Table 6. Summary of Baseline and Residual Risks – 400 MeV Test Area (MTA)/ITA

	Risk Tables Description	Baseline	Residual
		Risk	Risk
6.1	Radiological – Onsite-1 Facility Worker	R: I	R: III
6.2	Radiological – Onsite-2 Co-located Worker	R: I	R: III
6.3	Radiological – MOI Offsite	R: I	R: III
6.4	Toxic Materials – Onsite 1 Facility Worker	R: *	R: *
6.5	Toxic Materials – Onsite 2 Co-located Worker	R: *	R: *
6.6	Toxic Materials – MOI Offsite	R: *	R: *
6.7	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: *	R: *
6.8	Flammable & Combustible Materials – Onsite-2 Co-located worker	R: *	R: *
6.9	Flammable & Combustible Materials – MOI Offsite	R: *	R: *
6.10	Electrical Energy – Onsite-1 Facility Worker	R: *	R: *
6.11	Electrical Energy – Onsite-2 Co-located Worker	R: *	R: *
6.12	Electrical Energy – MOI Offsite	R: *	R: *
6.13	Thermal Energy – Onsite-1 Facility Worker	R: IV	R: IV
6.14	Thermal Energy – Onsite-2 Co-located Worker	R: IV	R: IV
6.15	Thermal Energy – MOI Offsite	R: N/A	R: N/A
6.16	Kinetic Energy – Onsite-1 Facility Worker	R: *	R: *
6.17	Kinetic Energy – Onsite-2 Co-located Worker	R: *	R: *
6.18	Kinetic Energy – MOI Offsite	R: *	R: *
6.19	Potential Energy- Onsite-1 Facility Worker	R: *	R: *
6.20	Potential Energy – Onsite-2 Co-located Worker	R: *	R: *
6.21	Potential Energy – MOI Offsite	R: *	R: *
6.22	Other Hazards – Onsite-1 Facility Worker	R: *	R: *
6.23	Other Hazards – Onsite-2 Co-located Worker	R: *	R: *
6.24	Other Hazards – MOI Offsite	R: *	R: *
6.25	Access & Egress – Onsite-1 Facility Worker	R: *	R: *
6.26	Access & Egress – Onsite-2 Co-located Worker	R: *	R: *
6.27	Access & Egress – MOI Offsite	R: *	R: *
6.28	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).

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Table 6 .1 Radiological – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with CCs)
Residual	Hazard: exposure to residual	L: A	P – General And/Or Job Specific RWP: A Radiological Work Permit is	L: BEU
activation	activation	C: H R: I	written by ES&H that specifies the work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure. P – Use Of A LSM: Use of a log survey monitor is specified by a RWP. The LSM allows for real time monitoring of radiation levels during work. P – Radiological Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. M – Radiological Signage, Fencing And Decay Time Requirements: Signs located in various places throughout the accelerator complex warn of various hazards and occupancy restrictions prior to entry. Furthermore, work may be restricted or prevented until sufficient time has passed such that radiation levels are sufficiently low to allow for safer work to proceed. This mitigation has passive and active components. M – Radiological Shielding: Material placed between radiation sources and	C: N R: IV
			the enclosure to be protected. This is a passive mitigation. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with CCs)
Groundwater	Hazard: exposure to radionuclides in	L: A	P – Sump Pumps: Pumps located in the accelerator enclosure that have an	L: BEU
Activation	ground water exceed regulatory levels	C: H R: I	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,	C: L R: IV
			 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. 	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with CCs)
Surface Water	Hazard: exposure to radionuclides in	L: A	P – Sump Pumps: Pumps located in the accelerator enclosure that have an	L: BEU
Activation	surface water exceed regulatory levels	C: H	underdrain network. The water is pumped to the surface, so it does	C: N
Activation	surface water exceed regulatory levels	C: H R: I	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	C: N R: IV
			by limiting the total amount of beam that could be delivered.	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with CCs)
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 R: I	 P – RSIS: The Radiation Safety Interlock System uses a key tree system that captures the keys to an accelerator enclosure. These keys are electrically monitored through the Radiation and Electrical Safety Systems to turn off the accelerator enclosure if any key is removed from the key tree. 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 to dilute activated air and provide cool off (decay) 	C: L R: IV
			time prior to release. Enclosure air flow design to give the activated air time to decay before exiting the enclosure. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. Specifies when MCR operators are allowed to issue keys for the enclosure. Prohibits personnel access before the appropriate amount of decay time has elapsed.	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with CCs)
Soil Interactions	Hazard: radionuclides are produced	L: A	P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to	L: A
	by beam interactions which may	C: N	convert radiation created by prompt dose due to beam loss into	C: N
	contaminate ground water	R: IV	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 Beam Dump: Design of a beam absorber that minimizes the radiological leakage through the use of shielding. M – Engineered 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.	R: IV
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 and Fencing: 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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with CCs)
Contamination	Hazard: persons are exposed to ionizing radiation beyond regulatory levels	L: BEU C: N R: IV	 P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates. 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 and Fencing: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions 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. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. 	L: BEU C: N R: IV
⁷ Be	Hazard: Potential radiation exposure to 7Be (uptake/committed dose).	L: A C: N R: IV	No prevention or mitigation is required. ⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV
Radioactive Sources	Hazard: Persons exposed to ionizing radiation beyond regulatory levels	L: A C: H R: I	 P – Radiological Signage on or Near Source Cabinets: Signs give warning of the presence of radioactive sources. P – Radiological Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. P – Kept Under Lock-and-key: Radioactive sources are kept in locked storage, where key issuance is a controlled process. M – Kept In Storage: Unused radioactive sources are kept in storage, which prevents the close proximity of these sources and people. M – Shielded Containers: Unused high activity sources are stored within shielded containers. 	L: BEU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with CCs)
Non-Ionizing	Hazard: Hazard: Exposure to Class	L: A	P:-Class 1 encased in (light tight) shielded structures	L: BEU
Radiation	3B and 4 lasers	C: H	P: Locked/Interlocked system or administrative control approved by the	C: H
Hazards		R: I	LSO P: LOTO procedure or other procedure approved by the LSO P: Affected areas are posted	R: III
	Exposure to Class 3R lasers	L: A C: L R: III	No analysis required	L: A C: L R: III
	Exposure to Class 1 and 2 Lasers	L: A C: N R: IV	No analysis required	L: A C: N R: IV

Likelihood (L, of event)/year	Cor	sequence (C, of event)/y	/ear	Risk (R, Qualitative Ra	nking)	Risk	Matrix	1			
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 (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		ences	Н	- 1	- 1	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	N = Negligible		IV = situation (event) of minimal concern		М	II	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsit	e-2 (co-located worker)	Onsite-1 (facility worker)	nbe	-	Ш	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ 25.0 rem		C ³ 100 rem	C ³ 100 rem	- Si					
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	┧╚	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 6.2 Radiological – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with controls)
Residual	Hazard: exposure to residual	L: A	P – General And/Or Job Specific RWP: A Radiological Work Permit is	L: BEU
activation	activation	C: H R: I	written by ES&H that specifies the work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure. P – Use Of A LSM: Use of a log survey monitor is specified by a RWP. The LSM allows for real time monitoring of radiation levels during work. P – Radiological Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. M – Radiological Signage, Fencing And Decay Time Requirements: Signs located in various places throughout the accelerator complex warn of various hazards and occupancy restrictions prior to entry. Furthermore, work may be restricted or prevented until sufficient time has passed such that radiation levels are sufficiently low to allow for safer work to proceed. This mitigation has passive and active components. M – Radiological Shielding: Material placed between radiation sources and the enclosure to be protected. This is a passive mitigation. M – Run Conditions: Operating parameters that reduce residual activation	C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with controls)
Groundwater Hazard	d: exposure to radionuclides in	L: A	P – Sump Pumps: Pumps located in the accelerator enclosure that have an	L: BEU
	d water exceed regulatory levels	C: H R: I	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 – 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) Credited Controls (CC) in Bo <mark>ld</mark>	Residual Qualitative Risk (with controls)
Surface Water	Hazard: exposure to radionuclides in	L: A	P – Sump Pumps: Pumps located in the accelerator enclosure that have an	L: BEU
Activation	surface water exceed regulatory levels	C: H	underdrain network. The water is pumped to the surface, so it does	C: N
Activation	surface water exceed regulatory levels	C: H R: I	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.	C: N R: IV
			M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	

Hazard Hazard Description		Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	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	P – RSIS: The Radiation Safety Interlock System uses a key tree system that	C: N
		R: I	captures the keys to an accelerator enclosure. These keys are electrically monitored through the Radiation and Electrical Safety Systems to turn off the accelerator enclosure if any key is removed from the key tree. 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 to dilute activated air and provide cool off (decay) time prior to release. Enclosure air flow design to give the activated air time to decay before exiting the enclosure. M—Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. Specifies when MCR operators are allowed to issue keys for the enclosure. Prohibits personnel access before the appropriate amount of decay time has elapsed.	R: IV

Hazard	Hazard Description		Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	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	convert radiation created by prompt dose due to beam loss into	C: N
		R: I	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 Beam Dump: Design of a beam absorber that minimizes the radiological leakage through the use of shielding. M – Engineered 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.	R: IV
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 and Fencing: 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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bo <mark>ld</mark>	Residual Qualitative Risk (with controls)
Contamination	Hazard: persons are exposed to ionizing radiation beyond regulatory levels	L: BEU C: N R: IV	 P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates. 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 and Fencing: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions 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. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. 	L:BEU C: N R: IV
⁷ Be	Hazard: Potential radiation exposure to 7Be (uptake/committed dose).	L: A C: N R: IV	No prevention or mitigation is required. ⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV
Radioactive Sources	Hazard: Persons are exposed to ionizing radiation beyond regulatory levels	L: A C: H R: I	 P – Radiological Signage on or Near Source Cabinets: Signs give warning of the presence of radioactive sources. P – Radiological Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. P – Kept Under Lock-and-key: Radioactive sources are kept in locked storage, where key issuance is a controlled process. M – Kept In Storage: Unused radioactive sources are kept in storage, which prevents the close proximity of these sources and people. M – Shielded Containers: Unused high activity sources are stored within shielded containers. 	L: BEU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with controls)
Non-Ionizing	Hazard: Exposure to Class 3B and	L: A	P:-Class 1 encased in (light tight) shielded structures	L: BEU
Radiation	4 lasers	C: H	P: Locked/Interlocked system or administrative control approved by the	C: H
Hazards		R: I	LSO P: LOTO procedure or other procedure approved by the LSO P: Affected areas are posted	R: III
	Exposure to Class 3R lasers	L: A C: L R: III	No analysis required	L: A C: L R: III
	Exposure to Class 1 and 2 Lasers	L: A C: N R: IV		L: A C: N R: IV
			No analysis required	

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				Likel	ihood		
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (ever	nt) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		III = situation (eve	(event) of minor concern		Н	-1	-	П	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern		nences	М	II	Ш	Ш	IV	
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	- ledn	ı	Ш	III	IV	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ³ 25.0 rem		C ³ 100 rem	C ³ 100 rem	- I si	_					
M = Mitigative (reduces event consequences)	М	25.0 rem > C ³ 5 rem	100	0 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 6.3 Radiological – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with controls)
Residual	Hazard: exposure to residual	L: BEU	P – Facility is locked and not accessible to the unescorted public.	L: BEU
activation	activation	C: H	P – Shielding in place around the beam line and experiment enclosures per	C: H
		R: III	the relevant shield assessments	R: III
			P – Interlock system preventing access to beam enclosure while beam is present.	
			P – Enclosure keys linked to radiological and controlled access training to enter enclosure	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with controls)
Groundwater	Hazard: radionuclides in ground	L: EU	P – Monitoring Wells: Wells that are drilled near accelerator enclosures in	L: EU
Activation	water exceed regulatory levels	C: H	areas that are sensitive to potential aquifer contamination. These	C: M
		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 – 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: III

Hazard	Hazard Description		Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with controls)
Surface Water	Hazard: radionuclides in surface water	L: U	P – Sump Pumps: Pumps located in the accelerator enclosure that have an	L: BEU
Activation	exceed regulatory levels	C: H	underdrain network. The water is pumped to the surface, so it does	C: N
Activation	exceed regulatory levels	C: H R: I	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	C: N R: IV
			 the system is reset by an operator. M – Pond Monitoring Program (Procedure): 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. 	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with controls)
Air Activation	Hazard: radionuclides in air exceed regulator levels	L: BEU C: N R: IV	 P – Facility is locked and not accessible to the unescorted public. P – Interlock system preventing access to beam enclosure while beam is present. P – Enclosure keys linked to radiological and controlled access training to enter enclosure 	L: BEU C: N R: IV
Soil Interactions	Hazard: radionuclides are produced which may contaminate ground water	L: BEU C: N 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 – Engineered 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. 	L: BEU C: N R: IV
Radioactive waste	Hazard: Persons are exposed to ionizing radiation beyond regulatory levels	L: BEU C: H R: III	P – Facility is locked and not accessible to the unescorted public. M – Radiological shielding to limit exposure to radioactive waste.	L:BEU C:M R: IV
Contamination	Hazard: Persons are exposed to ionizing radiation beyond regulatory levels	L: BEU C: N R: IV	P – Facility is locked and not accessible to the unescorted public. P – Radiological control prescreens items with contamination potential prior to acceptance. If contamination exists the item is rejected.	L:BEU C:N R:IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M) Credited Controls (CC) in Bold	Residual Qualitative Risk (with controls)
⁷ Be	Hazard: Potential radiation exposure to 7Be (uptake/committed dose).	L: A C: N R: IV	No prevention or mitigation is required. ⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV
Radioactive Sources	Hazard: Persons are exposed to ionizing radiation beyond regulatory levels	L: BEU C: H R: III	P – Facility is locked and not accessible to the unescorted public. P – All low activity sealed sources are kept in a lock box and registered through Radiological Control. M – Radiological training is required for source handling.	L: BEU C: M R: IV
Non-Ionizing Radiation Hazards	Hazard: N/A	L: C: R:	No further analysis required	L: BEU C: L R: IV

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	Con	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 (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	nces	Н	- 1	1	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern		enc	М	П	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	sedn	ı	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ 25.0 rem		C ³ 100 rem	C ³ 100 rem	i Si	<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	İĽ	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 6.4 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 1, Chapter 4	L: C: R:
Beryllium *	Hazard: Potential exposure to beryllium dust during manual handling of un-encased, activities.	L: C: R:	See Section 1, Chapter 4	L: C: R:
Pseudocumene in Liquid Scintillator Oil	Hazard: Airborne exposure via outgassing oil	L: A C: L R: III	P - A job-specific hazard analysis and procedure will prescribe Personal Protective Equipment (PPE) to prevent worker contact with the liquid scintillator. P - Modules, once filled, will completely contain the pseudocumene, resulting in no further exposure. P - A secondary containment membrane that has the capacity to contain 100% of the liquid scintillator oil will prevent a release to the environment. M - Emergency spill equipment, an eye wash and PPE will be stationed near the detector in the event of a release.	L: BEU C: N R: IV

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				Likelihood				
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (eve	ent) of concern			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	II	Ш		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	iences	М	П	Ш	Ш	IV		
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edno	-	III	Ш	IV	IV		
P = Preventive (reduce event occurrence likelihood)	Н	C ³ PAC-2		C ³ PAC-3	C 3 IDLH	Sug			***				
M = Mitigative (reduces event consequences)	М	PAC-2 > C ³ PAC-1	ı	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	N	Consequences less	Con	sequences less than	Consequences less than								
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		2224.21100 20101		20.0.	33334351100 20401								
TLV _c = Threshold Limit Value (ceiling)													

Table 6.5 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 1, Chapter 4	L: C: R:
Beryllium *	Hazard: Potential exposure to beryllium dust during manual handling of un-encased, activities.	L: C: R:	See Section 1, Chapter 4	L: C: R:
Pseudocumene in Liquid Scintillator Oil	Hazard: <u>Airborne exposure via</u> outgassing oil-	L: A C: L R: III	P - A job-specific hazard analysis and procedure will prescribe Personal Protective Equipment (PPE) to prevent worker contact with the liquid scintillator. P - Modules, once filled, will completely contain the pseudocumene, resulting in no further exposure. P - A secondary containment membrane that has the capacity to contain 100% of the liquid scintillator oil will prevent a release to the environment. M - Emergency spill equipment, an eye wash and PPE will be stationed near the detector in the event of a release.	L: BEU C: N R: IV

Chemical Hazard Consequences, derived from Figure C-	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				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	es	Н	- 1	- 1	II	Ш			
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	iences	М	П	Ш	Ш	IV			
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edno	1	III	Ш	IV	IV			
P = Preventive (reduce event occurrence likelihood)	Н	C ³ PAC-2		C ³ PAC-3	C 3 IDLH	Sug			***					
M = Mitigative (reduces event consequences)	М	PAC-2 > C ³ PAC-1	ı	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	N	Consequences less	Con	sequences less than	Consequences less than									
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		2224.300 2010.												
TLV _c = Threshold Limit Value (ceiling)														

Table 6.6 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 1, Chapter 4	L: C: R:
Beryllium *	Hazard: Potential exposure to beryllium dust during manual handling of un-encased, activities.	L: C: R:	See Section 1, Chapter 4	L: C: R:
Pseudocumene in Liquid Scintillator Oil	Hazard: <u>Airborne exposure via</u> outgassing oil-	L: EU C: N R: IV	P – Access controls to area prevent contact. P - Modules, once filled, will completely contain the pseudocumene, resulting in no further exposure. P - A secondary containment membrane that has the capacity to contain 100% of the liquid scintillator oil will prevent a release to the environment.	L: BEU C: N R: IV

Chemical Hazard Consequences, derived from Figure C-	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	Risk (R, Qualitative Ranking)			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 (eve	nt) 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	Se	Н	- 1	- 1	Ш	Ш		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	iences	М	Ш	Ш	Ш	IV		
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	ı	III	Ш	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	اللا	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	seguences less than	Consequences less than								
MOI = Maximally-exposed Offsite Individual		than those for Low		for Low Consequence	those for Low								
PAC = Protective Action Criteria		Consequence Level		Level	Consequence Level								
PEL = Permissible Exposure Limit		consequence rever		20101	Somsequence Ecver								
TLV_c = Threshold Limit Value (ceiling)													

Table 6.7 Flammable and Combustible Materials – Onsite -1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible materials (cables, Boxes, Paper, wood cribbing, etc.)	Hazard: This hazard is a potential facility fire. The presence of excessive combustible materials can pose a hazard stemming from inadequate housekeeping practices. This hazard can add to the fuel load of a potential facility fire. Poor housekeeping can also lead to life safety concerns, such as egress obstructions and tripping hazards. The exposure of the hazard to the facility worker is of major concern.	L: C: R:	See Section 1, Chapter 4	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Flammable	Hazard: The presence of	L:	See Section 1, Chapter 4	L:
Materials (e.g.,	flammable gases in cylinders or	C:		C:
flammable gas,	storage containers pose an	R:		R:
cleaning	inherent hazard due to their			
materials, etc.)	flammability/combustibility			
	properties.			
	Exposure to hot work provides a dangerous situation where flammable liquids will ignite. Unmitigated this could lead to an explosion and subsequent fire.			
	The exposure of the hazard to the facility worker is of major concern.			

Other Hazard Consequences, derived from Figure C-1, "					Dick	Matrix				
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)		onsequence (C, of event)/ H = High	•	anking) nt) of major concern	KISK	iviatrix		Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	· ·	ent) of minor concern	l sa	Н	- 1	- 1	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern	ences	М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequ	1	Ш	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons	N	IV	IV	IV	IV
Acronyms		serious effects, or	or acute injury that is	or acute injury that is						
•		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 6.8 Flammable and Combustible Materials – Onsite -2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible materials (cables, Boxes, Paper, wood cribbing, etc.)	Hazard: This hazard is a potential facility fire. The presence of excessive combustible materials can pose a hazard stemming from	L: C: R:	See Section 1, Chapter 4	L: C: R:
	inadequate housekeeping practices. This hazard can add to the fuel load of a potential facility fire.			
	Poor housekeeping can also lead to life safety concerns, such as egress obstructions and tripping hazards.			
	The exposure of the hazard to the facility worker is of major concern.			

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Flammable	Hazard: The presence of	L:	See Section 1, Chapter 4	L:
Materials (e.g.,	flammable gases in cylinders or	C:		C:
flammable gas,	storage containers pose an	R:		R:
cleaning	inherent hazard due to their			
materials, etc.)	flammability/combustibility			
	properties.			
	Exposure to hot work provides a dangerous situation where flammable liquids will ignite. Unmitigated this could lead to an explosion and subsequent fire.			
	The exposure of the hazard to the facility worker is of major concern.			

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	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 (ever	nt) of major concern				Like	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	ies es	Н	- 1	- I	Ш	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern	lenc	М	II	Ш	Ш	IV	
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbə	1	Ш	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	C ³ Prompt worker fatality or acute injury that is	Consequences	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	μ ,								
		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 6.9 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: The presence of excessive combustible materials can pose a hazard stemming from inadequate housekeeping practices. This hazard can add to the fuel load of a potential fire. Poor housekeeping can also lead to life safety concerns, such as egress obstructions and tripping hazards. The exposure of the hazard to the public is of minimal concern.	L: C: R:	See Section 1, Chapter 4	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Flammable	Hazard: The presence of	L:	See Section 1, Chapter 4	L:
Materials (e.g.,	flammable gases in cylinders or	C:		C:
flammable gas,	storage containers pose an	R:		R:
cleaning	inherent hazard due to their			
materials, etc.)	flammability/combustibility			
	properties.			
	Exposure to hot work provides a dangerous situation where flammable liquids will ignite. Unmitigated this could lead to an explosion and subsequent fire.			
	The exposure of the hazard to the public is of minor concern.			

Other Hazard Consequences, derived from Figure C-1, "					Rich	Matrix				
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)		onsequence (C, of event)/ H = High	•	anking) nt) of major concern	NISK	iviatiiX		Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low		ent) of minor concern	sa	Н	- 1	- 1	II	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern	ences	М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequ	1	Ш	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Cons	N	IV	IV	IV	IV
Acronyms		serious effects, or	or acute injury that is	or acute injury that is						
•		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 6.10 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	Hazard: Shock hazard, >50 V,	L:	See Section 1, Chapter 4	L:
Exposure	Non-interlocked enclosures	C: R:		C: R:
	Arc Flash, <u>Non-interlocked</u> <u>enclosures</u>			
Stored Energy	Hazard: Shock hazard,>50 V,		See Section 1, Chapter 4	L:
Exposure	<u>Interlocked</u> enclosure area			C: R:
High Voltage	Hazard: Shock hazard, voltage >	L:	See Section 1, Chapter 4	L:
Exposure	50 V, <u>Non-interlocked enclosures</u>	C: R:		C: R:
	Arc Flash, <u>Non-interlocked</u> <u>enclosures</u>			
High Voltage	Hazard: Shock hazard, voltage >		See Section 1, Chapter 4	
Exposure	50 V, <u>Interlocked enclosures</u> Are Elash Interlocked enclosures			
	Arc Flash, <u>Interlocked enclosures</u>			

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Low Voltage,	Hazard: Arc Flash, <u>Non-</u>	L:	See Section 1, Chapter 4	L:
High Current	interlocked enclosures	C:		C:
Exposure.		R:		R:
	Fire hazard from high current			
	causing smoke inhalation and			
	burns.			
Low Voltage,	Hazard: Arc Flash, <u>Interlocked</u>	L:	See Section 1, Chapter 4	L:
High Current	<u>enclosures</u>	C:		C:
exposure		R:		R:
	Fire hazard from high current			
	causing smoke inhalation and			
	burns.			

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", DOE-HDBK-116	3-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)/y	year Risk (R, Qualitative Ra	anking)	Risk	Matrix				
A = Anticipated (L > 1.0E-02)		H = High	I = situation (ever	nt) of major concern				Like	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	ces	Н	- 1	- 1	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	1	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 6.11 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: Shock hazard, >50 V,	L:	See Section 1, Chapter 4	L:
Exposure	Non-interlocked enclosures	C: R:		C: R:
	Arc Flash, <u>Non-interlocked</u> <u>enclosures</u>			
Stored Energy	Harard: Shock hazard, >50 V,	L:	See Section 1, Chapter 4	L:
Exposure	Interlocked enclosures	C:		C:
	Arc Flash, <u>Interlocked enclosures</u>	R:		R:
High Voltage	Hazard: Shock hazard, voltage >	L:	See Section 1, Chapter 4	L:
Exposure	50 V, Non-interlocked enclosures	C:		C:
		R:		R:
	Arc Flash, <u>Non-interlocked</u>			
	<u>enclosures</u>			
High Voltage	Hazard: Shock hazard, voltage >	L:	See Section 1, Chapter 4	L:
Exposure	50 V, <u>Interlocked enclosures</u>	C:		C:
		R:		R:
	Arc Flash, <u>Interlocked enclosures</u>			

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Low Voltage,	Hazard: Arc Flash Non-	L:	See Section 1, Chapter 4	L:
High Current	interlocked enclosures	C:		C:
Exposure.		R:		R:
	Fire hazard from high current			
	causing smoke inhalation and			
	burns service building areas.			
Low Voltage,	Hazard: Arc Flash, <u>Interlocked</u>	L:	See Section 1, Chapter 4	L:
High Current	<u>enclosures</u>	C:		C:
Exposure		R:		R:
	Fire hazard from high current			
	causing smoke inhalation and			
	burns, beam line enclosure areas			

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", DOE-HDBK-116	3-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)/y	year Risk (R, Qualitative Ra	anking)	Risk	Matrix				
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 (eve	ent) of minor concern	ces	Н	- 1	- 1	=	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	1	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 6.12 Electrical Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy	Hazard: Shock hazard, >50 V, Arc	L:	See Section 1, Chapter 4	L:
Exposure	flash	C:		C:
		R:		R:
High Voltage	Hazard: Shock hazard, >50 V, Arc	L:	See Section 1, Chapter 4	L:
Exposure	flash outside	C:		C:
·		R:		R:
Low Voltage,	Hazard: N/A	L:	No Further analysis required	L:
High Current		C:		C:
Exposure.		R:		R:

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Consequ	ience Matrix", DOE-HDBK-11	63-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event),	/year Risk (R, Qualitative F	Ranking)	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		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	III = situation (e	vent) of minor concern	es	Н	- 1	- 1	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (e	vent) 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	1	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 6.13 Thermal Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenic	Hazard: Hazard: Cryogenics are inherently a low risk on their own as they are nonflammable and non-toxic. However, if exposed to the cryogenic liquids, they have the potential of burning skin and creating an oxygen deficient atmosphere which can lead to death. The exposure of the hazard to the facility worker is of major concern.	L: EU C: L R: IV	P – Engineering analysis/note limits the amount of cryogens that can be brought in the MTA enclosure to ensure that MTA remains an ODH 0 area. P – WPC process/procedures provides instructions for use P – Cryogenic system engineered/designed and reviewed by qualified personnel P - Protective clothing rules are enforced when working in areas with exposure to cryogenic liquids. P- Training required for all personnel handling cryogenics M – Onsite Emergency services are provided	L:EU C: L R: IV
Magnet Bakeouts	Hazard: Heating equipment to high temperatures	L: C: R:	See Section I Chapter 04	L: C: R:
Hot work	Hazard: welding, brazing, grinding, and other operations which create high temperatures which can ignite a fire	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", 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 (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 (eve	ent) of minor concern	ces	Н	- 1	- 1	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	1	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 6.14 Thermal Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenic Liquids	Hazard: Cryogenic liquids, such as liquid helium and nitrogen are inherently a low risk on their own as they are nonflammable and non-toxic. However, if exposed to the cryogenic liquids, they have the potential of burning skin and creating an oxygen deficient atmosphere which can lead to death. The exposure of the hazard to the co-located worker is of minimal concern.	L: EU C: L R: IV	P – Engineering analysis/note limits the amount of cryogens that can be brought in the MTA enclosure to ensure that MTA remains an ODH 0 area. P – WPC process/procedures provides instructions for use P – Cryogenic system engineered/designed and reviewed by qualified personnel P - Protective clothing rules are enforced when working in areas with exposure to cryogenic liquids. P- Training required for all personnel handling cryogenics M – Onsite Emergency services are provided	L: EU C: L R: IV
Magnet Bakeouts	Hazard: Heating equipment to high temperatures	L: C: R:	See Section I Chapter 04	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hot work	Hazard: welding, brazing, grinding, and other operations which create high temperatures which can ignite a fire	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "	Exan	nple Qualitative Conseque	ence Matrix", DOE-HDBK-116	3-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)/	year Risk (R, Qualitative Ra	anking)	Risk	Matrix	<u> </u>			
\mathbf{A} = Anticipated (L > 1.0E-02)		H = High	I = situation (ever	I = situation (event) of major concern					lihood	1
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve	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	l se	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	П	111	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	L	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	,		Son	N	IV	IV	IV	IV
M = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is		14	1 V	10	10	1 V
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 6.15 Thermal Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenic	Hazard: N/A	L:	No further analysis required.	L:
Liquids		C:		C:
		R:		R:
Magnet	Hazard: N/A	L:	No further analysis required.	L:
Bakeouts		C:		C:
		R:		R:
Hot work	Hazard: N/A	L:	No further analysis required.	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	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 (ever	nt) of major concern				Like	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	ies es	Н	- 1	I	Ш	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern	lenc	М	II	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbə	1	Ш	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	C ³ Prompt worker fatality or acute injury that is	Consequences	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	permanently albabiling.	permanent, alsazinigi						
		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 6.16 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: Personnel injury due to	L:	See Section 1, Chapter 4	L:
1 OWEI 10013	improper use of power tools.	C:		C:
		R:		R:
Pumps and	Hazard: Personnel injury due to	L:	See Section 1, Chapter 4	L:
Motors	entrapment/entanglement.	C:		C:
		R:		R:
Motion Tables	Hazard: Personnel injury due to	L:	See Section 1, Chapter 4	L:
	pinch points, tip-overs, caught in	C:		C:
	between.	R:		R:
Mobile	Hazard: Personnel injury due to	L:	See Section 1, Chapter 4	L:
Shielding	pinch points, tip -overs, caught in	C:		C:
_	between, crushing.	R:		R:

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", 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 (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 (eve	ent) of minor concern	ces	Н	- 1	- 1	=	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	1	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	1					
		than those for Low	those for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 6.17 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: Personnel injury due to	L:	See Section 1, Chapter 4	L:
	power tool use (flying debris,	C:		C:
	struck by object).	R:		R:
Pumps and	Hazard: Personnel injury due to	L:	See Section 1, Chapter 4	L:
Motors	entrapment/entanglement.	C:		C:
		R:		R:
Motion Tables	Hazard: Personnel injury due to	L:	See Section 1, Chapter 4	L:
	tip-overs, caught in between,	C:		C:
	crushing	R:		R:
Mobile	Hazard: Personnel injury due to	L:	See Section 1, Chapter 4	L:
Shielding	tip-overs, caught in between,	C:		C:
_	crushing	R:		R:

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence N	/latrix", DOE-HDBK-116	3-2020.						
Likelihood (L, of event)/year	Co	onsequence (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				Likel	ihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate		II = situation (eve	ent) of concern	_		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	1	Ш	Ш
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			-2 (co-located worker)	Onsite-1 (facility worker)	sedu	L	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	Н	· ·		rompt worker fatality acute injury that is	C ³ Prompt worker fatality or acute injury that is	Con	N	IV	IV	IV	IV
Acronyms MOI = Maximally-exposed Offsite Individual		symptoms which could impair an individual's ability to take protective action.	i	immediately life- threatening or manently disabling.	immediately life- threatening or permanently disabling.						
		C ³ Mild, transient adverse effects. Mild, transient	imm per hosp	Serious injury, no nediate loss of life no manent disabilities; pitalization required.	C ³ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
		adverse effects > C		Minor injuries; no ospitalization > C	Minor injuries; no hospitalization > C						

Table 6.18 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:	No Further analysis required	L: C: R:
Pumps and Motors	Hazard: N/A	L: C: R:	No Further analysis required	L: C: R:
Motion Tables	Hazard: N/A	L: C: R:	No Further analysis required	L: C: R:
Mobile Shielding	Hazard: N/A	L: C: R:	No Further analysis required	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "	Exan	nple Qualitative Consequ	ence N	Matrix", 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 (eve	nt) of major concern				Like	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	ces	Н	I	1	П	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	lenc	М	Ш	П	111	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. Minor injuries; no nospitalization > C	C ³ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no hospitalization > C						

Table 6.19 Potential Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Compressed	Hazard: Personnel injury due to	L:	See Section 1, Chapter 4	L:
Gasses	unexpected release, or unsecure	C:		C:
	tanks.	R:		R:
Vacuum	Hazard: Personnel injury due to	L:	See Section 1, Chapter 4	L:
Pressure	unexpected pressure release.	C:		C:
Vessels/Piping		R:		R:
Vacuum Pumps	Hazard: Personnel injury due to	L:	See Section 1, Chapter 4	L:
	interaction with existing vacuum.	C:		C:
		R:		R:
Material	Hazard: Personnel injury due to	L:	See Section 1, Chapter 4	L:
Handling	moving/handing material	C:		C:
	(rollovers, crush, etc.)	R:		R:

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", 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 (ever	I = situation (event) 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 (eve	ent) of minor concern	ces	Н	- 1	- 1	=	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	1	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 6.20 Potential Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Compressed	Hazard: Collocated personnel	L:	See Section 1, Chapter 4	L:
Gasses	injury due to unexpected release,	C:		C:
	or unsecure tanks	R:		R:
Vacuum	Hazard: Collocated personnel	L:	See Section 1, Chapter 4	L:
Pressure Vessels	injury due to unexpected pressure	C:		C:
	release	R:		R:
	Hazard: Beam pipes under			
	vacuum			
Vacuum Pumps	Hazard: Hazard: Personnel injury	L:	See Section 1, Chapter 4	L:
	due to interaction with existing	C:		C:
	vacuum.	R:		R:
Material	Hazard: Collocated personnel	L:	See Section 1, Chapter 4j	L:
Handling	injury due to moving/handing	C:		C:
	material (rollovers, crush, etc.)	R:		R:

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", DOE-HDBK-116	3-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)/y	year Risk (R, Qualitative Ra	anking)	Risk	Matrix				
A = Anticipated (L > 1.0E-02)		H = High	I = situation (ever	I = situation (event) 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 (eve	ent) of minor concern	ces	Н	- 1	- 1	=	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	1	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 6.21 Potential Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Compressed	Hazard: Injury due to unexpected	L:	See Section 1, Chapter 4	L:
Gasses	release, or unsecure tanks outside	C:		C:
	of buildings	R:		R:
Vacuum	Hazard: Injury due to unexpected	L:	See Section 1, Chapter 4	L:
Pressure Vessels	release, or unsecure tanks outside	C:		C:
	of buildings	R:		R:
Vacuum Pumps	Hazard: N/A	L:	No Further analysis required	L:
		C:		C:
		R:		R:
Material	Hazard: N/A	L:	No Further analysis required	L:
Handling		C:		C:
J		R:		R:

Other Hazard Consequences, derived from Figure C-1, " Likelihood (L, of event)/year		onsequence (C, of event)/			Rick	Matrix				
A = Anticipated (L > 1.0E-02)	C	H = High	•	nt) of major concern	Nisk	iviatiix		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	<u> </u>	ent) of minor concern	sa	Н	- 1	- 1	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	·	ent) of minimal concern	ences	М	П	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	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	Consequ					
M = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	ا ا	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 6.22 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: Exposure to fringe fields	L:	See Section 1, Chapter 4	L:
	beyond allowable limits (worker	C:	See Section 1, Chapter 4	C D.
	with ferromagnetic or electronic	R:		R:
	medical device(s))			
	Exposure to fringe fields beyond			
	allowable limits (worker without			
	ferromagnetic or electronic			
	medical device(s))			
	Exposure to flying metallic			
	objects causing potential injury.			

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", DOE-HDBK-116	3-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event)/y	year Risk (R, Qualitative Ra	anking)	Risk	Matrix				
A = Anticipated (L > 1.0E-02)		H = High	I = situation (ever	I = situation (event) 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 (eve	ent) of minor concern	ces	Н	- 1	- 1	=	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	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 6.23 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: Exposure to fringe fields beyond allowable limits (worker with ferromagnetic or electronic medical device(s)) Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic medical device(s))	L: C: R:	See Section 1, Chapter 4	L: C: R:
	Exposure to flying metallic objects causing potential injury.			

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", 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 (ever	I = situation (event) 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 (eve	ent) of minor concern	ces	Н	- 1	- 1	=	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	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 6.24 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:	No further analysis required	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1, "	Exan	nple Qualitative Conseque	ence Matrix", 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 (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 (eve	ent) of minor concern	l se	Н	- 1	I	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern	lenc	М	II	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	ı	Ш	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	C ³ Prompt worker fatality or acute injury that is	Consequences	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	p , 0							
		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						
I		Consequence Level	Level	Consequence Level						

Table 6.22 Other hazards – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Noise	Hazard: Exposure above OELs via	L: C:	See Section 1, Chapter 4	L: C:
	use of machinery, tools, colocation w/ equipment, etc.	R:		R:
Silica	Hazard: Airborne exposure above OEL via concrete (or similar material) machining, moving dirt or gravel	L: C: R:	See Section 1, Chapter 4	L: C: R:
Ergonomics	Hazard: Office space, Industrial space (over lifting, repetitive motion, static posture)	L: C: R:	See Section 1, Chapter 4	L: C: R:
Asbestos	Hazard: Deteriorating building materials	L: C: R:	See Section 1, Chapter 4	L: C: R:
Working at Heights	Hazard: Falls, dropped tools/material	L: C: R:	See Section 1, Chapter 4	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", 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 (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 (eve	ent) of minor concern	ces	Н	- 1	- 1	=	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	ı	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	eversible, other C ³ Prompt worker fatality C		Cons					
M = Mitigative (reduces event consequences)		serious effects, or				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 6.23 Other hazards – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Noise	Hazard: Exposure above OELs via	L:	See Section 1, Chapter 4	L:
	use of machinery, tools, colocation w/ equipment, etc.	C: R:		C: R:
Silica	Hazard: Airborne exposure above OEL via concrete (or similar material) machining, moving dirt or gravel	L: C: R:	See Section 1, Chapter 4	L: C: R:
Ergonomics	Hazard: Office space, Industrial space (over lifting, repetitive motion, static posture)	L: C: R:	See Section 1, Chapter 4	L: C: R:
Asbestos	Hazard: Deteriorating building materials	L: C: R:	See Section 1, Chapter 4	L: C: R:
Working at Heights	Hazard: Struck by dropped tools/material	L: C: R:	See Section 1, Chapter 4	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", 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 (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 (eve	ent) of minor concern	ces	Н	- 1	- 1	=	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	ı	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	eversible, other C ³ Prompt worker fatality C		Cons					
M = Mitigative (reduces event consequences)		serious effects, or				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 6.24 Other hazards – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Noise	Hazard: Exposure above OELs via	L:	See Section 1, Chapter 4	L:
	use of machinery, tools, co-	C:		C:
	location w/ equipment, etc.	R:		R:
Silica	Hazard: Airborne exposure above	L:	See Section 1, Chapter 4	L:
	OEL via concrete (or similar	C:		C:
	material) machining, moving dirt	R:		R:
	or gravel			
Ergonomics	Hazard: N/A	L:	No Further analysis required	L:
		C:		C:
		R:		R:
Asbestos	Hazard: N/A	L:	No further analysis required	L:
		C:		C:
		R:		R:
Working at	Hazard: Struck by dropped	L:	See Section 1, Chapter 4	L:
Heights	tools/material.	C:		C:
_		R:		R:

Other Hazard Consequences, derived from Figure C-1, "					Rich	Matrix				
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)		onsequence (C, of event)/ H = High	•	anking) nt) of major concern	NISK	iviatiiX		Like	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	· ·	ent) of minor concern	l sa	Н	- 1	- 1	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern	ences	М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequ	1	Ш	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	·		Cons	N	IV	IV	IV	IV
M = Mitigative (reduces event consequences)				or acute injury that is						• •
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 6.25 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	Hazard: blocked egress would be	L:	See Section 1, Chapter 4	L:
Egress	of major life safety concern.	C:		C:
		R:		R:
	An egress might be blocked due			
	to construction work, poor			
	housekeeping, or faulty doors.			
	In the event of a fire or other life-			
	threatening event, a blocked			
	egress would be life threatening.			
	The exposure of the hazard to the			
	facility worker is of major			
	concern.			

Other Hazard Consequences, derived from Figure C-1, "	Exar	nple Qualitative Conseque	ence Matrix", 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 (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 (eve	ent) of minor concern	ces	Н	- 1	- 1	=	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern		М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedner	ı	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	eversible, other C ³ Prompt worker fatality C		Cons					
M = Mitigative (reduces event consequences)		serious effects, or				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 6.26 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	Hazard: A blocked egress would	L:	See Section 1, Chapter 4	L:
Egress	be of major life safety concern.	C: R:		C: R:
	An egress might be blocked due to construction work, poor housekeeping, or faulty doors.			
	In the event of a fire, a blocked egress would be life threatening.			
	The exposure of the hazard to the co-located worker is of concern.			

Other Hazard Consequences, derived from Figure C-1, "					Dick	Matrix				
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)		onsequence (C, of event)/ H = High	•	anкing) nt) of major concern	KISK	iviatrix		Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04)		M = Moderate	II = situation (eve	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		L = Low	· ·	ent) of minor concern	l sa	Н	- 1	- 1	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	ent) of minimal concern	ences	М	Ш	Ш	Ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequ	1	Ш	Ш	IV	IV
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	Н	C ³ Irreversible, other			Cons	N	IV	IV	IV	IV
Acronyms		symptoms which immediately life-		or acute injury that is						
MOI = Maximally-exposed Offsite Individual		could impair an threatening or		immediately life- threatening or						
		individual's ability to	permanently disabling.	permanently disabling.						
		take protective	permanently disabiling.	permanently disabiling.						
		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 6.27 Access & Egress – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety	Hazard: N/A	L:	No further analysis required	L:
Egress		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	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	ces	Н	- 1	- 1	Ш	Ш
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	ent) of minimal concern	eu	М	Ш	П	Ш	IV
Control(s) Type	С	Offsite (MOI) Onsite-2 (co-located worker) Onsite-1 (facility worker)		Onsite-1 (facility worker)	sedn		III	Ш	IV	IV	
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	Н	C ³ Irreversible, other C ³ Prompt worker fatality C ³ Prompt		C ³ Prompt worker fatality or acute injury that is	Cons	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.						
		take protective		, , , , , , , ,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,						
		action.									
	М	C ³ Mild, transient	C ^s	³ Serious injury, no	C ³ Serious injury, no						
		adverse effects.	imm	ediate loss of life no	immediate loss of life no						
			per	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	Con	sequences less than	Consequences less than						
		than those for Low	those	for Low Consequence	those for Low						
		Consequence Level		Level	Consequence Level						