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 11.25 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	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Noise	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Silica	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Ergonomics	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Co	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = \text{situation (even}$	ent) of concern			A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		<b>III</b> = situation (ex	vent) of minor concern	es	Н	I	I	II	III	
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	ences	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	mba	-					
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible.	C > F	Prompt worker fatality	C ≥ Prompt worker	Conse	L	III	III	IV	IV	
<b>M</b> = Mitigative (reduces event consequences)	_	other serious effects,		acute injury that is	fatality or acute injury that	Č	N	IV	IV	IV	IV	
Acronyms		or symptoms which		immediately life-	is immediately life-		1					
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		tening or permanently	threatening or							
		individual's ability to		disabling.	permanently disabling.							
		take protective										
		action.										

M	$C \ge Mild$ , transient	C ≥ Serious injury, no	C ≥ Serious injury, no	
	adverse effects.	immediate loss of life no	immediate loss of life no	
		permanent disabilities;	permanent disabilities;	
		hospitalization required.	hospitalization required.	
L	Mild, transient	Minor injuries; no	Minor injuries; no	
	adverse effects > C	hospitalization $> \mathbf{C}$	hospitalization $> \mathbf{C}$	
N	Consequences less	Consequences less than	Consequences less than	
	than those for Low	those for Low Consequence	those for Low	
	Consequence Level	Level	Consequence Level	

Table 11.26 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	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Noise	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Silica	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:
Ergonomics	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		<b>II</b> = situation (even	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		<b>III</b> = situation (ex	vent) of minor concern	ន	Н	I	I	II	III	
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		<b>IV</b> = situation (ev	vent) of minimal concern	enco	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn	-					
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible.	C ≥ Prompt worker fatality	Prompt worker fatality	C ≥ Prompt worker	S	L	III	III	IV	IV	
<b>M</b> = Mitigative (reduces event consequences)		other serious effects.		acute injury that is	fatality or acute injury that	S	N	IV	IV	IV	IV	
Acronyms		or symptoms which		immediately life-	is immediately life-							
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		tening or permanently	threatening or							
		individual's ability to		disabling.	permanently disabling.							
		take protective										
		action.										

M	$C \ge Mild$ , transient	C ≥ Serious injury, no	C ≥ Serious injury, no	
	adverse effects.	immediate loss of life no	immediate loss of life no	
		permanent disabilities;	permanent disabilities;	
		hospitalization required.	hospitalization required.	
L	Mild, transient	Minor injuries; no	Minor injuries; no	
	adverse effects > C	hospitalization $> \mathbf{C}$	hospitalization $> \mathbf{C}$	
N	Consequences less	Consequences less than	Consequences less than	
	than those for Low	those for Low Consequence	those for Low	
	Consequence Level	Level	Consequence Level	

**Table 11.27 Other hazards – MOI Offsite** 

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined	Hazard: N/A	L:	See section I Chapter IV	L:
Spaces		C:		C:
		R:		R:
Noise	Hazard: N/A	L:	See section I Chapter IV	L:
		C:		C:
		R:		R:
Silica	Hazard: N/A	L:	See section I Chapter IV	L:
		C:		C:
		R:		R:
Ergonomics	Hazard: N/A	L:	See section I Chapter IV	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-	1, "E	xample Qualitative Cons	sequer	nce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)/	/year	Risk (R, Qualitative	Ranking)	Risk Matrix					
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (eve	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		<b>III</b> = situation (ex	vent) of minor concern	es	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	seouenbe	M	II	П	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	l nba	-			***	***
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible.	C > F	Prompt worker fatality	C ≥ Prompt worker	ons	L	III	III	IV	IV
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that	Ö	N	IV	IV	IV	IV
Acronyms		or symptoms which		immediately life-	is immediately life-						
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an	threat	tening or permanently	threatening or						
		individual's ability to		disabling.	permanently disabling.						

	take protective		
	action.		
M	$C \ge Mild$ , transient	C ≥ Serious injury, no	C ≥ Serious injury, no
	adverse effects.	immediate loss of life no	immediate loss of life no
		permanent disabilities;	permanent disabilities;
		hospitalization required.	hospitalization required.
L	Mild, transient	Minor injuries; no	Minor injuries; no
	adverse effects > C	hospitalization $> C$	hospitalization $> \mathbf{C}$
N	Consequences less	Consequences less than	Consequences less than
	than those for Low	those for Low Consequence	those for Low
	Consequence Level	Level	Consequence Level

Table 11.28 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	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "E	Example Qualitative Con	sequence N	// Aatrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)	/year Ris	sk (R, Qualitative	Ranking)	Risk	Matri	X			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even	nt) of major concern			Likelihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	<b>M</b> = Moderate		ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (ev	vent) of minor concern	s	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co	o-located worker)	Onsite-1 (facility worker)	Consequences	т	III	III	IV	IV
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	$C \ge Irreversible$ ,	C ≥ Promp	pt worker fatality	C ≥ Prompt worker	ons	L	111	III	1 V	1 V
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	•	e injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV
Acronyms		or symptoms which		ediately life-	is immediately life-	-					·
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an	threatening	g or permanently	threatening or						
		individual's ability to	di	isabling.	permanently disabling.						
		take protective									
		action.									
	M	$C \ge Mild$ , transient	$C \ge Ser$	ious injury, no	C ≥ Serious injury, no						
		adverse effects.	immediat	te loss of life no	immediate loss of life no						
			permane	ent disabilities;	permanent disabilities;						
			hospitali	zation required.	hospitalization required.						
	L	Mild, transient	Minor	r injuries; no	Minor injuries; no						
		adverse effects > C	hospita	alization > C	hospitalization > C						
	N	Consequences less	Consequ	iences less than	Consequences less than						
		than those for Low	those for L	ow Consequence	those for Low						
		Consequence Level		Level	Consequence Level						

Table 11.29 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	Hazard: N/A	L: C: R:	See section I Chapter IV	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "E	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	ear Risk (R, Qualitative	Ranking)	Risk	Matri	X			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (eve	(event) of major concern			Likelihood			
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (even)	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$	III = situation (expression)	vent) of minor concern	s	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely $(1.0E-06>L)$		N = Negligible	IV = situation (evolution)	vent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	$\mathbf{C}$	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	ī	III	III	IV	IV
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Suo	L	111	111	1 V	1 V
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	or acute injury that is	fatality or acute injury that	$^{\circ}$	N	IV	IV	IV	IV
Acronyms		or symptoms which	immediately life-	is immediately life-						
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an	threatening or permanently	threatening or						
		individual's ability to	disabling.	permanently disabling.						
		take protective								
		action.								
	M	$C \ge Mild$ , transient	$C \ge Serious injury, no$	$C \ge$ Serious injury, no						
		adverse effects.	immediate loss of life no	immediate loss of life no						
			permanent disabilities;	permanent disabilities;						
			hospitalization required.	hospitalization required.						
	L	Mild, transient	Minor injuries; no	Minor injuries; no						
		adverse effects > C	hospitalization > C	hospitalization > C						
	N	Consequences less	Consequences less than	Consequences less than						
		than those for Low t	hose for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

**Table 11.30 Access & Egress – MOI Offsite** 

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

Other Hazard Consequences, derived from Figure C-	1, "E	Example Qualitative Con	sequence N	// Aatrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)	/year Ris	sk (R, Qualitative	Ranking)	Risk	Matri	X			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even	nt) of major concern			Likelihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	<b>M</b> = Moderate		ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (ev	vent) of minor concern	s	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co	o-located worker)	Onsite-1 (facility worker)	Consequences	т	III	III	IV	IV
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	$C \ge Irreversible$ ,	C ≥ Promp	pt worker fatality	C ≥ Prompt worker	ons	L	111	III	1 V	1 V
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	•	e injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV
Acronyms		or symptoms which		ediately life-	is immediately life-	-					·
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an	threatening	g or permanently	threatening or						
		individual's ability to	di	isabling.	permanently disabling.						
		take protective									
		action.									
	M	$C \ge Mild$ , transient	$C \ge Ser$	ious injury, no	C ≥ Serious injury, no						
		adverse effects.	immediat	te loss of life no	immediate loss of life no						
			permane	ent disabilities;	permanent disabilities;						
			hospitali	zation required.	hospitalization required.						
	L	Mild, transient	Minor	r injuries; no	Minor injuries; no						
		adverse effects > C	hospita	alization > C	hospitalization > C						
	N	Consequences less	Consequ	iences less than	Consequences less than						
		than those for Low	those for L	ow Consequence	those for Low						
		Consequence Level		Level	Consequence Level						

**Table 11.31 Environmental** 

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

Discharge of chemicals into	
onsite soils beyond permitted	
limits.	