Table 2. Summary of Baseline and Residual Risks (Muon Campus)

	Risk Tables Description	Baseline Risk	Residual Risk
2,1	Radiological – Onsite-1 Facility Worker	R: I	R: III, IV
2.2	Radiological – Onsite-2 Co-located Worker	R: I	R: III, IV
2.3	Radiological – MOI Offsite	R: I	R: III, IV
2.4	Toxic Materials – Onsite 1 Facility Worker	R: 1	R: IV
2.5	Toxic Materials – Onsite 2 Co-located Worker	R: 1	R: IV
2.6	Toxic Materials – MOI Offsite	R: 1	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: *

* See Section I Chapter 04

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).

 $Table~{\bf 2.1}~Radiological-Onsite-1~Facility~Worker$

Hazard	Hazard Description	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)	
Residual activation	Hazard: Accelerator components can become activated from beam loss. Exposure to these activated components is possible.	L: A C: H R: I	M – Shielding to reduce activation M – Proper dosimetry P – Employee Rad Worker training P – ALARA plan	L: EU C: L R: IV
Groundwater Activation	Hazard: Scattered beam has potential to activate ground water at low levels calculated in the shield assessment.	L: A C: N R: IV	M – Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment.	L: A C: N R: IV
Surface Water Activation	Hazard: Potential exposure to activated surface water due to beam loss leakage from beam enclosures, located under the surface water impoundment.	L: A C: N R: IV	P – Beam loss monitors (in enclosures) prevent excessive beam loss. M – Shielding (soil, concrete, and/or steel) reduces surface water activation.	L: U C: N R: IV
	Potential exposure to activated surface water due to mixing surface water with a captured groundwater source.	L: A C: N R: IV	 P – Off-site discharge limit is applied to any water mixed into onsite surface water. This prevents surface water concentrations from approaching the Derived Concentration Standard. M – In situations where surface water activation is higher than expected (discovered by monitoring), facility stops operation until facility upset condition is resolved. 	L: U C: N R: IV
Radioactive Water (RAW) Systems	Hazard: RAW water system is used to cool the Lithium Lens, Pulsed Magnet and the beam absorber in the APO target hall.	L: A C: M R: II	P – Locked cage containing water equipment is controlled by the RSO who only grants access once radiation rates have dropped to safe levels. P – Radiation training required to access the water cage. M – Radiation Technician coverage required for water cage access M – Dosimetry as required by the relevant RWP	L: EU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)	
Air Activation Hazard: The 8 GeV protons interacting with the target and immediate air volume can radioactivate the air which could then migrate to accessible areas.		L: A C: H R: I	 P – Interlock system preventing access to beam enclosure while beam is present. P – Enclosure and service building keys linked to radiological and controlled access training to enter enclosure P – Activated air monitor is installed in the service building. M – Air flow controlled to route air through HEPA filter and decay path to allow activation to decay before being released. 	L: BEU C: M R: IV	
Soil Interactions	Hazard: Scattered beam has potential to activate soil at low levels calculated in the shield assessment.	L: A C: N R: IV	M - Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment.	L: A C: N R: IV	
Radioactive waste	Hazard: Persons are exposed to ionizing radiation beyond regulatory levels	L: A C: H R: I	 P – Radiological worker training P – Any item in a beam enclosure during beam-on conditions is removed and surveyed by radiological workers and classified appropriately (typically class 0 at these facilities). P – Any item identified for disposal is surveyed and processed by Radiological Control organization personnel in accordance with FRCM chapter 4. M – Labeling required by material survey and release process. 	L: BEU C: M R: IV	
Contamination	Hazard: Activated dust or debris could be ingested by worker or removed from radiation area unintentionally.	L: A C: H R: I	P – Radiation surveys of areas before work. P – Contamination wipes taken regularly in areas of likely contamination. P – RWP specifies PPE P – training – frisking upon exit	L: BEU C: H R: III	
⁷ Be	Hazard: Potential radiation exposure to 7Be (uptake/committed dose).	L: A C: N R: IV	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Non-ionizing		L:	See Section I Chapter 04	L:
Radiation		C:		C:
Hazards		R:		R:

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.													
Likelihood (L, of event)/year	Consequence (C, of event)/year Risk (R, Qualitative Ranking) Risk Matrix												
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even)	t) of major concern				Like	lihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (even)	nt) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (even)	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)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	edn		Ш	111	TX 7	IV		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	Cons	L	111	III	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		N	IV	IV	IV	IV		
Acronyms MOI - Maximally averaged Offsite 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 2.2 Radiological – Onsite-2 Co-located Worker

Hazard	Hazard Description		Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Residual Activation	Hazard: Accelerator components can become activated from beam loss. Exposure to these activated components is possible.	L: A C: N R: IV	M – Shielding to reduce activation M – Proper dosimetry P – Employee Rad Worker training P – ALARA plan	L: EU C: L R: IV
Groundwater Activation	Hazard: Scattered beam has potential to activate ground water at low levels calculated in the shield assessment.	L: A C: N R: IV	M – Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment.	L: A C: N R: IV
Surface Water Activation	Hazard: Potential exposure to activated surface water due to beam loss leakage from beam enclosures, located under the surface water impoundment.	L: A C: N R: IV	P – Beam loss monitors (in enclosures) prevent excessive beam loss. M – Shielding (soil, concrete, and/or steel) reduces surface water activation.	L: U C: N R: IV
	Potential exposure to activated surface water due to mixing surface water with a captured groundwater source.	L: A C: N R: IV	 P – Off-site discharge limit is applied to any water mixed into onsite surface water. This prevents surface water concentrations from approaching the Derived Concentration Standard. M – In situations where surface water activation is higher than expected (discovered by monitoring), facility stops operation until facility upset condition is resolved. 	L: U C: N R: IV
Radioactive Water (RAW) Systems	Hazard: RAW water system is used to cool the Lithium Lens, Pulsed Magnet and the beam absorber in the APO target hall.	L: A C: M R: II	 P – Locked cage containing water equipment is controlled by the RSO who only grants access once radiation rates have dropped to safe levels. P – Radiation training required to access the water cage. M – Radiation Technician coverage required for water cage access M – Dosimetry as required by the relevant RWP M – PPE as required by the relevant RWP 	L: EU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Air Activation	Hazard: The 8 GeV protons interacting with the target and immediate air volume can radioactivate the air which could then migrate to accessible areas.	L: A C: H R: I	 P – Interlock system preventing access to beam enclosure while beam is present. P – Enclosure and service building keys linked to radiological and controlled access training to enter enclosure P – Activated air monitor is installed in the service building. M – Air flow controlled to route air through HEPA filter and decay path to allow activation to decay before being released. 	L: BEU C: M R: IV
Soil Interactions	Hazard: Scattered beam has potential to activate soil at low levels calculated in the shield assessment.	L: A C: N R: IV	M – Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment.	L: A C: N R: IV
Radioactive waste	Hazard: Persons are exposed to ionizing radiation beyond regulatory levels	L: A C: H R: I	 P – Radiological worker training P – Any item in a beam enclosure during beam-on conditions that is removed is surveyed by radiological workers and classified appropriately. P – Any item identified for disposal is surveyed and processed by Radiological Control organization personnel in accordance with FRCM chapter 4. M – Labeling required by material survey and release process. 	L: BEU C: M R: IV
Contamination	Hazard: Activated dust or debris could be ingested by worker or removed from radiation area unintentionally.	L: A C: H R: I	P – Radiation surveys of areas before work. P – Contamination wipes taken regularly in areas of likely contamination. P – RWP specifies PPE P – training – frisking upon exit	L: BEU C: H R: III

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
⁷ Be	Hazard: Potential radiation exposure to 7Be (uptake/committed dose).	L: A C: N R: IV	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV
Non-ionizing Radiation Hazards		L: C: R:	See Section I Chapter 04	L: C: R:

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Cor	nsequence (C, of event)/y	year	Risk (R, Qualitative F	(anking)	king) Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even	t) of major concern				Likelihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = \text{situation (even}$	nt) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (evo	ent) of minor concern	seo	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)	Onsi	te-2 (co-located worker)	Onsite-1 (facility worker)	edn		TTT	TTT	13.7	TX 7	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	Suo	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	00 rem > C ≥ 25 rem	100 rem > C ≥ 25 rem		N	IV	IV	IV	IV	
Acronyms MOI – Mayimally, avmaged Offsite 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)
Residual	Hazard: Accelerator components can	L: A	M – Shielding to reduce activation	L: EU
Activation	become activated from beam loss.	C: N	M – Proper dosimetry	C: L
	Exposure to these activated components is possible.	R: IV	P – Employee Rad Worker training P – ALARA plan	R: IV
Groundwater	Hazard: Scattered beam has potential	L: A	P – Public screening at Fermi site boundary	L: EU
Activation	to activate ground water at low levels	C: N	P – Facility is locked preventing unescorted access	C: N
	calculated in the shield assessment.	R: IV	M – Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment.	R: IV
Surface Water	Hazards: Potential exposure to	L: A	P – Beam loss monitors (in enclosures) prevent excessive beam loss.	L: U
Activation	activated surface water due to beam	C: N	M – Shielding (soil, concrete, and/or steel) reduces surface water	C: N
	loss leakage from beam enclosures, located under the surface water impoundment.	R: IV	activation.	R: IV
			P – Off-site discharge limit is applied to any water mixed into onsite surface water. This prevents surface water concentrations from	
	Potential exposure to activated	L: A	approaching the Derived Concentration Standard.	L: U
	surface water due to mixing surface water with a captured groundwater source.	C: N R: IV	M – In situations where surface water activation is higher than expected (discovered by monitoring), facility stops operation until facility upset condition is resolved.	C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Water (RAW) Systems	Hazard: RAW water system is used to cool the Lithium Lens, Pulsed Magnet and the beam absorber in the APO target hall.	L: A C: M R: II	 P – Public screening at Fermi site boundary P – Facility is locked preventing unescorted access P – Locked cage containing water equipment is controlled by the RSO who only grants access once radiation rates have dropped to safe levels. P – Radiation training required to access the water cage. M – Radiation Technician coverage required for water cage access 	L:BEU C: N R: IV
Air Activation	Hazard: The 8 GeV protons interacting with the target and immediate air volume can radioactivate the air which could then migrate to accessible areas.	L: A C: H R: I	 M – Dosimetry as required by the relevant RWP P – Interlock system preventing access to beam enclosure while beam is present. P – Enclosure and service building keys linked to radiological and controlled access training to enter enclosure P – Activated air monitor is installed in the service building. M – Air flow controlled to route air through HEPA filter and decay path to allow activation to decay before being released. 	L: BEU C: M R: IV
Soil Interactions	Hazard: Scattered beam has potential to activate soil at low levels calculated in the shield assessment.	L: A C: N R: IV	P – Public screening at Fermi site boundary M - Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment.	L: U C: N R: IV
Radioactive waste	Hazard: persons are exposed to ionizing radiation beyond regulatory levels	L: A C: H R: I	P – Public screening at Fermi site boundary P – Facility is locked preventing unescorted access P – Any item identified for disposal is surveyed and processed by Radiological Control organization personnel in accordance with FRCM chapter 4. M – Labeling required by material survey and release process.	L: BEU C: H R: III

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	Hazard: Activated dust or debris	L: A	P – Radiation surveys of areas before work.	L: BEU
	could be encountered if it were	C: H	P – Contamination wipes taken regularly in areas of likely contamination.	C: H
	unintentionally removed from	R: I	P – RWP specifies PPE	R: III
	radiation area.		P – training – frisking upon exit	
⁷ Be	Hazard: Potential radiation exposure	L: BEU	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't	L: BEU
	to 7Be (uptake/committed dose).	C: N	hazardous in this pattern of use by facility.	C: N
		R: IV		R: IV
Non-ionizing	Hazard: Laser tracker equipment used	L: EU	P – Metrology group is trained in safe use of laser tracker equipment.	L: BEU
Radiation	by metrology personnel could cause	C: N		C: N
Hazards	eye injuries.	R: IV		R: IV

Likelihood (L, of event)/year	Cor	nsequence (C, of event)/	year	Risk (R, Qualitative R	(anking)	Risk Matrix					
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even	t) of major concern						
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 $(1.0E-06>L)$		$\mathbf{N} = \text{Negligible}$		IV = situation (even)	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)	nbə		***	***	TX 7	77.7
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	Suo	L	III	III	IV	IV
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	00 rem > C ≥ 25 rem	100 rem > C ≥ 25 rem)	N	IV	IV	IV	IV
Acronyms MOL Manipully approach 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 2.4 Toxic Materials – Onsite 1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fluorinert & Its	Hazard: Potential exposure to	L: A	Not Applicable	L: A
byproducts	Fluorinert	C: N		C: N
		R: IV		R: IV
	Potential exposure to Fluorinert	L: A	P – Fluorinert and decomposition products are contained in a closed	L: EU
	decomposition products (HF, PFIB).	C: H	system.	C: L
		R: I	 P – Maintenance Program identifies and implements appropriate controls to prevent exposure if system is to be breached. M – Fluorinert handling procedures exist for workers dealing with devices containing Fluorinert. M – Enclosure circulation and ventilation fans would disperse any released 	R: IV
			Fluorinert byproducts.	

C-1	, "Example Qualitative	Conseq	quence Matrix", DOE-	HDBK-1163-2020.						
Co	onsequence (C, of event))/year	Risk (R, Qualitative	Ranking)	Risk	Matri	X			
	$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like		
	$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			Α	U	EU	BEU
	L = Low		III = situation (e	vent) of minor concern	s	Н	I	I	II	III
	N = Negligible		IV = situation (ev	vent) of minimal concern		M	II	II	III	IV
C	Offsite (MOI) Onsite-2		e-2 (co-located worker)	Onsite-1 (facility worker)	nbə	т .	TIT	TIT	13.7	IV
Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	ous	L	111	Ш	1 V	1 V
M	$PAC-2 > C \ge PAC-1$	P/	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$	0	N	IV	IV	IV	IV
L	PAC-1 > C		PAC-2 > C	PEL or $TLV_c > C$						
N	Consequences less than those for Low Consequence Level		•	Consequences less than those for Low Consequence Level						
	C H	Consequence (C, of event) $H = High$ $M = Moderate$ $L = Low$ $N = Negligible$ $C $	Consequence (C, of event)/year $H = High$ $M = Moderate$ $L = Low$ $N = Negligible$ C Offsite (MOI) Onsite $H C \ge PAC-2$ $M PAC-2 > C \ge PAC-1 PAC-1 > C$ $N Consequences less Contains those for Low those$		$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$

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)
Fluorinert & Its	Hazard: Potential exposure to	L: U	Evaluated as non-hazardous through pattern of use.	L: U
byproducts	Fluorinert	C: N		C: N
		R: IV		R: IV
	Potential exposure to Fluorinert decomposition products (HF, PFIB).	L: U C: H R: I	 P – Fluorinert and decomposition products are contained in a closed system. P – Maintenance Program identifies and implements appropriate controls to prevent exposure if system is to be breached. M – Filtration installed to remove hazardous byproducts reduces consequences of exposure. M – Fluorinert handling procedures exist for workers dealing with devices containing Fluorinert. 	L: BEU C: L R: IV

Chemical Hazard Consequences, derived from Figure	C-1	, "Example Qualitative	Conseq	quence Matrix", DOE-	HDBK-1163-2020.									
Likelihood (L, of event)/year	C	onsequence (C, of event)/year	Risk (R, Qualitative	Risk (R, Qualitative Ranking)			Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Likelihood					
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern	_		A	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (e	vent) of minor concern	sea	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)	Offsite (MOI) Onsite-2		Onsite-1 (facility worker)	edn	T	III	Ш	IV	IV			
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	Suo	L		111	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 IDLH = Immediately Dangerous to Life and Health	L	PAC-1 > C		PAC-2 > C	PEL or $TLV_c > C$									
MOI = Maximally-exposed Offsite Individual PAC = Protective Action Criteria PEL = Permissible Exposure Limit TLV _c = Threshold Limit Value (ceiling)	N	Consequences less than those for Low Consequence Level		nsequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level									

Table 2.6 Toxic Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fluorinert & Its	Hazard: Potential exposure to	L: EU	Evaluated as non-hazardous through pattern of use.	L: EU
byproducts	Fluorinert	C: N		C: N
		R: IV		R: IV
	Potential exposure to Fluorinert	L: EU	P – Access to systems containing Fluorinert is prevented.	L: BEU
	decomposition products (HF, PFIB).	C: H	P – Fluorinert and decomposition products are contained in a closed	C: M
		R: II	system.	R: IV
			M – Filtration installed to remove hazardous byproducts reduces	
			consequences of exposure.	

Chemical Hazard Consequences, derived from Figure	C-1	, "Example Qualitative (Conseq	quence Matrix", DOE-	HDBK-1163-2020.							
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern							
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			Α	U	EU	BEU	
$\mathbf{EU} = \text{Extremely Unlikely } (1.0\text{E}-04 > \text{L} > 1.0\text{E}-06)$		$\mathbf{L} = \text{Low}$		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	e-2 (co-located worker)	Onsite-1 (facility worker)	edn	Ţ	***	***	***	***	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	ons	L	III	III	IV	IV	
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$	M	$PAC-2 > C \ge PAC-1$	P/	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$	C	N	IV	IV	IV	IV	
Acronyms	T.	$PAC-1 > \mathbf{C}$	- 11	$\frac{10.9 \times 0.2 \times 1110.2}{\text{PAC-2} \times C}$	PEL or TLV $_{c} > C$							
IDLH = Immediately Dangerous to Life and Health MOI = Maximally-exposed Offsite Individual PAC = Protective Action Criteria PEL = Permissible Exposure Limit TLV _c = Threshold Limit Value (ceiling)	N	Consequences less than those for Low Consequence Level		nsequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level							

 ${\bf Table~2.7~Flammable~and~Combustible~Materials-Onsite~-1~Facility~Worker}$

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

Other Hazard Consequences, derived from Figure C-1	, "F	Example Qualitative Cons	sequen	ce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/	/year	Risk (R, Qualitative	Ranking)	Risk Matrix					
$\mathbf{A} = \text{Anticipated (L} > 1.0\text{E}-02)$		$\mathbf{H} = \text{High}$		I = situation (event) of major concern					Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = situation (evolution (evolution for 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	uces	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	- E	M	П	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)		Onsite-1 (facility worker)	sedn	_	***	***	77.7	77.7
	Н	C ≥ Irreversible,	C ≥ Pr	rompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV
M = Mitigative (reduces event consequences)		other serious effects,	_		fatality or acute injury that	٥	N	IV	IV	IV	IV
Acronyms		or symptoms which			is immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an			threatening or						
		individual's ability to		disabling.	permanently disabling.						
		take protective		-							
		action.									
	M	$C \ge Mild$, transient	C ≥	Serious injury, no	C ≥ Serious injury, no						
		adverse effects.	imme	ediate loss of life no	immediate loss of life no						
			pern	nanent disabilities;	permanent disabilities;						
			hospi	italization required.	hospitalization required.						
	L	Mild, transient	M	Iinor injuries; no	Minor injuries; no						
		adverse effects > C	ho	ospitalization > C	hospitalization $> \mathbf{C}$						
	N	Consequences less	Cons	sequences less than	Consequences less than						
		than those for Low	those f	or 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		L: C:	See Section I Chapter 04	L: C:
materials (cables, Boxes,		R:		R:
Paper, wood cribbing, etc.)				
Flammable		L:	See Section I Chapter 04	L:
Materials		C:		C:
(Flammable gas,		R:		R:
cleaning				
materials, etc.)				

Other Hazard Consequences, derived from Figure C-1	, "F	Example Qualitative Cons	sequenc	ce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/	/year	Risk (R, Qualitative	Ranking)	Risk Matrix					
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \text{High}$		I = situation (eve	ent) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)	$\mathbf{M} = \mathbf{Moderate}$			$\mathbf{II} = situation (evolution (evolution for evolution $	ent) of concern		ı	A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	uces	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	- E	M	П	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)		Onsite-1 (facility worker)	nbəs		***	***	77.7	77.7
	Н	C ≥ Irreversible,	C ≥ Pro	ompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is immediately life-		fatality or acute injury that	5	N	IV	IV	IV	IV
Acronyms		or symptoms which			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	$C \ge Mild$, transient	C ≥ 3	Serious injury, no	C ≥ Serious injury, no						
		adverse effects.	imme	ediate loss of life no	immediate loss of life no						
			perm	nanent disabilities;	permanent disabilities;						
			hospit	italization required.	hospitalization required.						
	L	Mild, transient	Mi	inor injuries; no	Minor injuries; no						
		adverse effects > C	hos	spitalization > C	hospitalization $> \mathbf{C}$						
	N	Consequences less	Cons	sequences less than	Consequences less than						
		than those for Low	those fo	or 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		C:		C:
(cables, Boxes,		R:		R:
Paper, wood				
cribbing, etc.)				
Flammable		L:	See Section I Chapter 04	L:
Materials		C:		C:
(Flammable gas,		R:		R:
cleaning				
materials, etc.)				

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event)/	year Risk (R, Qualitative	Ranking)	Risk Matrix							
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (eve	ent) of major concern				Like	lihood			
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	ences	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs		TTT	***	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)	N	IV	IV	IV	IV		
Acronyms		or symptoms which	immediately life-	is immediately life-					•	<u> </u>		
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or permanently	threatening or								
		individual's ability to	disabling.	permanently disabling.								
		take protective	J									
		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	1							
		adverse effects > C	hospitalization > C	hospitalization $> \mathbf{C}$								
	N	Consequences less	Consequences less than	Consequences less than								
		than those for Low	those for Low Consequence	those for Low								
		Consequence Level	Level	Consequence Level								

Table 2.10 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:
1		R:		R:
High Voltage		L:	See Section I Chapter 04	L:
Exposure		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-	1, "E	xample Qualitative Cons	sequence Matrix", DOE-HE	DBK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High	I = situation (eve	ent) of major concern	Risk	Matri	Likelihood			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)		$\mathbf{M} = \text{Moderate}$ $\mathbf{L} = \text{Low}$ $\mathbf{N} = \text{Negligible}$	III = situation (e	II = situation (event) of concern III = situation (event) of minor concern IV = situation (event) of minimal concern			I II	I	II	III
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) Onsite-1 (facility worker)						III	IV	IV
		other serious effects, or symptoms which could impair an individual's ability to take protective action.	or acute injury that is immediately life-threatening 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	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 those for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy		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:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event))/year	Risk (R, Qualitative	Ranking)	Risk Matrix					
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (event) of major concern					Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		\mathbf{H} = situation (ev	ent) of concern	l	1	A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	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	C	Offsite (MOI)	Onsite-2	2 (co-located worker)	Onsite-1 (facility worker)	sednences		***	***	77.7	***
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Pro	ompt worker fatality	C ≥ Prompt worker	Coms	L	III	III	IV	IV
M = Mitigative (reduces event consequences)		other serious effects,		cute injury that is	fatality or acute injury that	5	N	IV	IV	IV	IV
Acronyms		or symptoms which		mediately life-	is immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	threater	ning 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.	immed	diate loss of life no	immediate loss of life no						
			perm	anent disabilities;	permanent disabilities;						
			hospit	talization required.	hospitalization required.						
	L	Mild, transient	Mi	nor injuries; no	Minor injuries; no						
		adverse effects > C	hos	spitalization > C	hospitalization $> \mathbf{C}$						
	N	Consequences less	Conse	equences less than	Consequences less than	1					
		than those for Low	those fo	or Low Consequence	those for Low						
		Consequence Level		Level	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:
1		R:		R:
High Voltage		L:	See Section I Chapter 04	L:
Exposure		C:		C:
1		R:		R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Cons	sequen	nce Matrix", DOE-HD	BK-1163-2020.						
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 ≥ Irreversible, other serious effects,	Onsite $C \ge P$	II = situation (ev III = situation (ev	ent) of major concern	Consequences	H M L N	A I III III IV	Like U I II III IV	Iihood EU II III IV IV	BEU III IV IV IV
		or symptoms which could impair an individual's ability to take protective action.	i	ammediately life- tening or permanently disabling.	is immediately life- threatening or permanently disabling.						
	M	C ≥ Mild, transient adverse effects.	imm per hosp	≥ Serious injury, no lediate loss of life no manent disabilities; pitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
		Mild, transient adverse effects $> \mathbf{C}$		Minor injuries; no ospitalization > C	Minor injuries; no hospitalization > C						
	N	Consequences less than those for Low Consequence Level		nsequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level						

Table 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)	year Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	$\mathbf{I} = \text{situation (ev}$	ent) of major concern				lihood			
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	vent) of concern	l		A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$	III = situation (e	event) of minor concern	nces	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (e	event) of minimal concern	- E	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs			777	13.7	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	1 V	
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	or acute injury that is	fatality or acute injury that)	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	1						
		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:	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)/	year Risk (R, Qualitative	Ranking)	Risk Matrix							
$\mathbf{A} = \text{Anticipated (L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (ever	nt) of major concern				lihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (even}$	ent) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (evolution)	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	ences	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 ≥ Irreversible,	C ≥ 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	స్త్రే	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		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 $> \mathbf{C}$								
	N	Consequences less	Consequences less than	Consequences less than								
		than those for Low	those for Low Consequence	those for Low								
		Consequence Level	Level	Consequence Level								

Table 2.15 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	l, "E	xample Qualitative Con	sequence Matrix", DOE-HD	BK-1163-2020.								
Likelihood (L, of event)/year	Co	onsequence (C, of event)/	year Risk (R, Qualitative	Ranking)	Risk	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (eve	ent) of major concern				lihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	ent) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$	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	ences	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbesi	_	TTT	***	77.7	TX /		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	$C \ge Prompt worker fatality$	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	5	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	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 $> \mathbf{C}$	hospitalization $> \mathbf{C}$								
	Ν	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 2.16 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: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors		L: C: R:	See Section I Chapter 04	L: C: R:
Motion Tables		L: C: R:	See Section I Chapter 04	L: C: R:
Mobile Shielding		L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event)/	year Risk (R, Qualitative	Ranking)	Risk	Matri	ix					
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)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	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	sə	Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ex	vent) of minimal concern	ences	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs		***	***	77.7	TX /		
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)	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	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 $> \mathbf{C}$								
	N	Consequences less	Consequences less than	Consequences less than								
		than those for Low	those for Low Consequence	those for Low								
		Consequence Level	Level	Consequence Level								

Table 2.17 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: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors		L: C: R:	See Section I Chapter 04	L: C: R:
Motion Tables		L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event).	/year	Risk (R, Qualitative	Ranking)	Risk	Matri	X				
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern							
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (evolution)	ent) of concern			A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	(event) of minor concern	uces	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	II 5	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	ī	III	III	IV	IV	
 P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 	H	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 lifetening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately lifethreatening or permanently disabling.	Cons	N	IV	IV	IV	IV	
	M L	C ≥ Mild, transient adverse effects. Mild, transient adverse effects > C	imm per hosp	≥ Serious injury, no lediate loss of life no manent disabilities; pitalization required. Minor injuries; no lospitalization > 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:
rower tools		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	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	Matri	X				
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern							
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (even	ent) of concern		1	A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	(event) of minor concern	nces	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely $(1.0E-06>L)$		N = Negligible		IV = situation (ev	vent) of minimal concern		M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	Ι.	Ш	III	IV	IV	
 P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 	H	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 lifetening 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 hosp	≥ 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 2.19 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:	See Section I Chapter 04	L:
Operations		C:		C:
•		R:		R:
Compressed		L:	See Section I Chapter 04	L:
Gasses		C:		C:
		R:		R:
Vacuum/		L:	See Section I Chapter 04	L:
Pressure Vessels		C:		C:
		R:		R:
Vacuum Pumps		L:	See Section I Chapter 04	L:
_		C:		C:
		R:		R:
Material		L:	See Section I Chapter 04	L:
Handling		C:		C:
J		R:		R:

Other Hazard Consequences, derived from Figure C-	l, "F	Example Qualitative Conso	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	I = situation (eve	ent) of major concern	Risk	Matri		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)		$\mathbf{M} = \text{Moderate}$ $\mathbf{L} = \text{Low}$ $\mathbf{N} = \text{Negligible}$	III = situation (ex	 II = situation (event) of concern III = situation (event) of minor concern IV = situation (event) of minimal concern 		Н	I II	I I	EU II	BEU III IV		
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	C H	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	2 (co-located worker) Onsite-1 (facility worker)			III	III	IV	IV		
		other serious effects, or symptoms which could impair an individual's ability to take protective action.	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.	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	Mild, transient adverse effects $> \mathbf{C}$	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C								
	N	Consequences less than those for Low Consequence Level	Consequences less than hose for Low Consequence Level	Consequences less than those for Low Consequence Level								

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

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

Other Hazard Consequences, derived from Figure C-1	, "F	Example Qualitative Cons	sequenc	ce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/	/year	Risk (R, Qualitative	Ranking)	Risk	Matri	ix			
$\mathbf{A} = \text{Anticipated (L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	ent) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = situation (evolution (evolution for 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	nces	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern		M	П	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-	2 (co-located worker)	Onsite-1 (facility worker)	sedn	_	***	***	77.7	77.7
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Pr	compt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV
M = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV
Acronyms		or symptoms which		nmediately life-	is immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	threate	ening or permanently	threatening or						
		individual's ability to		disabling.	permanently disabling.						
		take protective		-							
		action.									
	M	$C \ge Mild$, transient	C ≥	Serious injury, no	C ≥ Serious injury, no						
		adverse effects.	imme	ediate loss of life no	immediate loss of life no						
			pern	nanent disabilities;	permanent disabilities;						
			hospi	italization required.	hospitalization required.						
	L	Mild, transient	M	linor injuries; no	Minor injuries; no						
		adverse effects > C	ho	spitalization > C	hospitalization $> \mathbf{C}$						
	N	Consequences less	Cons	sequences less than	Consequences less than						
		than those for Low	those for	or Low Consequence	those for Low						
		Consequence Level		Level	Consequence Level						

 ${\bf Table~2.21~Potential~Energy-MOI~Offsite}$

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

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/	year Risk (R, Qualitative	Ranking)	Risk	Matri	X			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (eve	ent) of major concern				Like	lihood	
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	ences	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs		TTT	***	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)	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	J							
		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	1					
		adverse effects > C	hospitalization > C	hospitalization $> \mathbf{C}$						
	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 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)	year Risk (R, Qualitative	Ranking)	Risk	Matri	ix			
$\mathbf{A} = \text{Anticipated (L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$	$\mathbf{I} = \text{situation (eve}$	ent) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$	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 (ev	vent) of minimal concern	ences	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 ≥ 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	Francisco, asserting.						
		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 $> \mathbf{C}$	hospitalization $> \mathbf{C}$						
	N	Consequences less	Consequences less than	Consequences less than						
		than those for Low	those for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

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

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Con	sequence Matrix", DOE-H	DBK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year Risk (R, Qualitativ	ve Ranking)	Risk	Matri	ix			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (e	I = situation (event) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation}$ (event) of concern		1	A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation	(event) 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)	Consequences				***	***
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Suc	L	III	III	IV	IV
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	ت	N	IV	IV	IV	IV
Acronyms		or symptoms which	immediately life-	is immediately life-		1		ı		
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or permanently	•						
		individual's ability to	disabling.	permanently disabling.						
		take protective	disasing.	permanently disacting.						
		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 $> \mathbf{C}$						
	N	Consequences less	Consequences less than	Consequences less than						
		than those for Low	those for Low Consequence	e 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	, "E	xample Qualitative Con	sequence Matrix", DOE-HI	DBK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)	year Risk (R, Qualitative	Ranking)	Risk	Matri	ix			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	$\mathbf{I} = \text{situation (ev}$	ent) of major concern				Like	lihood	
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	vent) of concern	l		A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$	$III = situation (\epsilon$	event) of minor concern	nces	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (e	event) of minimal concern	- E	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs			777	13.7	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	1 V
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	or acute injury that is	fatality or acute injury that)	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	1					
		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 2.25 Other hazards – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined		L:	See Section I Chapter 04	L:
Spaces		C: R:		C: R:
Noise		L: C: R:	See Section I Chapter 04	L: C: R:
Silica		L: C: R:	See Section I Chapter 04	L: C: R:
Ergonomics		L: C: R:	See Section I Chapter 04	L: C: R:
Working at heights		L: C: R:	See Section I Chapter 04	L: C: R:
Lithium	Hazard: Lithium is used in the focusing lens in the AP0 target station. Lithium itself is reactive and flammable. Contact with moisture produces lithium hydroxide which is caustic.	L: A C: H R: I	 P – The lithium in the lens is completely encased and there are conductivity interlocks that are an early indicator of a containment breach. P – Spare lithium is kept in an oil container to avoid contact with air or moisture. P – The container for spare lithium is kept in a flammable material cabinet in the APO service building. M – A fire extinguisher suitable for lithium is maintained in APO M – The Fermilab fire department is trained on the lithium hazard at APO and the response to an incident. 	L: BEU C: L R: IV

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/	year Risk (R, Qualitative	Ranking)	Risk	Matri	ix			
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)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	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	sə	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ex	vent) of minimal concern	ences	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs		***	***	77.7	***
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	or acute injury that is	fatality or acute injury that	5	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 $> \mathbf{C}$						
	N	Consequences less	Consequences less than	Consequences less than						
		than those for Low	those for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 2.26 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		L:	See Section I Chapter 04	L:
Spaces		C: R:		C: R:
Noise		L: C: R:	See Section I Chapter 04	L: C: R:
Silica		L: C: R:	See Section I Chapter 04	L: C: R:
Ergonomics		L: C: R:	See Section I Chapter 04	L: C: R:
Working at		L:	See Section I Chapter 04	L:
heights		C: R:		C: R:
Lithium	Hazard: Lithium is used in the focusing lens in the AP0 target station. Lithium itself is reactive and flammable. Contact with moisture produces lithium hydroxide which is caustic.	L: A C: H R: I	 P – The lithium in the lens is completely encased and there are conductivity interlocks that are an early indicator of a containment breach. P – Spare lithium is kept in an oil container to avoid contact with air or moisture. P – The container for spare lithium is kept in a flammable material cabinet in the APO service building. M – A fire extinguisher suitable for lithium is maintained in APO M – The Fermilab fire department is trained on the lithium hazard at APO and the response to an incident. 	L: BEU C: L R: IV

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 Ris	sk (R, Qualitative	Ranking)	Risk	Matri	X				
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even	nt) of major concern				Likelihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = situation (evolution (evolution for evolution $	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (ev	vent) of minor concern	uces	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern		M	II	II	Ш	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co	o-located worker)	Onsite-1 (facility worker)	nbəs		***	***	TX 7	77.7	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Promr	pt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)		other serious effects,	_	e injury that is	fatality or acute injury that	၁	N	IV	IV	IV	IV	
Acronyms		or symptoms which		ediately life-	is immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an	threatening	g or permanently	threatening or							
		individual's ability to	_	isabling.	permanently disabling.							
		take protective		_								
		action.										
	M	$C \ge Mild$, transient	C ≥ Seri	rious injury, no	C ≥ Serious injury, no							
		adverse effects.	immediat	te loss of life no	immediate loss of life no							
			permane	ent disabilities;	permanent disabilities;							
			hospitaliz	zation required.	hospitalization required.							
	L	Mild, transient	Minor	r injuries; no	Minor injuries; no							
		adverse effects > C	hospita	alization > C	hospitalization $> \mathbf{C}$							
	N	Consequences less	Consequ	iences less than	Consequences less than							
		than those for Low	those for L	Low Consequence	those for Low							
		Consequence Level		Level	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		L: C: R:	See Section I Chapter 04	L: C: R:
Noise		L: C: R:	See Section I Chapter 04	L: C: R:
Silica		L: C: R:	See Section I Chapter 04	L: C: R:
Ergonomics		L: C: R:	See Section I Chapter 04	L: C: R:
Working at heights		L: C: R:	See Section I Chapter 04	L: C: R:
Lithium	Hazard: Lithium is used in the focusing lens in the AP0 target station. Lithium itself is reactive and flammable. Contact with moisture produces lithium hydroxide which is caustic.	L: A C: H R: I	 P – Lithium is confined to the AP0 target service building which is away from any publicly accessible area. P – The lithium in the lens is completely encased and there are conductivity interlocks that are an early indicator of a containment breach. P – Spare lithium is kept in an oil container to avoid contact with air or moisture. P – The container for spare lithium is kept in a flammable material cabinet in the AP0 service building. M – A fire extinguisher suitable for lithium is maintained in AP0 M – The Fermilab fire department is trained on the lithium hazard at AP0 and the response to an incident. 	L: BEU C: L R: IV

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	Matri	X				
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \text{High}$	I = situation (eve	ent) of major concern				Likelihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (e	vent) of minor concern	sə	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ex	vent) of minimal concern	ences	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs		TTT	***	77.7	TX /	
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)	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	C								
		action.									
	M	$C \ge Mild$, transient	C ≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects > C	hospitalization > C	hospitalization > C							
	N	Consequences less	Consequences less than	Consequences less than							
		than those for Low	those for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 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		L:	See Section I Chapter 04	L:
Egress		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)	year Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated (L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (eve.	nt) of major concern				Likelihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = situation (evolution (evolution for evolution $	ent) of concern		ı	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$	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	ences	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 ≥ 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		Francisco, assurance,							
		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 $> \mathbf{C}$							
	N	Consequences less	Consequences less than	Consequences less than							
		than those for Low	those for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 2.29 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		L:	See Section I Chapter 04	L:
Egress		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).	/year Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$	$\mathbf{I} = \text{situation (eve}$	ent) of major concern				Likelihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$	III = situation (ex	vent) of minor concern	nces	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	- E	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	_					
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	$C \ge Prompt$ worker fatality	C ≥ Prompt worker	1 1 2	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	స్త్రా	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	disdoinig.	permanentry disabiling.							
		action.									
	M	$C \ge Mild$, transient	C ≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects > C	hospitalization $> \mathbf{C}$	hospitalization > 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 2.30 Access & Egress – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety		L:	See Section I Chapter 04	L:
Egress		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)	/year Risk (R, Qualitati	ve Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated (L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$	$\mathbf{I} = \text{situation } (\epsilon)$	vent) of major concern				Likelihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation}$ (event) of concern	I	1	A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$	III = situation	(event) of minor concern	nces	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely $(1.0E-06>L)$		N = Negligible	IV = situation	(event) of minimal concern	- E	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	,		TTT	13.7	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatalit	C ≥ Prompt worker	Cons	L	III	III	IV	1 V	
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	or acute injury that is	fatality or acute injury that		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								
		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 $> \mathbf{C}$							
	N	Consequences less	Consequences less than	Consequences less than							
		than those for Low	those for Low Consequence	e 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		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:
Water		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:
Soil		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R: