Table 2. Summary of Baseline and Residual Risks – NuMI

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

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

NOTE:

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

"Events with an unmitigated risk value of III or IV would not require additional control assignments to provide reasonable assurance of adequate protection. Whereas, for events with an unmitigated risk value of I or II, controls would need to be assigned to either reduce the likelihood or the consequence, and therefore the overall mitigated risk. Generally, preventive controls are applied prior to a loss event – reflecting a likelihood reduction and mitigative controls are applied after a loss event – reflecting a consequence reduction. Each control is credited for a single "bin drop" either in likelihood or consequence; not both. Following a standard hierarchy of controls, controls are applied until the residual risk is acceptable – reflecting a mitigated risk value of III or IV. After controls are credited, events with a remaining unacceptable residual risk (i.e., I or II) are candidates for additional analyses and additional controls, often quantitative in nature." For Fermilab, these controls for accelerator-specific hazards are identified as Credited Controls and further summarized in the Accelerator Safety Envelope (ASE).

Table 2.1 Radiological – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Prompt Ionizing	Hazard: Exposure to ionizing	L: A	P – RSIS: The Radiation Safety Interlock System uses a key tree system	L: BEU
Radiation	radiation beyond regulatory limits.	C: H	that captures the keys to an accelerator enclosure. These keys are	C: L
		R: I	electrically monitored through the Radiation and Electrical Safety	R: IV
			Systems to turn off the accelerator enclosure if any key is removed	
			from the key tree.	
			P – Radiological Signage: Signs located in various places throughout the accelerator complex warn of various hazards and occupancy restrictions.	
			P – Radiological Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing.	
			M – Interlocked Beam Loss Detectors: Certified radiation detectors are	
			electrically monitored through the Radiation Safety System that	
			turns off an accelerator enclosure if the detected radiation is	
			measured to be over a predetermined threshold. This is an active	
			mitigation.	
			M – Radiological Shielding: Material placed between radiation sources	
			and the enclosure to be protected. This is a passive mitigation.	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Residual Activation	Hazard: Exposure to ionizing radiation beyond regulatory limits.	L: A C: H R: I	 P - General and/or Job Specific RWP: A Radiological Work Permit is 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 on 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 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 - Target Pile Shielding: Material placed between radiation sources in the target pile and the enclosure to be protected. This is a passive mitigation. P - As needed: the RCT or RSO will monitor the job as specified by the RWP. 	L: BEU C: L R: IV
Groundwater Activation	Hazard: Radionuclides in ground water exceed regulatory levels	L: A C: H R: I	 P – Active and automatic beam tuning is performed to limit beam losses. P – Monitoring wells are sampled periodically to determine the levels if any detectable in the groundwater. P – Sump pump systems are engineered systems engineered to limit water radioactivation. 	L: BEU C: L R: IV
Surface Water Activation	Hazard: Radionuclides in surface water exceed regulatory levels	L: A C: H R: I	See Section I Chapter 04	L: BEU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive	Hazard: Persons are exposed, beyond	L: A	P – RAW Key Control System: Multiple key systems prevent personnel	L: BEU
Water (RAW)	regulatory levels, to radioactive water	C: H	access to radioactive water systems.	C: L
Systems		R: I	 P – Secondary Containment is engineered containment that prevents unintended exposure to contaminated water. P – General and/or Job Specific RWP: A Radiological Work Permit is 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 an LSM: Use of a log survey monitor is specified by a RWP. The LSM allows for real time monitoring of radiation levels during work. M – Run Conditions: Operating parameters that reduce activation by limiting the total amount of beam that can be delivered are specified. Specifically, this includes an operating limit for protons/hr. This is an active mitigation and the systems that must be operational for running beam are spelled out. M – RCT Or RSO Monitoring: A RWP will specify that a Radiation Control Technician or Radiation Safety Officer be present during certain kinds of work or work conditions. The radiological expert can make real time decisions to limit, stop, or prevent radiation exposure to personnel. This is an active mitigation. 	R: IV
Air Activation	Hazard: Radionuclides in air exceed	L: A	See Section I Chapter 04	L: EU
	regulatory levels	C: H		C: N
		R: I		R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Soil Interactions	Hazard: Radionuclides are produced by beam which may contaminate soil near the decay pipe	L: A C: N R: IV	 P – Active and automatic beam tuning is performed to limit beam losses. M – Beamline Design and Engineered Beam Dump: the beamline is designed that includes measures to reduce unwanted beam particle losses, as well as the use of a beam dump (absorber) design that minimizes radiological leakage through the use of shielding. This is a passive mitigation. M – Run Conditions: Operating parameters that reduce activation by limiting the total amount of beam that can be delivered are specified. Specifically, this includes an operating limit for protons/hr. This is an active mitigation and the systems that must be operational for running beam are spelled out. M – Past studies have characterized the migration of tritium into shielding and lessons have been applied. 	L: U C: N R: IV
Radioactive Waste	Hazard: Persons are exposed to ionizing radiation beyond regulatory levels	L: A C: L R: III	 P - General and/or Job Specific RWP: A Radiological Work Permit is 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 an LSM: Use of a log survey monitor is specified by a RWP. The LSM allows for real time monitoring of radiation levels during work. M - Decay Time Requirements: 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 is an active mitigation. M - Material Survey and Release Process: Any item exposed to beam-on conditions is surveyed by radiological workers and classified appropriately when removed from an enclosure. Items identified for disposal are surveyed and processed by Radiological Control organization personnel in accordance with FRCM Chapter 4. This is an active mitigation. 	L: EU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	Hazard: Persons are exposed to ionizing radiation beyond regulatory levels	L: A C: H R: I	 P - Shielding for Activated Contamination: Shielding material prevents unintended exposure to sources and personnel. P - Radiological Surveying and Cleaning: RCTs and RSOs survey for and clean radiological contamination as part of the RWP process. P - General and/or Job Specific RWP: A Radiological Work Permit is 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 an LSM: Use of a log survey monitor is specified by a RWP as necessary. The LSM allows for real time monitoring of radiation levels during work. M - Material Survey and Release Process: Any item exposed to beam-on conditions is surveyed by radiological workers and classified appropriately when removed from an enclosure. Items identified for disposal are surveyed and processed by Radiological Control organization personnel in accordance with FRCM Chapter 4. This is an active mitigation. Active mitigation by containing contaminated items to prevent release is used as necessary M - PPE: A RWP may specify that personal protective equipment be used during certain kinds of work or work conditions. The PPE limits the likelihood of bodily exposure to activated material and contamination. This is an active mitigation. 	L: BEU C: L R: IV
⁷ Be	Hazard: Potential radiation exposure to ⁷ Be (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

Likelihood (L, of event)/year	Co	nsequence (C, of event)/y	year 1	Risk (R, Qualitative R	lanking)	Risk Matrix					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (even	I = situation (event) of major concern				Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ever	nt) of concern		1	A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (eve	ent) of minor concern	es	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern		enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-	-2 (co-located worker)	Onsite-1 (facility worker)	edn		***			
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	ons	L	III	III	IV	IV
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	100	$rac{1}{1}$ rem $rac{1}{1}$ rem $rac{1}{1}$ rem	100 rem > C ≥ 25 rem	0	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 2.2 Radiological – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Prompt Ionizing Radiation	Hazard: exposure to ionizing radiation beyond regulatory limits.	L: A 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 - Radiological Signage: Signs located in various places throughout the accelerator complex warn of various hazards and occupancy restrictions. P - Radiological Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. M - Interlocked Beam Loss Detectors: Certified radiation detectors are electrically monitored through the Radiation Safety System that turns off an accelerator enclosure if the detected radiation is measured to be over a predetermined threshold. This is an active mitigation. M - Radiological Shielding: Material placed between radiation sources and the enclosure to be protected. This is a passive mitigation. 	L: BEU C: L R: IV
Residual Activation	Hazard: exposure to ionizing radiation beyond regulatory limits.	L: A C: H R: I	 P – General and/or job specific RWP: A Radiological Work Permit is 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 – LSM: Monitors radiation levels during job P – Radiological Training: educates workers about radiological hazards, and general means and methods to reduce exposure. M – Radiological signage and cool off (decay) time requirements prior to entry M – Target pile shielding: attenuates radiation. 	L: BEU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Groundwater	Hazard: radionuclides in ground	L: A	See Section I Chapter 04	L: BEU
Activation	water exceed regulatory levels	C: H		C: L
Surface Water Activation	Hazard radionuclides in surface water exceed regulatory levels	R: I L: A C: H R: I	See Section I Chapter 04	R: IV L: BEU C: L R: IV
Radioactive Water (RAW) Systems	Hazard: persons are exposed, beyond regulatory levels, to radioactive water	L: A C: H R: I	 P – Active and automatic beam tuning is performed to limit beam losses. P – Monitoring wells are sampled periodically to determine the levels if any detectable in the groundwater. P – Sump pump systems are engineered systems engineered to limit water radioactivation. M – Run Conditions: Operating parameters that reduce activation by limiting the total amount of beam that can be delivered are specified. Specifically, this includes an operating limit for protons/hr. This is an active mitigation and the systems that must be operational for running beam are spelled out. 	L: BEU C: L R: IV
Air Activation	Hazard: radionuclides in air exceed regulatory levels	L: A C: H R: I	See Section I Chapter 04	L: EU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Soil Interactions	Hazard: radionuclides are produced which may contaminate ground water	L: A C: N R: IV	 P – Active and automatic beam tuning is performed to limit beam losses. M – Beamline Design and Engineered Beam Dump: the beamline is designed that includes measures to reduce unwanted beam particle losses, as well as the use of a beam dump (absorber) design that minimizes radiological leakage through the use of shielding. This is a passive mitigation. M – Run Conditions: Operating parameters that reduce activation by limiting the total amount of beam that can be delivered are specified. Specifically, this includes an operating limit for protons/hr. This is an active mitigation and the systems that must be operational for running beam are spelled out. M – Past studies have characterized the migration of tritium into shielding and lessons have been applied. 	L: U C: N R: IV
Radioactive Waste	Hazard: persons are exposed to ionizing radiation beyond regulatory levels	L: A C: L R: III	 P - General and/or Job Specific RWP: A Radiological Work Permit is 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 an LSM: Use of a log survey monitor is specified by a RWP. The LSM allows for real time monitoring of radiation levels during work. M - Decay Time Requirements: 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 is an active mitigation. M - Material Survey and Release Process: Any item exposed to beam-on conditions is surveyed by radiological workers and classified appropriately when removed from an enclosure. Items identified for disposal are surveyed and processed by Radiological Control organization personnel in accordance with FRCM Chapter 4. This is an active mitigation. 	L: EU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	Hazard: persons are exposed to ionizing radiation beyond regulatory levels	L: A C: H R: I	 P - Shielding for Activated Contamination: Shielding material prevents unintended exposure to sources and personnel. P - Radiological Surveying and Cleaning: RCTs and RSOs survey for and clean radiological contamination as part of the RWP process. P - General and/or Job Specific RWP: A Radiological Work Permit is 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 an LSM: Use of a log survey monitor is specified by a RWP as necessary. The LSM allows for real time monitoring of radiation levels during work. M - Material Survey and Release Process: Any item exposed to beam-on conditions is surveyed by radiological workers and classified appropriately when removed from an enclosure. Items identified for disposal are surveyed and processed by Radiological Control organization personnel in accordance with FRCM Chapter 4. This is an active mitigation. Active mitigation by containing contaminated items to prevent release is used as necessary M - PPE: A RWP may specify that personal protective equipment be used during certain kinds of work or work conditions. The PPE limits the likelihood of bodily exposure to activated material and contamination. This is an active mitigation. 	L: BEU C: L 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

Likelihood (L, of event)/year	Cor	nsequence (C, of event)/y	year	Risk (R, Qualitative F	Ranking)	Risk Matrix						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (event) of major concern					Likelihood			
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		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	ent) of minor concern	ences	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely $(1.0E-06 > L)$		N = Negligible		IV = situation (eve	IV = situation (event) of minimal concern		M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	edn	_	TTT	TTT	17.7	13.7	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	ous	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	$00 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	100 rem > C ≥ 25 rem	C	N	IV	IV	IV	IV	
Acronyms MOI = Manipus 11 p. 2002 and Official Individual	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 2.3 Radiological – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Prompt Ionizing Radiation	Hazard: exposure to ionizing radiation beyond regulatory limits.	L: BEU C: H R: III	 P - Access to areas with this hazard are protected by on site access restrictions and restricted access to buildings. 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 - Radiological Signage: Signs located in various places throughout the accelerator complex warn of various hazards and occupancy restrictions. M - Radiological Shielding: Material placed between radiation sources and the above ground areas. This is a passive mitigation. 	L: BEU C: L R: IV
Residual Activation	Hazard: exposure to ionizing radiation beyond regulatory limits.	L: BEU C: H R: III	 P - Access to areas with this hazard are protected by on site access restrictions and restricted access to buildings P - Access to the enclosure is further protected by interlocked keys. These keys are not issued to members of the public. This prevents them from being exposed to residual activation. P - Radiological Signage: Signs located in various places throughout the accelerator complex warn of various hazards and occupancy restrictions. 	L: BEU C: M R: IV
Groundwater Activation	Hazard: radionuclides in ground water exceed regulatory levels	L: A C: H R: I	See Section I Chapter 04	L: EU C:M R: III

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Surface Water	Hazard: radionuclides in surface	L: A	See Section I Chapter 04	L: BEU
Activation	water exceed regulatory levels	C: H		C: M
		R: I		R: IV
Radioactive	Hazard: persons are exposed, beyond	L: BEU	P – RAW Key Control System: Multiple key systems prevent personnel	L: BEU
Water (RAW)	regulatory levels, to radioactive water	C: H	access to radioactive water systems.	C: M
Systems		R: III	 P – Secondary Containment is engineered containment that prevents unintended exposure to contaminated water. M – Run Conditions: Operating parameters that reduce activation by limiting the total amount of beam that can be delivered are specified. Specifically, this includes an operating limit for protons/hr. This is an active mitigation and the systems that must be operational for running beam are spelled out. M – RCT Or RSO Monitoring: A RWP will specify that a Radiation Control Technician or Radiation Safety Officer be present during certain kinds of work or work conditions. The radiological expert can make real time decisions to limit, stop, or prevent radiation exposure to personnel. This is an active mitigation. 	R: IV
Air Activation	Hazard: radionuclides in air exceed	L: BEU	See Section I Chapter 04	L: BEU
	regulatory levels	C: H		C: M
		R: III		R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Soil Interactions	Hazard: radionuclides are produced which may contaminate ground water	L: BEU C: H R: III	 P – Active and automatic beam tuning is performed to limit beam losses. M – Beamline Design and Engineered Beam Dump: the beamline is designed that includes measures to reduce unwanted beam particle losses, as well as the use of a beam dump (absorber) design that minimizes radiological leakage through the use of shielding. This is a passive mitigation. M – Run Conditions: Operating parameters that reduce activation by limiting the total amount of beam that can be delivered are specified. Specifically, this includes an operating limit for protons/hr. This is an active mitigation and the systems that must be operational for running beam are spelled out. M – Past studies have characterized the migration of tritium into shielding and lessons have been applied. 	L: BEU C: M R: IV
Radioactive Waste	Hazard: persons are exposed to ionizing radiation beyond regulatory levels	L: BEU C: H R: III	 P – Access to areas with this hazard are protected by on site access restrictions and restricted access to buildings. P – Radiological Signage: Signs located in various places throughout the accelerator complex warn of various hazards and occupancy restrictions. M – Material Survey and Release Process: Any item exposed to beam-on conditions is surveyed by radiological workers and classified appropriately when removed from an enclosure. Items identified for disposal are surveyed and processed by Radiological Control organization personnel in accordance with FRCM Chapter 4. This is an active mitigation. 	L: BEU C: M R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	Hazard: persons are exposed to	L: BEU	P – Access to areas with this hazard are protected by on site access	L: BEU
	ionizing radiation beyond regulatory	C: H	restrictions and restricted access to buildings.	C: M
	levels	R: III	 P – Radiological Signage: Signs located in various places throughout the accelerator complex warn of various hazards and occupancy restrictions. P – Shielding for Activated Contamination: Shielding material prevents unintended exposure to sources and personnel. M – Material Survey and Release Process: Any item exposed to beam-on conditions is surveyed by radiological workers and classified appropriately when removed from an enclosure. Items identified for disposal are surveyed and processed by Radiological Control organization personnel in accordance with FRCM Chapter 4. This is an active mitigation. Active mitigation by containing contaminated items to prevent release is used as necessary. 	R: IV
⁷ Be	Hazard: Potential radiation exposure	L: A	No prevention or mitigation is required. ⁷ Be isn't hazardous in this pattern	L: A
	to 7Be (uptake/committed dose).	C: N	of use by facility.	C: N
		R: IV		R: IV

Likelihood (L, of event)/year	Co	nsequence (C, of event)/y	ear Risk (R, Qualitative	Ranking)	Risk	Matri	x			
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \text{High}$		I = situation (event) of major concern				Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (eve	-			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ex	vent) of minor concern	ences	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	IV = situation (event) of minimal concern		M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nba	_				
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem	C ≥ 100 rem	C ≥ 100 rem	ons	L	III	III	IV	IV
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	$\frac{\text{C} = 100 \text{ rem}}{100 \text{ rem} > \text{C} \ge 25 \text{ rem}}$	$100 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	C	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 2.4 Toxic Materials – Onsite 1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Beryllium	Hazard: Beryllium beam windows may rupture and fragment.	L: U C: L R: III	P — Windows designed to be contained by consumable and replaceable components rather than released into the target hall. M — Engineered designs assure appropriate pressure differential across particle windows.	L: EU C: N R: IV

Chemical Hazard Consequences, derived from Figure	C-1	, "Example Qualitative	Consec	quence Matrix", DOE-	HDBK-1163-2020.							
Likelihood (L, of event)/year	C	onsequence (C, of event))/year	Risk (R, Qualitative Ranking)			isk N	latri	K			
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern					Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern	_			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	3	ß	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	N = Negligible		vent) of minimal concern			M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)		<u>-</u>	т -	TTT	TTT	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	940		L	III	III	IV	IV
M = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$			N	IV	IV	IV	IV
Acronyms	Τ.	PAC-1 > C		$\frac{\text{PAC-2} > \mathbf{C}}{\text{PAC-2} > \mathbf{C}}$	PEL or $TLV_c > C$							
IDLH = Immediately Dangerous to Life and Health	N	Consequences less	Cor	nsequences less than	Consequences less than							
MOI = Maximally-exposed Offsite Individual	11	^		•	_							
PAC = Protective Action Criteria		than those for Low	tnose	for Low Consequence	those for Low							
PEL = Permissible Exposure Limit		Consequence Level		Level	Consequence Level							
TLV _c = Threshold Limit Value (ceiling)												

Table 2.5 Toxic Materials – Onsite 2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Beryllium	Hazard: Beryllium beam windows	L: U	P – Windows designed to be contained by consumable and replaceable	L:EU
	may rupture and fragment.	C: L	components rather than released into the target hall.	C: N
		R: III	M – Engineered designs assure appropriate pressure differential across particle windows.	R: IV

Chemical Hazard Consequences, derived from Figure	C-1	, "Example Qualitative	Consec	quence Matrix", DOE-	HDBK-1163-2020.	•		•				
Likelihood (L, of event)/year	C	onsequence (C, of event)/year	Risk (R, Qualitative Ranking)			Risk Matrix					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (eve	I = situation (event) of major concern					Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern	l —			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ex	vent) of minor concern		S	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	N = Negligible		ent) of minimal concern			M	II	II	Ш	IV
Control(s) Type	C	Offsite (MOI)	Offsite (MOI) Onsite-2		Onsite-1 (facility worker)		_ nhas	T	Ш	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2	C ≥ PAC-2		C ≥ IDLH			L	III	1111	1 V	1 V
M = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P/	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$			N	IV	IV	IV	IV
Acronyms	L	PAC-1 > C		PAC-2 > C	PEL or $TLV_c > C$							
IDLH = Immediately Dangerous to Life and Health	N	Consequences less	Cor	nsequences 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	those	Level	Consequence Level							
PEL = Permissible Exposure Limit		Consequence Level		Level	Consequence Lever							
TLV_c = Threshold Limit Value (ceiling)												

Table 2.6 Toxic Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Beryllium	Hazard: Potential exposure to beryllium dust during manual handling of un-encased, or machining dusts from fabrication shop activities.	L: BEU C:H R:III	P – The NuMI Area is beyond the public access gates P – Components are in beamline, thus inaccessible to public.	L: BEU C: H R: III

Chemical Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event)/year	Risk (R, Qualitative	Ris	k Matr					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (eve	I = situation (event) of major concern				Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (ev	vent) of minor concern	es	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible			vent) of minimal concern	ences	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbag	r	Ш	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	Ons	L	1111	111	1 V	1 V
M = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P.A	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$		N	IV	IV	IV	IV
Acronyms	L	PAC-1 > C		PAC-2 > C	PEL or $TLV_c > C$						
IDLH = Immediately Dangerous to Life and Health MOI = Maximally-exposed Offsite Individual PAC = Protective Action Criteria PEL = Permissible Exposure Limit	N	Consequences less than those for Low Consequence Level		nsequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level						
TLV _c = Threshold Limit Value (ceiling)											

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible Materials (cables, Boxes, Paper, wood cribbing, etc.)	Hazard:	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Con	sequen	nce Matrix", DOE-HD	BK-1163-2020.							
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative Ranking)			Risk Matrix					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				lihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	ses	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV	
Control(s) Type P = Proportion (reduce exert accommon a likelihead)	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	L	III	III	IV	IV	
 P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 	Н	C ≥ Irreversible, other serious effects,		Prompt worker fatality acute injury that is	$C \ge Prompt worker$ fatality or acute injury that	Cor	N	IV	IV	IV	IV	
		or symptoms which could impair an individual's ability to take protective action.		mmediately life- tening or permanently disabling.	is immediately life- threatening or permanently disabling.							
	M	C ≥ Mild, transient adverse effects.	imm per	≥ Serious injury, no lediate loss of life no manent disabilities; bitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.							
	L	Mild, transient		Minor injuries; no	Minor injuries; no							
		adverse effects > C		ospitalization > C	hospitalization > C							
	IN	Consequences less		sequences less than	Consequences less than							
		than those for Low	those	for Low Consequence	those for Low							
		Consequence Level		Level	Consequence Level							

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible Materials (cables,		L: C:	See Section I Chapter 04	L: C:
Boxes, Paper, wood cribbing, etc.)		R:		R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	year Risk (R, Qualitative	Ranking)	Risk Matrix							
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	ent) of major concern				Likelihood				
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{H} = \text{situation (ev}$	ent) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ex	vent) of minor concern	es	Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	_	***	***	77.7	***		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker		L	III	III	IV	IV		
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	Col	N	IV	IV	IV	IV		
Acronyms		or symptoms which	immediately life-	is immediately life-								
MOI = Maximally-exposed Offsite Individual		· ·	threatening or permanently	threatening or								
		individual's ability to	disabling.	permanently disabling.								
		take protective	5									
		action.										
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no								
		adverse effects.	immediate loss of life no	immediate loss of life no								
			permanent disabilities;	permanent disabilities;								
			hospitalization required.	hospitalization required.								
	L	Mild, transient	Minor injuries; no	Minor injuries; no								
		adverse effects > 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 2.9 Flammable and Combustible Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible		L:	See Section I Chapter 04	L:
Materials (cables,		C:		C:
Boxes, Paper,		R:		R:
wood cribbing,				
etc.)				

Other Hazard Consequences, derived from Figure C-1	l, "E	xample Qualitative Cons	sequer	nce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L > 1.0E-04) EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L) Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	C H	onsequence (C, of event)/ $H = High$ M = Moderate L = Low N = Negligible Offsite (MOI) $C \ge Irreversible$,	Onsite $C \ge P$	II = situation (ev. III = situation (ev. IV = situation (ev. 2-2 (co-located worker) Prompt worker fatality	ent) of major concern ent) of concern event) of minor concern event) of minimal concern event) of minimal concern Onsite-1 (facility worker) C ≥ Prompt worker	Risk	H M L	A I II	U I II	Iihood EU II III IV	BEU III IV IV
		other serious effects, or symptoms which could impair an individual's ability to take protective action.	i	acute injury that is immediately life- tening or permanently disabling.	fatality or acute injury that is immediately life- threatening or permanently disabling.		N	IV	IV	IV	IV
	M L	C ≥ Mild, transient adverse effects. Mild, transient	imm per hosp	≥ Serious injury, no nediate loss of life no manent disabilities; pitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	Cor	ospitalization > C nsequences less than for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

Table 2.10 Electrical Energy – Onsite-1 Facility Worker

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

Other Hazard Consequences, derived from Figure C-	l, "E	Example Qualitative Cons	equence Matrix", DOE-H	DBK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L > 1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (e	vent) of major concern	Risk	Matri	A A	Like U	lihood EU	BEU
EU = Extremely Unlikely $(1.0E-04 > L > 1.0E-06)$ BEU = Beyond Extremely Unlikely $(1.0E-06 > L)$		M - ModerateL = LowN = Negligible	III = situation	event) of concern (event) of minor concern (event) of minimal concern	ences	H M	I	I	II III	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	C H	C ≥ Irreversible, other serious effects, or symptoms which	Onsite-2 (co-located worker) C ≥ Prompt worker fatality or acute injury that is immediately life- threatening or permanently disabling.	fatality or acute injury that is immediately life-	Consequences	L N	III IV	III IV	IV IV	IV IV
	M L	C ≥ Mild, transient adverse effects. Mild, transient adverse effects > C	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no hospitalization > C	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no hospitalization > C						
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than	-					

Table 2.11 Electrical Energy 1 Onsite-2 Co-located Worker

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

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Conse	quence Matrix", DOE-HD	BK-1163-2020.							
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	nt) of major concern	Risk	Matri	A	Likelihood			
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \mathbf{M}$ $\mathbf{L} = \mathbf{L}$ $\mathbf{N} = \mathbf{N}$ $\mathbf{N} = \mathbf{N}$	-	vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I	II	BEU III IV	
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	С	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsu	L	III	III	IV	IV	
		other serious effects, or symptoms which	or acute injury that is immediately life- threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	Cor	N	IV	IV	IV	IV	
	M	C ≥ Mild, transient adverse effects. Mild, transient	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no							
	N	adverse effects > C Consequences less	hospitalization > C Consequences less than	hospitalization > C Consequences less than							
			hose for Low Consequence Level	those for Low Consequence Level							

Table 2.12 Electrical Energy – MOI Offsite

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

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Conse	quence Matrix", DOE-HD	BK-1163-2020.							
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	nt) of major concern	Risk	Matri	A	Likelihood			
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \mathbf{M}$ $\mathbf{L} = \mathbf{L}$ $\mathbf{N} = \mathbf{N}$ $\mathbf{N} = \mathbf{N}$	-	vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I	II	BEU III IV	
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	С	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsu	L	III	III	IV	IV	
		other serious effects, or symptoms which	or acute injury that is immediately life- threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	Cor	N	IV	IV	IV	IV	
	M	C ≥ Mild, transient adverse effects. Mild, transient	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no							
	N	adverse effects > C Consequences less	hospitalization > C Consequences less than	hospitalization > C Consequences less than							
			hose for Low Consequence Level	those for Low Consequence Level							

Table 2.13 Thermal Energy – Onsite-1 Facility Worker

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

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	year Risk (R, Qualitative	Ranking)	Risk Matrix						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	nt) of major concern			Likelihood				
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (even	ent) of concern			A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ev	vent) of minor concern	es	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely $(1.0E-06 > L)$		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	П	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	_	***	***	***	***	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV	
Acronyms		or symptoms which	immediately life-	is immediately life-							
MOI = Maximally-exposed Offsite Individual			threatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective									
		action.									
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects > 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 2.14 Thermal Energy – Onsite-2 Co-located Worker

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

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event).	year Risk (R, Qualitative	Ranking)	Risk Matrix						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	nt) of major concern			Likelihood				
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (even	ent) of concern	_	ı	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ex	vent) of minor concern	ses	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	edn	_	YYY	***	***	***	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	$C \ge Prompt$ worker fatality	C ≥ Prompt worker	Suo	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	Co	N	IV	IV	IV	IV	
Acronyms		or symptoms which	immediately life-	is immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective	2								
		action.									
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects > 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 2.15 Thermal Energy – MOI Offsite

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

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

Table 2.16 Kinetic Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power Tools		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:
Pumps and		L:	See Section I Chapter 04	L:
Motors		C:		C:
		R:		R:
Motion Tables		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.										
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L >1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	Risk (R, Qualitative Ranking) I = situation (event) of major concern			Likelihood A U EU			BEU
EU = Extremely Unlikely $(1.0\text{E}-04 > \text{L} > 1.0\text{E}-06)$ BEU = Beyond Extremely Unlikely $(1.0\text{E}-06 > \text{L})$		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$		vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I	II III	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	С	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsu	L	III	III	IV	IV
		other serious effects, or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	Сог	N	IV	IV	IV	IV
	M L	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	hospitalization > C Consequences less than hose for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power tools		L:	See Section I Chapter 04	L:
		C: R:		C: R:
Pumps and		L:	See Section I Chapter 04	L:
Motors		C:		C:
		R:		R:
Motion Tables		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1	, "E	xample Qualitative Con	sequer	nce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk Matrix					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (eve	ent) of major concern			Likelihood			
U = Unlikely (1.0E-02 > L > 1.0E-04)		M = Moderate		II = situation (ev	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	se	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	sedneuces	L	III	III	IV	IV
 P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 	Н	C ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	or i	Prompt worker fatality acute injury that is immediately life-tening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately lifethreatening or permanently disabling.	Con	N	IV	IV	IV	IV
	M L	C ≥ Mild, transient adverse effects. Mild, transient adverse effects > C	imm per hos <u>p</u>	≥ Serious injury, no nediate loss of life no manent disabilities; pitalization required. Minor injuries; no ospitalization > C	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no hospitalization > C						

Table 2.18 Kinetic Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power tools		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:
Pumps and		L:	See Section I Chapter 04	L:
Motors		C:		C:
		R:		R:
Motion Tables		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1	l, "E	xample Qualitative Con	sequer	ce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk Matrix					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (eve	ent) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ex	vent) of minor concern	s	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	sednences	L	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	Н	C ≥ Irreversible, other serious effects,		rompt worker fatality acute injury that is	C ≥ Prompt worker fatality or acute injury that	Con	N	IV	IV	IV	IV
Acronyms MOI = Maximally-exposed Offsite Individual		or symptoms which could impair an individual's ability to take protective action.	i	mmediately life- ening or permanently disabling.	is immediately life- threatening or permanently disabling.						
	M	C ≥ Mild, transient adverse effects.	imm per	E Serious injury, no sediate loss of life no manent disabilities; bitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	L	Mild, transient adverse effects > C		Minor injuries; no ospitalization > C	Minor injuries; no hospitalization > C						

Table 2.19 Potential Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane		L:		L:
Operations		C:	See Section I Chapter 04	C:
_		R:		R:
Compressed		L:		L:
Gasses		C:	See Section I Chapter 04	C:
		R:		R:
Vacuum Pumps		L:		L:
		C:	See Section I Chapter 04	C:
		R:		R:
Material		L:		L:
Handling		C:	See Section I Chapter 04	C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) L = Unlikelike (1.0E-02) L > 1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	ent) of major concern	Risk	Matri	A	Likelihood		
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$	-	vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I	II III	BEU III IV
Control(s) Type	C H	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsı	L	III	III	IV	IV
M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	.1	other serious effects, or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	Cor	N	IV	IV	IV	IV
	M L	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	hospitalization > C Consequences less than hose for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

Table 2.20 Potential Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:
Compressed		L:	See Section I Chapter 04	L:
Gasses		C:		C:
		R:		R:
Vacuum Pumps		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:
Material Handling		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Conse	quence Matrix", DOE-HD	BK-1163-2020.							
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	nt) of major concern	Risk	Matri	A	Likelihood			
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \mathbf{M}$ $\mathbf{L} = \mathbf{L}$ $\mathbf{N} = \mathbf{N}$ $\mathbf{N} = \mathbf{N}$	-	vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I	II III	BEU III IV	
Control(s) Type P = Preventive (reduce event occurrence likelihood)	С	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsu	L	III	III	IV	IV	
M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	11	other serious effects, or symptoms which	or acute injury that is immediately life- threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	Cor	N	IV	IV	IV	IV	
	M	C ≥ Mild, transient adverse effects. Mild, transient	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no							
	N	adverse effects > C Consequences less	hospitalization > C Consequences less than	hospitalization > C Consequences less than							
			hose for Low Consequence Level	those for Low Consequence Level							

Table 2.21 Potential Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations		L:	See Section I Chapter 04	L:
		C: R:		C: R:
Compressed Gasses		L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps		L: C: R:	See Section I Chapter 04	L: C: R:
Material Handling		L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	ent) of major concern	Risk	Matri	A	Likelihood		
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$		vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I	II III	BEU III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood)	C H	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsı	L	III	III	IV	IV
M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual		other serious effects, or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	Cor	N	IV	IV	IV	IV
	M L	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	hospitalization > C Consequences less than hose for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

Table 2.22 Magnetic Fields – Onsite-1 Facility Worker

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

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.										
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	vear Risk (R, Qualitative	Ranking)	Risk	Matri	ix			
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (ever	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (evolution)	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ev	vent) of minor concern	es	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	II	П	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences		TTT	TTT	77.7	TY 7
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV
Acronyms		or symptoms which	immediately life-	is immediately life-						
MOI = Maximally-exposed Offsite Individual			threatening or permanently	threatening or						
		individual's ability to	disabling.	permanently disabling.						
		take protective	_							
		action.								
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no						
		adverse effects.	immediate loss of life no	immediate loss of life no						
			permanent disabilities;	permanent disabilities;						
			hospitalization required.	hospitalization required.						
	L	Mild, transient	Minor injuries; no	Minor injuries; no						
		adverse effects > C	hospitalization > C	hospitalization > C						
	N	Consequences less	Consequences less than	Consequences less than						
		than those for Low t	those for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 2.23 Magnetic Fields – Onsite-2 Co-located Worker

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

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

Table 2.24 Magnetic Fields – MOI Offsite

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

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.										
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	vear Risk (R, Qualitative	Ranking)	Risk	Matri	ix			
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (ever	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (evolution)	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ev	vent) of minor concern	es	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences		TTT	TTT	77.7	TY 7
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV
Acronyms		or symptoms which	immediately life-	is immediately life-						
MOI = Maximally-exposed Offsite Individual			threatening or permanently	threatening or						
		individual's ability to	disabling.	permanently disabling.						
		take protective	_							
		action.								
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no						
		adverse effects.	immediate loss of life no	immediate loss of life no						
			permanent disabilities;	permanent disabilities;						
			hospitalization required.	hospitalization required.						
	L	Mild, transient	Minor injuries; no	Minor injuries; no						
		adverse effects > C	hospitalization > C	hospitalization > C						
	N	Consequences less	Consequences less than	Consequences less than						
			those for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 2.25 Other hazards – Onsite-1 Facility Worker

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

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Conse	quence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	nt) of major concern	Risk	Matri	A	Like U	lihood EU	BEU
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$	-	vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I	II III	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood)	С	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsu	L	III	III	IV	IV
M = Mitigative (reduces event occurrence intermoda) Acronyms MOI = Maximally-exposed Offsite Individual	11	other serious effects, or symptoms which	or acute injury that is immediately life- threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	Cor	N	IV	IV	IV	IV
	M	C ≥ Mild, transient adverse effects. Mild, transient	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	N	adverse effects > C Consequences less	Minor injuries; no hospitalization > C Consequences less than	Minor injuries; no hospitalization > C Consequences less than						
			hose for Low Consequence Level	those for Low Consequence Level						

Table 2.26 Other hazards – Onsite-2 Co-located Worker

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

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	ent) of major concern	Risk	Matri	A	Like U	lihood EU	BEU
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$		vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I	II III	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood)	C H	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsı	L	III	III	IV	IV
M = Mitigative (reduces event occurrence inclinious) Acronyms MOI = Maximally-exposed Offsite Individual		other serious effects, or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	Cor	N	IV	IV	IV	IV
	M L	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	hospitalization > C Consequences less than hose for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

Table 2.27 Other hazards – MOI Offsite

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

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Conse	quence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/yo H = High	I = situation (eve	ent) of major concern	Risk	Matr	ix A	Like U	elihood EU	BEU
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		 M = Moderate L = Low N = Negligible 	,	vent) of minor concern vent) of minimal concern	nces	Н	I	I	II	III
Control(s) Type P = Preventive (reduce event occurrence likelihood)	C H	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	M L	III	III	III IV	IV IV
 F - Freventive (reduce event occurrence intermoda) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 	П	other serious effects, or symptoms which	C ≥ Prompt worker fatality or acute injury that is immediately life- hreatening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately lifethreatening or permanently disabling.	CON		IV	IV	IV	IV
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	L N	Mild, transient adverse effects > C Consequences less than those for Low	Minor injuries; no hospitalization > C Consequences less than nose for Low Consequence	Minor injuries; no hospitalization > C Consequences less than those for Low						
		Consequence Level	Level	Consequence Level						

Table 2.28 Access & Egress – Onsite-1 Facility Worker

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

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.										
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	vear Risk (R, Qualitative	Ranking)	Risk	Matri	ix			
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (ever	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (evolution)	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ev	vent) of minor concern	sə	Н	I	I	II	III
BEU = Beyond Extremely Unlikely $(1.0E-06 > L)$		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences		TTT	TTT	77.7	YX /
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV
Acronyms		or symptoms which	immediately life-	is immediately life-				•	•	
MOI = Maximally-exposed Offsite Individual			threatening or permanently	threatening or						
		individual's ability to	disabling.	permanently disabling.						
		take protective	C							
		action.								
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no						
		adverse effects.	immediate loss of life no	immediate loss of life no						
			permanent disabilities;	permanent disabilities;						
			hospitalization required.	hospitalization required.						
	L	Mild, transient	Minor injuries; no	Minor injuries; no						
		adverse effects > C	hospitalization > C	hospitalization $> C$						
	N	Consequences less	Consequences less than	Consequences less than						
		than those for Low t	those for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 2.29 Access & Egress – Onsite-2 Co-located Worker

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

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	Consequence (C, of event)/year Risk (R, Qualitative Ranking)				Risk Matrix					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (ever	nt) of major concern	Likeliho						
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (evolution)	ent) of concern			A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ev	vent) of minor concern	es	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	П	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	_	***	***	77.7	***	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV	
Acronyms		or symptoms which	immediately life-	is immediately life-				•	•		
MOI = Maximally-exposed Offsite Individual			threatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective	C								
		action.									
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects > C	hospitalization > C	hospitalization $> C$							
	N	Consequences less	Consequences less than	Consequences less than							
		than those for Low t	those for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 2.30 Access & Egress – MOI Offsite

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

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	Consequence (C, of event)/year Risk (R, Qualitative Ranking)				Risk Matrix						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (ever	nt) of major concern	Likelih							
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (evolution)	ent) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ev	vent) of minor concern	es	Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences		TTT	TTT	77.7	TY 7		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV		
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV		
Acronyms		or symptoms which	immediately life-	is immediately life-								
MOI = Maximally-exposed Offsite Individual			threatening or permanently	threatening or								
		individual's ability to	disabling.	permanently disabling.								
		take protective	_									
		action.										
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no								
		adverse effects.	immediate loss of life no	immediate loss of life no								
			permanent disabilities;	permanent disabilities;								
			hospitalization required.	hospitalization required.								
	L	Mild, transient	Minor injuries; no	Minor injuries; no								
		adverse effects > C	hospitalization > C	hospitalization > C								
	N	Consequences less	Consequences less than	Consequences less than								
		than those for Low t	those for Low Consequence	those for Low								
		Consequence Level	Level	Consequence Level								

Table 2.31 Environmental

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