Table 9. Summary of Baseline and Residual Risks-8 GeV Line

	Risk Tables Description	Baseline Risk	Residual Risk
9.1	Radiological – Onsite-1 Facility Worker	R: I	R: IV
9.2	Radiological – Onsite-2 Co-located Worker	R: I	R: IV
9.3	Radiological – MOI Offsite	R:NA	R:NA
9.4	Toxic Materials – Onsite 1 Facility Worker	R: *	R: *
9.5	Toxic Materials – Onsite 2 Co-located Worker	R: *	R: *
9.6	Toxic Materials – MOI Offsite	R: *	R: *
9.7	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: NA*	R: NA*
9.8	Flammable & Combustible Materials – Onsite-2 Co-located worker	R: *	R: *
9.9	Flammable & Combustible Materials – MOI Offsite	R: *	R: *
9.10	Electrical Energy – Onsite-1 Facility Worker	R: *	R: *
9.11	Electrical Energy – Onsite-2 Co-located Worker	R: *	R: *
9.12	Electrical Energy – MOI Offsite	R: NA*	R: NA*
9.13	Thermal Energy – Onsite-1 Facility Worker	R: *	R: *
9.14	Thermal Energy – Onsite-2 Co-located Worker	R: *	R: *
9.15	Thermal Energy – MOI Offsite	R: NA*	R: NA*
9.16	Kinetic Energy – Onsite-1 Facility Worker	R: *	R: *
9.17	Kinetic Energy – Onsite-2 Co-located Worker	R: *	R: *
9.18	Kinetic Energy – MOI Offsite	R: NA*	R: NA*
9.19	Potential Energy- Onsite-1 Facility Worker	R: *	R: *
9.20	Potential Energy – Onsite-2 Co-located Worker	R: *	R: *
9.21	Potential Energy – MOI Offsite	R: NA*	R: NA*
9.22	Magnetic Fields – Onsite-1 Facility Worker	R: *	R: *
9.23	Magnetic Fields – Onsite-2 Co-located Worker	R: *	R: *
9.24	Magnetic Fields – MOI Offsite	R: NA*	R: NA*
9.25	Other Hazards – Onsite-1 Facility Worker	R: *	R: *
9.26	Other Hazards – Onsite-2 Co-located Worker	R: *	R: *
9.27	Other Hazards – MOI Offsite	R: NA*	R: NA*
9.28	Access & Egress – Onsite-1 Facility Worker	R: *	R: *
9.29	Access & Egress – Onsite-2 Co-located Worker	R: *	R: *
9.30	Access & Egress – MOI Offsite	R: NA*	R: NA*
9.31	Environmental Hazards	R: *	R: *

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

NOTE:

Per DOE-HDBK-1163-2020, Appendix C, "Risk Assessment Methodology":

"Events with an unmitigated risk value of III or IV would not require additional control assignments to provide reasonable assurance of adequate protection. Whereas, for events with an unmitigated risk value of I or II, controls would need to be assigned to either reduce the likelihood or the consequence, and therefore the overall mitigated risk. Generally, preventive controls are applied prior to a loss event – reflecting a likelihood reduction and mitigative controls are applied after a loss event – reflecting a consequence reduction. Each control is credited for a single "bin drop" either in likelihood or consequence; not both. Following a standard hierarchy of controls, controls are applied until the residual risk is acceptable – reflecting a mitigated risk value of III or IV. After controls are credited, events

with a remaining unacceptable residual risk (i.e., I or II) are candidates for additional analyses and additional controls, often quantitative in nature." For Fermilab, these controls for accelerator-specific hazards are identified as Credited Controls and further summarized in the Accelerator Safety Envelope (ASE).

Table 9.1 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: L
		R: I	 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. 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. 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. 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. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. 	R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Groundwater	Hazard: Radionuclides in ground	L: A	P – Monitoring Wells: Wells that are drilled near accelerator enclosures	L: EU
Activation	water exceed regulatory levels	C: H	in areas that are sensitive to potential aquifer contamination. These	C: L
		R: I	wells are periodically sampled and analyzed by ES&H to ensure the aquifer is not becoming contaminated from accelerator operations. 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. 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 – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Surface Water	Hazard: Radionuclides in surface	L: A	P – Sump Pumps: Pumps located in the accelerator enclosure that have	L: BEU
Activation	water exceed regulatory levels	C: H R: I	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. 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 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 – 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	C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Air Activation	Hazard: Radionuclides in air exceed regulatory levels	L: A C: H R: I	 P – Air Monitoring: Air sampled from the enclosure for activation M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. 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 – Engineered Air Flow: Enclosure air flow design to give the activated air time to decay before exiting the enclosure. 	L: EU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Soil Interactions	Hazard: Radionuclides are produced	L: A	P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to	L: U
	which may contaminate ground water	C: H R: I	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 – 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. M – Beam position auto-tune program maintains desired beam position through the collimator region of the 8-GeV Line segment.	C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
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: L
	levels	R: I	 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. 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. 	R: IV
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 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 basic worker knowledge through presentations and testing. 	R: IV
⁷ Be	Hazard: Potential radiation exposure	L: A	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't	L: A
	to ⁷ Be (uptake/committed dose)	C: N	hazardous in this pattern of use by facility.	C: N
		R: IV		R: IV

Likelihood (L, of event)/year	Cor	sequence (C, of event)/y	ear	Risk (R, Qualitative Ra	nking)	Risk	Matrix				
A = Anticipated (L > 1.0E-02)		H = High		I = situation (even	t) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (event) of concern		nt) of concern			Α	U	EU	BEL
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (event) of minor concern		es	Н	- 1	- 1	П	Ш	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	N = Negligible IV = situation (event) of minimal concern		enc	М	Ш	Ш	III	IV	
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	- ledn	1	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ 25.0 rem		C ³ 100 rem	C ³ 100 rem	Sug					
M = Mitigative (reduces event consequences)	М	25.0 rem > C ³ 5 rem	10	00 rem > C ³ 25 rem	100 rem > C ³ 25 rem	L	N	IV	IV	IV	IV
Acronyms	L	5 rem > C		25 rem > C	25 rem > C						
MOI = Maximally-exposed Offsite Individual	N	0.5 rem > C		5 rem > C	5 rem > C						
rem = Roentgen equivalent man											

Table 9.2 Radiological – Onsite-2 Co-located 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: L
		R: I	 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. 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. 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. 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. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. 	R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Groundwater	Hazard: Radionuclides in ground	L: A	P – Monitoring Wells: Wells that are drilled near accelerator enclosures	L: BEU
Activation	water exceed regulatory levels	C: H	in areas that are sensitive to potential aquifer contamination. These	C: L
		R: I	wells are periodically sampled and analyzed by ES&H to ensure the aquifer is not becoming contaminated from accelerator operations. 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. 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.	R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Surface Water	Hazard: Radionuclides in surface	L: A	P – Sump Pumps: Pumps located in the accelerator enclosure that have	L: BEU
Activation	water exceed regulatory levels	C: H	an underdrain network. The water is pumped to the surface, so it	C: N
		R: I	does not stagnate in the accelerator and becomes activated prior to removing the water from the enclosure. 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.	R: IV

Hazard Hazard Description		Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Air Activation	Hazard: Radionuclides in air exceed	L: A	P – Air Monitoring: Air sampled from the enclosure for activation	L: BEU
	regulatory levels	C: H	M – Run Conditions: Operating parameters that reduce residual	C: L
		R: I	activation by limiting the total amount of beam that could be delivered. 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— Engineered Air Flow: Enclosure air flow design to give the activated air time to decay before exiting the enclosure.	R: IV
Soil Interactions	Hazard: Radionuclides are produced	L: A	P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to	L: EU
	which may contaminate ground water	C: H	convert radiation created by prompt dose due to beam loss. This	C: L
		R: I	 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 – 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. M – Beam position auto-tune program maintains desired beam position through the collimator region of the 8-GeV Line segment. 	R: IV

Hazard Hazard Description		Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive	Hazard: Persons are exposed to	L: A	P – Locked Gates: Barriers to entrances of areas that contain radioactive	L: U
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 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. 	R: IV
Contamination	Hazard: Persons are exposed to	L: A	P – Locked Gates: Barriers to entrances of areas that contain radioactive	L: BEU
	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 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 basic worker knowledge through presentations and testing. 	R: IV
⁷ Be	Hazard: Potential radiation exposure	L: A	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't	L:EU
	to ⁷ Be (uptake/committed dose)	C: N	hazardous in this pattern of use by facility.	C: L
		R: IV		R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
				L: A
				C: N
				R: IV

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Cor	sequence (C, of event)/ye	ear	Risk (R, Qualitative Ranking)			Risk Matrix					
A = Anticipated (L > 1.0E-02)		H = High		I = situation (even	t) of major concern				Like	ihood		
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (ever	nt) of concern		1	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (eve	nt) of minor concern	is s	Н	- 1	- 1	Ш	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern			М	П	Ш	Ш	IV	
Control(s) Type	С	Offsite (MOI)	Onsit	e-2 (co-located worker)	Onsite-1 (facility worker)	Sedi	1	Ш	Ш	IV	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ³ 25.0 rem		C ³ 100 rem	C ³ 100 rem	- l	<u> </u>					
M = Mitigative (reduces event consequences)	М	25.0 rem > C ³ 5 rem	1	00 rem > C ³ 25 rem	100 rem > C ³ 25 rem		N	IV	IV	IV	IV	
Acronyms	L	5 rem > C		25 rem > C	25 rem > C							
MOI = Maximally-exposed Offsite Individual rem = Roentgen equivalent man	N	0.5 rem > C		5 rem > C	5 rem > C							

Table 9.3 Radiological – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Residual	Hazard: Exposure to residual	L: BEU	Not Applicable. No prevention or mitigation is required. The area is	L: BEU
Activation	activation	C: N	located beyond the public access gate.	C: N
		R: IV		R: IV

Hazard			Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Groundwater	Hazard: Radionuclides in ground	L: A	P – Monitoring Wells: Wells that are drilled near accelerator enclosures in	L: BEU
Activation	water exceed regulatory levels	C: H R: I	areas that are sensitive to potential aquifer contamination. These wells are periodically sampled and analyzed by ES&H to ensure the aquifer is not becoming contaminated from accelerator operations. 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. 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.	C: L R: IV

Hazard Hazard Description		Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)	
Surface Water	Hazard: Radionuclides in surface	L: A	P – Sump Pumps: Pumps located in the accelerator enclosure that have	L: BEU	
Activation	water exceed regulatory levels	C: H R: I	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. 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.	C: L 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	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Soil Interactions	Hazard: Radionuclides are produced which may contaminate ground water	L: BEU C: N	Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate.	L: BEU C: N
	The state of the s	R: IV	located softens the passes gate.	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
⁷ Be	Hazard: Potential radiation exposure to ⁷ Be (uptake/committed dose)	L: A C: N R: I	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Cor	Consequence (C, of event)/year		Risk (R, Qualitative Ranking)		Risk Matrix						
A = Anticipated (L > 1.0E-02)		H = High		I = situation (event) of major concern						Like	ihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (event) of concern					Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (event) of minor concern		8	6 H	1	1	-	П	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern				Л	П	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2	2 (co-located worker)	Onsite-1 (facility worker)		nhac	L	Ш	III	IV	IV
P = Preventive (reduce event occurrence likelihood)		C ³ 25.0 rem		C ³ 100 rem	C ³ 100 rem	[]	<u> </u>					
M = Mitigative (reduces event consequences)	М	25.0 rem > C ³ 5 rem	100	rem > C ³ 25 rem	100 rem > C ³ 25 rem		ון	N	IV	IV	IV	IV

Acronyms	L	5 rem > C	25 rem > C	25 rem > C	
MOI = Maximally-exposed Offsite Individual	N	0.5 rem > C	5 rem > C	5 rem > C	
rem = Roentgen equivalent man					

Table 9.4 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 un- encased lead bricks, lead shot, and lead sheets	L: C: R:	See Section I Chapter 04.	L: C: R:

Chemical Hazard Consequences, derived from Figure C-	L, "E	xample Qualitative Cons	equend	e Matrix", DOE-HDBK-	1163-2020.							
Likelihood (L, of event)/year	Co	nsequence (C, of event)	/year	Risk (R, Qualitative Ranking)			Matrix	1				
A = Anticipated (L > 1.0E-02)		H = High		I = situation (eve	nt) of major concern				Likelihood			
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (eve	ent) of concern		1	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	ces	Н	- 1	- I	Ш	Ш	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	IV = situation (event) of minimal concern			Ш	Ш	Ш	IV	
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)] beg	1	Ш	Ш	IV	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ³ PAC-2		C ³ PAC-3	C 3 IDLH] io						
M = Mitigative (reduces event consequences)	М	PAC-2 > C ³ PAC-1	F	PAC-3 > C ³ PAC-2	IDLH > C 3 PEL or TLVc		N	IV	IV	IV	IV	
Acronyms	L	PAC-1 > C		PAC-2 > C	PEL or TLV _c > C							
IDLH = Immediately Dangerous to Life and Health	N	Consequences less	Con	sequences less than	Consequences less than	1						
MOI = Maximally-exposed Offsite Individual		than those for Low	those	for Low Consequence	those for Low							
PAC = Protective Action Criteria		Consequence Level		Level	Consequence Level							
PEL = Permissible Exposure Limit												
TLV _c = Threshold Limit Value (ceiling)												

Table 9.5 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 Shielding	Hazard: Potential exposure to lead	L: A	See Section I Chapter 04.	L: BEU
	dust during manual handling of un-	C: H		C: L
	encased lead bricks, lead shot, and	R: I		R: IV
	lead sheets			

Chemical Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Co	nsequence (C, of event)	/year	Risk (R, Qualitative R	anking)	Risk	Matrix					
A = Anticipated (L > 1.0E-02)		H = High		I = situation (eve	nt) of major concern				Like	ihood		
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (eve	ent) of concern	l —		Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	es	Н	- 1	- 1	Ш	Ш	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	enc	М	II	Ш	Ш	IV	
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn	ı	Ш	III	IV	IV	
P = Preventive (reduce event occurrence likelihood)	н	C ³ PAC-2		C ³ PAC-3	C 3 IDLH	Sons						
M = Mitigative (reduces event consequences)	М	PAC-2 > C ³ PAC-1	F	PAC-3 > C ³ PAC-2	IDLH > C 3 PEL or TLV _c		N	IV	IV	IV	IV	
Acronyms	L	PAC-1 > C		PAC-2 > 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 _c = Threshold Limit Value (ceiling)	N	Consequences less than those for Low Consequence Level		sequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level							

Table 9.6 Toxic Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead Shielding	Hazard: Potential exposure to lead	L:	See Section I Chapter 04.	L:
	dust during manual handling of un-	C:		C:
	encased lead bricks, lead shot, and	R:		R:
	lead sheets			

Chemical Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.													
Likelihood (L, of event)/year	Co	nsequence (C, of event)	/year	Risk (R, Qualitative R	anking)	Risk	Matrix						
A = Anticipated (L > 1.0E-02)		H = High		I = situation (eve	nt) of major concern				Like	ihood	,		
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (eve	ent) of concern	l	1	Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	es	Н	- 1	- 1	Ш	Ш		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	ences	М	II	Ш	Ш	IV		
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	1	Ш	III	IV	IV		
P = Preventive (reduce event occurrence likelihood)	Н	C ³ PAC-2		C ³ PAC-3	C 3 IDLH	l si							
M = Mitigative (reduces event consequences)	М	PAC-2 > C ³ PAC-1	F	PAC-3 > C ³ PAC-2	IDLH > C 3 PEL or TLV _c	1 L	N	IV	IV	IV	IV		
Acronyms	L	PAC-1 > C		PAC-2 > 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 _c = Threshold Limit Value (ceiling)	N	Consequences less than those for Low Consequence Level		sequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level								

Table 9.7 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		L:	See Section I Chapter 04.	L:
materials (cables,		C:		C:
Boxes, Paper,		R:		R:
wood cribbing,				
etc.)				
Flammable		L:	See Section I Chapter 04.	L:
Materials		C:		C:
(Flammable gas,		R:		R:
cleaning				
materials, etc.)				

Likelihood (L, of event)/year	Co	onsequence (C, of event)/	year Risk (R, Qualitative R	anking)	Risk	Matrix	(
A = Anticipated (L > 1.0E-02)		H = High		I = situation (event) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve				Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (ev	rent) of minor concern	l sa	Н	- 1	- 1	II	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	•	vent) of minimal concern	enc	М	П	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	seduences			III	IV	IV
P = Preventive (reduce event occurrence likelihood)	н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons	L	III	""	IV	IV
M = Mitigative (reduces event consequences)	Γ.	serious effects, or	or acute injury that is	or acute injury that is	0	N	IV	IV	IV	IV
Acronyms		symptoms which	immediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or	threatening or						
		individual's ability to	permanently disabling.	permanently disabling.						
		take protective	, ,	, , , , , , , , , , , ,						
		action.								
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ 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 9.8 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		L:	See Section I Chapter 04.	L:
materials (cables,		C:		C:
Boxes, Paper,		R:		R:
wood cribbing,				
etc.)				
Flammable		L:	See Section I Chapter 04.	L:
Materials		C:		C:
(Flammable gas,		R:		R:
cleaning				
materials, etc.)				

Likelihood (L, of event)/year	Co	onsequence (C, of event)/	year Risk (R, Qualitative R	anking)	Risk	Matrix	(
A = Anticipated (L > 1.0E-02)		H = High		I = situation (event) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve				Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (ev	rent) of minor concern	l sa	Н	- 1	- 1	II	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	•	vent) of minimal concern	enc	М	П	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	seduences			III	IV	IV
P = Preventive (reduce event occurrence likelihood)	н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons	L	III	""	IV	IV
M = Mitigative (reduces event consequences)	Γ.	serious effects, or	or acute injury that is	or acute injury that is	0	N	IV	IV	IV	IV
Acronyms		symptoms which	immediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or	threatening or						
		individual's ability to	permanently disabling.	permanently disabling.						
		take protective	, ,	, , , , , , , , , , , ,						
		action.								
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ 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 9.9 Flammable and Combustible Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible		L:	See Section I Chapter 04.	L:
materials (cables,		C:		C:
Boxes, Paper,		R:		R:
wood cribbing,				
etc.)				
Flammable		L:	See Section I Chapter 04.	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	Co	onsequence (C, of event),	year Risk (R, Qualitative R	anking)	Risk	Matrix	(
A = Anticipated (L > 1.0E-02)		H = High	I = situation (eve	nt) of major concern				Like	lihood				
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve	ent) of concern	l —	1	Α	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (ev	ent) of minor concern	es	Н	- 1	- 1	Ш	III			
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern	lenc	М	Ш	П	Ш	IV			
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	-	Ш	III	IV	IV			
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons	<u> </u>							
M = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	اك	N	IV	IV	IV	IV			
Acronyms		symptoms which	immediately life-	immediately life-									
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or	threatening or									
		individual's ability to	permanently disabling.	permanently disabling.									
		take protective											
		action.											
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ 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 9.10 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		L:	See Section I Chapter 04.	L:
Exposure		C:		C:
		R:		R:
High Voltage		L:	See Section I Chapter 04.	L:
Exposure		C:		C:
		R:		R:
Low Voltage, High		L:	See Section I Chapter 04.	L:
Current Exposure.		C:		C:
		R:		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 R	tanking)	Risk	Matrix	(
A = Anticipated (L > 1.0E-02)		H = High	I = situation (eve	ent) of major concern				lihood					
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (ev	ent) of concern	l —	1	Α	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (ev	vent) of minor concern	ces	Н	- 1	- 1	Ш	Ш			
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	lenc	М	П	П	Ш	IV			
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedn	ı	III	III	IV	IV			
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons								
M = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	╎└	N	IV	IV	IV	IV			
Acronyms		symptoms which	immediately life-	immediately life-									
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or	threatening or									
		individual's ability to	permanently disabling.	permanently disabling.									
		take protective											
		action.											
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ 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 9.11 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		L:	See Section I Chapter 04.	L:
Exposure		C:		C:
		R:		R:
High Voltage		L:	See Section I Chapter 04.	L:
Exposure		C:		C:
		R:		R:
Low Voltage, High		L:	See Section I Chapter 04.	L:
Current Exposure.		C:		C:
		R:		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 R	Risk (R, Qualitative Ranking)		Risk Matrix_							
A = Anticipated (L > 1.0E-02)		H = High	I = situation (eve	I = situation (event) of major concern			Likelihood						
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve	II = situation (event) of concern		1	Α	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (ev	III = situation (event) of minor concern		Н	- 1	- 1	Ш	III			
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	IV = situation (event) of minimal concern		М	Ш	П	Ш	IV			
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	-	Ш	III	IV	IV			
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons	<u> </u>							
M = Mitigative (reduces event consequences)AcronymsMOI = Maximally-exposed Offsite Individual		serious effects, or	or acute injury that is	or acute injury that is		N	IV	IV	IV	IV			
		symptoms which	immediately life-	immediately life-									
		could impair an	threatening or	threatening or									
		individual's ability to	permanently disabling.	permanently disabling.									
		take protective											
		action.											
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ 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 9.12 Electrical Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy		L:	See Section I Chapter 04.	L:
Exposure		C:		C:
		R:		R:
High Voltage		L:	See Section I Chapter 04.	L:
Exposure		C:		C:
		R:		R:
Low Voltage, High		L:	See Section I Chapter 04.	L:
Current Exposure.		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1, "I	Exar	nple Qualitative Consequ	uence Mat	trix", DOE-HDBK-116	3-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event),	/year R	Risk (R, Qualitative R	anking)	Risk	Matrix	(
A = Anticipated (L > 1.0E-02)		H = High		I = situation (event) of major concern					Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		<pre>II = situation (eve</pre>	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	nces	Н	- 1	- 1	П	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	lenc	М	П	H	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2	(co-located worker)	Onsite-1 (facility worker)	sedn	ı	Ш	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	rsible, other C ³ Prompt worker fatality C		C ³ Prompt worker fatality	Cons					
M = Mitigative (reduces event consequences)		serious effects, or		tute injury that is	or acute injury that is		N	IV	IV	IV	IV
Acronyms		symptoms which		mediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	th	nreatening or	threatening or						
		individual's ability to	perma	anently disabling.	permanently disabling.						
		take protective									
		action.									
	М	C ³ Mild, transient	C ³ Se	erious injury, no	C ³ Serious injury, no						
		adverse effects.	immed	diate loss of life no	immediate loss of life no						
			perma	anent disabilities;	permanent disabilities;						
			hospita	alization required.	hospitalization required.						
	L	Mild, transient	Mir	nor injuries; no	Minor injuries; no						
		adverse effects > C	hos	pitalization > C	hospitalization > C						
	N	Consequences less	Conse	quences less than	Consequences less than						
		than those for Low	those fo	r Low Consequence	those for Low						
		Consequence Level		Level	Consequence Level						

Table 9.13 Thermal Energy – Onsite-1 Facility Worker

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

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Consequ	ence Matrix	(", DOE-HDBK-116	3-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)/	/year Risk	(R, Qualitative R	anking)	Risk	Matrix				
A = Anticipated (L > 1.0E-02)		H = High		I = situation (event) of major concern				Likelihood			
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (eve	ent) of concern	l	1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	i s	Н	- 1	I	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	l en	М	П	H	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co	-located worker)	Onsite-1 (facility worker)	sednences	ı	Ш	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt	t worker fatality	C ³ Prompt worker fatality	Cons					
M = Mitigative (reduces event consequences)		serious effects, or	or acute	e injury that is	or acute injury that is		N	IV	IV	IV	IV
Acronyms		symptoms which	imme	diately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	threa	atening or	threatening or						
		individual's ability to	permane	ently disabling.	permanently disabling.						
		take protective									
		action.									
	М	C ³ Mild, transient	C ³ Serio	ous injury, no	C ³ Serious injury, no						
		adverse effects.	immediat	e loss of life no	immediate loss of life no						
			permane	ent disabilities;	permanent disabilities;						
			hospitaliz	ation required.	hospitalization required.						
	L	Mild, transient	Minor	injuries; no	Minor injuries; no						
		adverse effects > C	hospit	alization > C	hospitalization > C						
	N	Consequences less	Conseque	ences less than	Consequences less than						
		than those for Low	those for Lo	ow Consequence	those for Low						
I		Consequence Level		Level	Consequence Level						

Table 9.14 Thermal Energy – Onsite-2 Co-located Worker

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

Likelihood (L, of event)/year	Co	onsequence (C, of event)/	year	Risk (R, Qualitative R	anking)	Risk	Matrix				
A = Anticipated (L > 1.0E-02)		H = High		I = situation (ever	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (event) of concern				Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	L = Low		ent) of minor concern	ces	Н	- 1	- I	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	enc	М	Ш	П	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-	2 (co-located worker)	Onsite-1 (facility worker)	sedu	-	III	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	Н	C ³ Irreversible, other serious effects, or	· · · · · · · · · · · · · · · · · · ·		C ³ Prompt worker fatality or acute injury that is	Cons	N	IV	IV	IV	IV
Acronyms		symptoms which	, ,		immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an			threatening or						
		individual's ability to	pern	manently disabling.	permanently disabling.						
		take protective		,							
		action.									
	М	C ³ Mild, transient	C ³	Serious injury, no	C ³ Serious injury, no						
		adverse effects.	imme	ediate loss of life no	immediate loss of life no						
			pern	manent disabilities;	permanent disabilities;						
			hospi	italization required.	hospitalization required.						
	L	Mild, transient	M	linor injuries; no	Minor injuries; no						
		adverse effects > C	ho	ospitalization > C	hospitalization > C						
	N	Consequences less	Cons	sequences less than	Consequences less than						
		than those for Low	those f	for Low Consequence	those for Low						
		Consequence Level		Level	Consequence Level						

Table 9.15 Thermal Energy – MOI Offsite

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

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Consequ	ience M	atrix", DOE-HDBK-116	3-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event),	/year	Risk (R, Qualitative Ra	anking)	Risk	Matrix				
A = Anticipated (L > 1.0E-02)		H = High		I = situation (event) of major concern						lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (event) of concern		l —	1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	ces	Н	- 1	I	П	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	l	М	Ш	Ш	111	IV
Control(s) Type	С	Offsite (MOI)	Onsite-	2 (co-located worker)	Onsite-1 (facility worker)	sedr	ı	III	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	Н	C ³ Irreversible, other serious effects, or			C ³ Prompt worker fatality or acute injury that is	Cons	N	IV	IV	IV	IV
Acronyms		symptoms which		nmediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an		threatening or	threatening or						
		individual's ability to	pern	nanently disabling.	permanently disabling.						
		take protective									
		action.									
	М	C ³ Mild, transient	C ³	Serious injury, no	C ³ Serious injury, no						
		adverse effects.	imme	ediate loss of life no	immediate loss of life no						
			pern	nanent disabilities;	permanent disabilities;						
			hospi	italization required.	hospitalization required.						
	L	Mild, transient	M	linor injuries; no	Minor injuries; no						
		adverse effects > C	hc	ospitalization > C	hospitalization > C						
	N	Consequences less	Cons	sequences less than	Consequences less than						
		than those for Low	those f	for Low Consequence	those for Low						
		Consequence Level		Level	Consequence Level						

Table 9.16 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		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Pumps and		L:	See Section I Chapter 04.	L:
Motors		C:		C:
		R:		R:
Motion Tables		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Mobile Shielding		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:

Likelihood (L, of event)/year	Co	onsequence (C, of event)/	year Risk (R, Qualitative R	anking)	Risk	Matrix	(
A = Anticipated (L > 1.0E-02)		H = High		I = situation (event) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve				Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (ev	rent) of minor concern	l sa	Н	- 1	- 1	II	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	•	vent) of minimal concern	enc	М	П	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	seduences			III	IV	IV
P = Preventive (reduce event occurrence likelihood)	н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons	L	III	""	IV	IV
M = Mitigative (reduces event consequences)	Γ.	serious effects, or	or acute injury that is	or acute injury that is	0	N	IV	IV	IV	IV
Acronyms		symptoms which	immediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or	threatening or						
		individual's ability to	permanently disabling.	permanently disabling.						
		take protective	, ,	, , , , , , , , ,						
		action.								
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ 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 9.17 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		L:	See Section I Chapter 04.	L:
		C: R:		C: R:
Pumps and		L:	See Section I Chapter 04.	L:
Motors		C:		C:
		R:		R:
Motion Tables		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Mobile Shielding		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1, "	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	Co	nsequence (C, of event),	/year	Risk (R, Qualitative R	anking)	Risk	Matri	K				
A = Anticipated (L > 1.0E-02)		H = High		I = situation (ever	nt) of major concern				Likelihood			
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (eve	ent) of concern	l	1	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	nces	Н	- 1	- 1	П	Ш	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	lenc	М	П	П	III	IV	
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	sedr	L	III	III	IV	IV	
P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	Н	C ³ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	or i	rompt worker fatality acute injury that is immediately life-threatening or manently disabling.	C ³ Prompt worker fatality or acute injury that is immediately life- threatening or permanently disabling.	Con	N	IV	IV	IV	IV	
	M	C ³ Mild, transient adverse effects. Mild, transient adverse effects > C	imm per hosp	Serious injury, no nediate loss of life no manent disabilities; pitalization required. Winor injuries; no nospitalization > C	C ³ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no hospitalization > C							

Table 9.18 Kinetic Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power Tools		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Pumps and		L:	See Section I Chapter 04.	L:
Motors		C:		C:
		R:		R:
Motion Tables		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Mobile Shielding		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		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 R	anking)	Risk Matrix						
\mathbf{A} = Anticipated (L > 1.0E-02)		H = High		I = situation (eve	nt) of major concern					Likel	ihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (eve	ent) of concern		-	ı	A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	seou	Н		I	- 1	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	lenc	М	1	II	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	sedn	L	1	П	Ш	IV	IV
 P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 	Н	C ³ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	or i	rompt worker fatality acute injury that is immediately life- threatening or manently disabling.	C ³ Prompt worker fatality or acute injury that is immediately life- threatening or permanently disabling.	Con	N	Г	V	IV	IV	IV
	M L	C ³ Mild, transient adverse effects. C ³ Se immedi permai hospita Mild, transient Mind		Serious injury, no nediate loss of life no manent disabilities; pitalization required. Minor injuries; no no nospitalization > C	C ³ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no hospitalization > C							

Table 9.19 Potential Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Compressed		L:	See Section I Chapter 04.	L:
Gasses		C:		C:
		R:		R:
Vacuum/		L:	See Section I Chapter 04.	L:
Pressure Vessels		C:		C:
		R:		R:
Vacuum Pumps		L:	See Section I Chapter 04.	L:
vacuum rumps		C:		C:
		R:		R:
Material Handling		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		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 I	Ranking)	Risk	Matrix	(
A = Anticipated (L > 1.0E-02)		H = High	I = situation (ev	I = situation (event) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (ev	II = situation (event) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (e	vent) of minor concern	nces	Н	- 1	- 1	П	Ш	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (e	vent) of minimal concern	l l oue	М	П	H	Ш	IV	
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedn	ı	Ш	III	IV	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons						
M = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	∣╚	N	IV	IV	IV	IV	
Acronyms		symptoms which	immediately life-	immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or	threatening or							
		individual's ability to	permanently disabling.	permanently disabling.							
		take protective									
		action.									
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ 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 9.20 Potential Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Compressed		L:	See Section I Chapter 04.	L:
Gasses		C:		C:
		R:		R:
Vacuum/		L:	See Section I Chapter 04.	L:
Pressure Vessels		C:		C:
		R:		R:
Vacuum Dumns		L:	See Section I Chapter 04.	L:
Vacuum Pumps		C:		C:
		R:		R:
Material Handling		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		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 Ra	anking)	Risk	Matrix				
\mathbf{A} = Anticipated (L > 1.0E-02)		H = High		I = situation (ever	nt) of major concern				Like	lihood	_
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		<pre>II = situation (eve</pre>	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		$\mathbf{L} = Low$		III = situation (ev	ent) of minor concern	ses	Н	- 1	- 1	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	enc	М	Ш	П	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	sednences		Ш	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Pr	ompt worker fatality	C ³ Prompt worker fatality	Cons					
M = Mitigative (reduces event consequences)		serious effects, or		acute injury that is	or acute injury that is		N	IV	IV	IV	IV
Acronyms		symptoms which		mmediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an		threatening or	threatening or						
		individual's ability to	peri	manently disabling.	permanently disabling.						
		take protective		, -							
		action.									
	М	C ³ Mild, transient	C ³	Serious injury, no	C ³ Serious injury, no						
		adverse effects.	imm	ediate loss of life no	immediate loss of life no						
			peri	manent disabilities;	permanent disabilities;						
			hosp	italization required.	hospitalization required.						
	L	· ·		linor injuries; no	Minor injuries; no						
		adverse effects > C hospitalization > C		hospitalization > C							
	N	Consequences less Consequences less than Conseque		Consequences less than							
		than those for Low those for Low Consequence those for Low									
		Consequence Level		Level	Consequence Level						

Table 9.21 Potential Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Compressed		L:	See Section I Chapter 04.	L:
Gasses		C:		C:
		R:		R:
Vacuum/		L:	See Section I Chapter 04.	L:
Pressure Vessels		C:		C:
		R:		R:
Vacuum Dumns		L:	See Section I Chapter 04.	L:
Vacuum Pumps		C:		C:
		R:		R:
Material Handling		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		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 Ra	anking)	Risk	Matrix				
\mathbf{A} = Anticipated (L > 1.0E-02)		H = High		I = situation (ever	nt) of major concern				Like	lihood	_
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		<pre>II = situation (eve</pre>	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		$\mathbf{L} = Low$		III = situation (ev	ent) of minor concern	ses	Н	- 1	- 1	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	enc	М	Ш	П	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	sednences		Ш	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Pr	ompt worker fatality	C ³ Prompt worker fatality	Cons					
M = Mitigative (reduces event consequences)		serious effects, or		acute injury that is	or acute injury that is		N	IV	IV	IV	IV
Acronyms		symptoms which		mmediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an		threatening or	threatening or						
		individual's ability to	peri	manently disabling.	permanently disabling.						
		take protective		, -							
		action.									
	М	C ³ Mild, transient	C ³	Serious injury, no	C ³ Serious injury, no						
		adverse effects.	imm	ediate loss of life no	immediate loss of life no						
			peri	manent disabilities;	permanent disabilities;						
			hosp	italization required.	hospitalization required.						
	L	· ·		linor injuries; no	Minor injuries; no						
		adverse effects > C hospitalization > C		hospitalization > C							
	N	Consequences less Consequences less than Conseque		Consequences less than							
		than those for Low those for Low Consequence those for Low									
		Consequence Level		Level	Consequence Level						

Table 9.22 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		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		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 Ra	anking)	Risk	Matrix				
A = Anticipated (L > 1.0E-02)		H = High		I = situation (event) of major concern						lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		<pre>II = situation (eve</pre>	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (eve	ent) of minor concern	ses	Н	- 1	1	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	Juer	М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-	-2 (co-located worker)	Onsite-1 (facility worker)	sednences	L	Ш	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other C ³ Promp		ompt worker fatality	C ³ Prompt worker fatality	Con	N	IV	IV	IV	IV
M = Mitigative (reduces event consequences)		serious effects, or		acute injury that is	or acute injury that is						. •
Acronyms		symptoms which		mmediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an		threatening or	threatening or						
		individual's ability to	peri	manently disabling.	permanently disabling.						
		take protective									
		action.									
	М	C ³ Mild, transient	C ³	Serious injury, no	C 3 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 Mi		/linor injuries; no	Minor injuries; no						
		adverse effects > C hosp		ospitalization > C	hospitalization > C						
		Consequences less	Cons	sequences less than	Consequences less than						
		than those for Low	those	for Low Consequence	those for Low						
		Consequence Level		Level	Consequence Level						

Table 9.23 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		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1, "	## High I = situation (event) of major concern II = situation (event) of minor concern IV = situation												
Likelihood (L, of event)/year	Co	onsequence (C, of event),	/year	Risk (R, Qualitative Ra	anking)	Risk	Matrix						
A = Anticipated (L > 1.0E-02)		H = High		I = situation (event) of major concern					Like				
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		<pre>II = situation (eve</pre>	ent) of concern		1	Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	es	Н	- 1	- 1	Ш	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	lenc	М	П	П	Ш	IV		
Control(s) Type	С	Offsite (MOI)	Onsite-2	(co-located worker)	Onsite-1 (facility worker)	sedn	ı	Ш	Ш	IV	IV		
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Pro	mpt worker fatality	C ³ Prompt worker fatality	Sous	<u> </u>						
M = Mitigative (reduces event consequences)		serious effects, or	or ac	cute injury that is	or acute injury that is	Ľ	N	IV	IV	IV	IV		
Acronyms		symptoms which	im	nmediately life-									
MOI = Maximally-exposed Offsite Individual		could impair an	t	hreatening or	threatening or								
		individual's ability to	perm	nanently disabling.	permanently disabling.								
		take protective											
		action.											
	М	C ³ Mild, transient	C ³ S	Serious injury, no	C ³ Serious injury, no								
		adverse effects.	immed	diate loss of life no	immediate loss of life no								
			perm	anent disabilities;	permanent disabilities;								
			hospit	talization required.	hospitalization required.								
	L	Mild, transient	Mi	inor injuries; no	Minor injuries; no								
		adverse effects > C	hos	spitalization > C	hospitalization > C								
	N	Consequences less	Conse	equences less than	Consequences less than								
		than those for Low	those fo	or Low Consequence	those for Low								
		Consequence Level		Level	Consequence Level								

Table 9.24 Magnetic Fields – MOI Offsite

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

Likelihood (L, of event)/year	Co	onsequence (C, of event)/y	year	Risk (R, Qualitative Ra	Risk (R, Qualitative Ranking)			:			
A = Anticipated (L > 1.0E-02)		H = High		I = situation (ever	nt) of major concern				Likel	ihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (eve	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	es	Η	- 1	- 1	П	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible			ent) of minimal concern	enc	М	П	Ш	≡	IV
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	1	Ш	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н			ompt worker fatality	C ³ Prompt worker fatality	Consequences	N	IV	IV	IV	IV
 M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 		serious effects, or symptoms which could impair an individual's ability to take protective action.	ii perr	acute injury that is mmediately life- threatening or manently disabling.	or acute injury that is immediately life- threatening or permanently disabling.						
	M	C ³ Mild, transient adverse effects.	imm perr	Serious injury, no ediate loss of life no manent disabilities; oitalization required.	C ³ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	L	Mild, transient		Ainor injuries; no	Minor injuries; no						
	N	adverse effects > C Consequences less		ospitalization > C sequences less than	hospitalization > C Consequences less than						
				for Low Consequence	those for Low						
		Consequence Level	11036	Level	Consequence Level						

Table 9.25 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		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Silica		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Ergonomics		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		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 Ra	anking)	Risk	Matrix					
\mathbf{A} = Anticipated (L > 1.0E-02)		H = High		I = situation (ever	nt) of major concern				Like	lihood	_	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		<pre>II = situation (eve</pre>	ent) of concern		1	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		$\mathbf{L} = Low$		III = situation (ev	ent) of minor concern	ses	Н	- 1	- 1	Ш	Ш	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	enc	М	Ш	П	III	IV	
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	sednences		Ш	Ш	IV	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Pr	ompt worker fatality	C ³ Prompt worker fatality	Cons						
M = Mitigative (reduces event consequences)		serious effects, or		acute injury that is	or acute injury that is		N	IV	IV	IV	IV	
Acronyms		symptoms which		mmediately life-	immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an	<i>'</i> .		threatening or							
		individual's ability to	•		permanently disabling.							
		take protective	, I ,									
		action.										
	М	C ³ Mild, transient	C ³	Serious injury, no	C ³ Serious injury, no							
		adverse effects.	imm	ediate loss of life no	immediate loss of life no							
			peri	manent disabilities;	permanent disabilities;							
			hosp	italization required.	hospitalization required.							
	L	Mild, transient	N	linor injuries; no	Minor injuries; no							
		adverse effects > C	h	ospitalization > C	hospitalization > C							
	N	Consequences less	Cons	sequences less than	Consequences less than							
		than those for Low	those	for Low Consequence	those for Low							
		Consequence Level		Level	Consequence Level							

Table 9.26 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		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Silica		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Ergonomics		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Consequ	ence Matrix", DOE-HDBK-116	53-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event),	year Risk (R, Qualitative R	Risk (R, Qualitative Ranking)			(
A = Anticipated (L > 1.0E-02)		H = High	I = situation (eve	nt) of major concern			Likelihood			
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (ev	ent) of minor concern	i s	Н	- 1	- 1	П	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern	lenc	М	Ш	П	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	-	Ш	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons	<u> </u>				
M = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	∣∟	N	IV	IV	IV	IV
Acronyms		symptoms which	immediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or	threatening or						
		individual's ability to	permanently disabling.	permanently disabling.						
		take protective								
		action.								
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ 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 9.27 Other hazards – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined Spaces		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Silica		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		R:
Ergonomics		L:	See Section I Chapter 04.	L:
		C:		C:
		R:		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 Ra	anking)	Risk	Matrix					
\mathbf{A} = Anticipated (L > 1.0E-02)		H = High		I = situation (ever	nt) of major concern				Like	lihood	_	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		<pre>II = situation (eve</pre>	ent) of concern		1	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		$\mathbf{L} = Low$		III = situation (ev	ent) of minor concern	ses	Н	- 1	- 1	Ш	Ш	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	enc	М	Ш	П	III	IV	
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	sednences		Ш	Ш	IV	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Pr	ompt worker fatality	C ³ Prompt worker fatality	Cons						
M = Mitigative (reduces event consequences)		serious effects, or		acute injury that is	or acute injury that is		N	IV	IV	IV	IV	
Acronyms		symptoms which		mmediately life-	immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an	<i>'</i> .		threatening or							
		individual's ability to	•		permanently disabling.							
		take protective	, I ,									
		action.										
	М	C ³ Mild, transient	C ³	Serious injury, no	C ³ Serious injury, no							
		adverse effects.	imm	ediate loss of life no	immediate loss of life no							
			peri	manent disabilities;	permanent disabilities;							
			hosp	italization required.	hospitalization required.							
	L	Mild, transient	N	linor injuries; no	Minor injuries; no							
		adverse effects > C	h	ospitalization > C	hospitalization > C							
	N	Consequences less	Cons	sequences less than	Consequences less than							
		than those for Low	those	for Low Consequence	those for Low							
		Consequence Level		Level	Consequence Level							

Table 9.28 Access & Egress – Onsite-1 Facility Worker

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

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Consequ	ience M	latrix", DOE-HDBK-116	53-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event),	/year	Risk (R, Qualitative R	anking)	Risk	Matrix				
A = Anticipated (L > 1.0E-02)		H = High		I = situation (ever	nt) of major concern					lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (eve	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	ses	Н	ı	I	П	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		<pre>IV = situation (ev</pre>	ent) of minimal concern	Juer	М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	sednences	L	Ш	III	IV	IV
P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences)	Н	C ³ Irreversible, other serious effects, or		rompt worker fatality acute injury that is	C ³ Prompt worker fatality or acute injury that is	Con	N	IV	IV	IV	IV
Acronyms		symptoms which		mmediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an		threatening or	threatening or						
		individual's ability to	peri	manently disabling.	permanently disabling.						
		take protective									
		action.									
	M	C 3 Mild, transient	C ³	³ Serious injury, no	C 3 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	Minor injuries; no	Minor injuries; no						
		adverse effects > C	h	ospitalization > C	hospitalization > C						
	N	Consequences less		sequences less than	Consequences less than						
		than those for Low	those	for Low Consequence	those for Low						
		Consequence Level		Level	Consequence Level						

Table 9.29 Access & Egress – Onsite-2 Co-located Worker

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

Likelihood (L, of event)/year		Consequence (C, of event)/year		Risk (R, Qualitative Ra	anking)	Risk	Matrix			•	•
A = Anticipated (L > 1.0E-02)		H = High		I = situation (ever	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		<pre>II = situation (eve</pre>	ent) of concern	l	1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (ev	ent) of minor concern	ses	Н	-1	- 1	П	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	enc	М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2	2 (co-located worker)	Onsite-1 (facility worker)	nbə		Ш	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	Н	C ³ Irreversible, other serious effects, or		ompt worker fatality acute injury that is	C ³ Prompt worker fatality or acute injury that is	Cons	N	IV	IV	IV	IV
Acronyms		symptoms which		nmediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an		threatening or	threatening or						
		individual's ability to		nanently disabling.	permanently disabling.						
		take protective		, -							
		action.									
	М	C ³ Mild, transient	C 3	Serious injury, no	C ³ Serious injury, no						
		adverse effects.	imme	ediate loss of life no	immediate loss of life no						
			pern	nanent disabilities;	permanent disabilities;						
			hospi	italization required.	hospitalization required.						
	L	Mild, transient	М	linor injuries; no	Minor injuries; no						
		adverse effects > C	ho	ospitalization > C	hospitalization > C						
	N	Consequences less	Cons	sequences less than	Consequences less than						
		than those for Low	those f	for Low Consequence	those for Low						
		Consequence Level		Level	Consequence Level						

Table 9.30 Access & Egress – MOI Offsite

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

Likelihood (L, of event)/year	Co	onsequence (C, of event)/y	ear Risk (R, Qualitative Ra	anking)	Risk Matrix					
A = Anticipated (L > 1.0E-02)		H = High	I = situation (ever	nt) of major concern						
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (eve	ent) of minor concern	es	Н	-1	- 1	П	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern	enc	М	П	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences		Ш	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons	-	- ""			
M = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is		N	IV	IV	IV	IV
Acronyms		symptoms which	immediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or	threatening or						
		individual's ability to	permanently disabling.	permanently disabling.						
		take protective								
		action.								
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ 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	hose for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 9.31 Environmental

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

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	Discharge of chemicals into onsite	
	soils beyond permitted limits	