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 2.1 Radiological – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	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.* *Potential exposure to activated surface water due to mixing surface water with a captured groundwater source.*	L: A C: N R: IV 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. 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 L: U 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 AP0 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
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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
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
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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ³ 25.0 rem	**C** ³ 100 rem	**C** ³ 100 rem
M	25.0 rem > **C** ³ 5 rem	100 rem **> C** ³ 25 rem	100 rem **> C** ³ 25 rem
L	5 rem > **C**	25 rem **> C**	25 rem **> C**

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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)
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.* *Potential exposure to activated surface water due to mixing surface water with a captured groundwater source.*	L: A C: N R: IV 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. 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 L: U 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 AP0 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
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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
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
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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual
- **rem =** Roentgen equivalent man

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ³ 25.0 rem	**C** ³ 100 rem	**C** ³ 100 rem
M	25.0 rem > **C** ³ 5 rem	100 rem **> C** ³ 25 rem	100 rem **> C** ³ 25 rem
L	5 rem > **C**	25 rem **> C**	25 rem **> C**
N	0.5 rem > **C**	5 rem **> C**	5 rem **> C**

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

Table 2.3 Radiological – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	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	P – Public screening at Fermi site boundary P – Facility is locked preventing unescorted access M – Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment.	L: EU C: N R: IV
Surface Water Activation	*Hazards: Potential exposure to activated surface water due to beam loss leakage from beam enclosures, located under the surface water impoundment.* *Potential exposure to activated surface water due to mixing surface water with a captured groundwater source.*	L: A C: N R: IV 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. 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 L: U 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 AP0 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 M – Dosimetry as required by the relevant RWP	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	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 could be encountered if it were unintentionally removed from radiation area.	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: BEU 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: BEU C: N R: IV
Non-ionizing Radiation Hazards	*Hazard:* Laser tracker equipment used by metrology personnel could cause eye injuries.	L: EU C: N R: IV	P – Metrology group is trained in safe use of laser tracker equipment.	L: BEU C: N R: IV

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

Likelihood (L, of event)/year

- **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)

Consequence (C, of event)/year

- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)

- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type

- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms

- **MOI =** Maximally-exposed Offsite Individual
- **rem =** Roentgen equivalent man

C	**Offsite (MOI)**	**Onsite-2 (co-located worker)**	**Onsite-1 (facility worker)**
H	**C** ³ 25.0 rem	**C** ³ 100 rem	**C** ³ 100 rem
M	25.0 rem > **C** ³ 5 rem	100 rem **> C** ³ 25 rem	100 rem **> C** ³ 25 rem
L	5 rem > **C**	25 rem **> C**	25 rem **> C**
N	0.5 rem > **C**	5 rem **> C**	5 rem **> C**

Risk Matrix

Consequences	**Likelihood** A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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 byproducts	*Hazard:* Potential exposure to Fluorinert	L: A C: N R: IV	**Not Applicable**	L: A C: N R: IV
	Potential exposure to Fluorinert decomposition products (HF, PFIB).	L: A 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 – Fluorinert handling procedures exist for workers dealing with devices containing Fluorinert. M – Enclosure circulation and ventilation fans would disperse any released Fluorinert byproducts.	L: EU C: L R: IV

Chemical 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)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **IDLH** = Immediately Dangerous to Life and Health
- **MOI =** Maximally-exposed Offsite Individual
- **PAC** = Protective Action Criteria
- **PEL** = Permissible Exposure Limit

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ³ PAC-2	**C** ³ PAC-3	**C** ³ IDLH
M	PAC-2 > **C** ³ PAC-1	PAC-3 **> C** ³ PAC-2	IDLH **> C** ³ PEL or TLV_c
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	Consequences less than those for Low Consequence Level

Risk Matrix

Consequences \ Likelihood	A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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)
Fluorinert & Its byproducts	*Hazard :*Potential exposure to Fluorinert	L: U C: N R: IV	**Evaluated as non-hazardous through pattern of use.**	L: U C: N 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 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)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **IDLH** = Immediately Dangerous to Life and Health
- **MOI =** Maximally-exposed Offsite Individual
- **PAC** = Protective Action Criteria

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ³ PAC-2	**C** ³ PAC-3	**C** ³ IDLH
M	PAC-2 > **C** ³ PAC-1	PAC-3 > **C** ³ PAC-2	IDLH > **C** ³ PEL or TLV_c
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	Consequences less than those for Low Consequence Level

Risk Matrix

Consequences \ Likelihood	A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

PEL = Permissible Exposure Limit **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)
Fluorinert & Its byproducts	*Hazard:* Potential exposure to Fluorinert	L: EU C: N R: IV	**Evaluated as non-hazardous through pattern of use.**	L: EU C: N R: IV
	Potential exposure to Fluorinert decomposition products (HF, PFIB).	L: EU C: H R: II	P – Access to systems containing Fluorinert is prevented. P – Fluorinert and decomposition products are contained in a closed system. M – Filtration installed to remove hazardous byproducts reduces consequences of exposure.	L: BEU C: M R: IV

Chemical 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)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **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)

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ^{3} PAC-2	**C** ^{3} PAC-3	**C** ^{3} IDLH
M	PAC-2 > **C** ^{3} PAC-1	PAC-3 > **C** ^{3} PAC-2	IDLH > **C** ^{3} PEL or TLV_c
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	Consequences less than those for Low Consequence Level

Risk Matrix

Consequences \ Likelihood	A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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.)		L: C: R:	See Section I Chapter 04	L: C: R:
Flammable Materials (Flammable gas, cleaning materials, etc.)		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

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)

Consequence (C, of event)/year

H = High
M = Moderate
L = Low
N = Negligible

Risk (R, Qualitative Ranking)

I = situation (event) of major concern
II = situation (event) of concern
III = situation (event) of minor concern
IV = situation (event) of minimal concern

Control(s) Type

P = Preventive (reduce event occurrence likelihood)
M = Mitigative (reduces event consequences)

Acronyms

MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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

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)

Consequence (C, of event)/year

H = High
M = Moderate
L = Low
N = Negligible

Risk (R, Qualitative Ranking)

I = situation (event) of major concern
II = situation (event) of concern
III = situation (event) of minor concern
IV = situation (event) of minimal concern

Control(s) Type

P = Preventive (reduce event occurrence likelihood)
M = Mitigative (reduces event consequences)

Acronyms

MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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

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)

Consequence (C, of event)/year

H = High
M = Moderate
L = Low
N = Negligible

Risk (R, Qualitative Ranking)

I = situation (event) of major concern
II = situation (event) of concern
III = situation (event) of minor concern
IV = situation (event) of minimal concern

Control(s) Type

P = Preventive (reduce event occurrence likelihood)
M = Mitigative (reduces event consequences)

Acronyms

MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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 Exposure		L: C: R:	See Section I Chapter 04	L: C: R:
High Voltage Exposure		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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	Minor injuries; no hospitalization **> C**

Risk Matrix

Consequences \ Likelihood	A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	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 Exposure		L: C: R:	See Section I Chapter 04	L: C: R:
High Voltage Exposure		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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

	L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 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 Exposure		L: C: R:	See Section I Chapter 04	L: C: R:
High Voltage Exposure		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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	Minor injuries; no hospitalization **> C**

Risk Matrix

Consequences \ Likelihood	A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

	N	Consequences less than those for Low Consequence Level	Consequences less than those 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: 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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	**Offsite (MOI)**	**Onsite-2 (co-located worker)**	**Onsite-1 (facility worker)**
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	Minor injuries; no hospitalization **> C**

Risk Matrix

Consequences	**Likelihood** A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low 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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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: 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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood A	Likelihood U	Likelihood EU	Likelihood BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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, "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)
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)
BEU = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year

H = High
M = Moderate
L = Low
N = Negligible

Risk (R, Qualitative Ranking)

I = situation (event) of major concern
II = situation (event) of concern
III = situation (event) of minor concern
IV = situation (event) of minimal concern

Control(s) Type

P = Preventive (reduce event occurrence likelihood)
M = Mitigative (reduces event consequences)

Acronyms

MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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, "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)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	**Offsite (MOI)**	**Onsite-2 (co-located worker)**	**Onsite-1 (facility worker)**
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	Minor injuries; no hospitalization **> C**

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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: 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, "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)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	**Offsite (MOI)**	**Onsite-2 (co-located worker)**	**Onsite-1 (facility worker)**
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	Minor injuries; no hospitalization **> C**

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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 Operations		L: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses		L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum/ Pressure Vessels		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, "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)
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)
BEU = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year

H = High
M = Moderate
L = Low
N = Negligible

Risk (R, Qualitative Ranking)

I = situation (event) of major concern
II = situation (event) of concern
III = situation (event) of minor concern
IV = situation (event) of minimal concern

Control(s) Type

P = Preventive (reduce event occurrence likelihood)
M = Mitigative (reduces event consequences)

Acronyms

MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses		L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum/ Pressure Vessels		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, "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)
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)
BEU = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year

H = High
M = Moderate
L = Low
N = Negligible

Risk (R, Qualitative Ranking)

I = situation (event) of major concern
II = situation (event) of concern
III = situation (event) of minor concern
IV = situation (event) of minimal concern

Control(s) Type

P = Preventive (reduce event occurrence likelihood)
M = Mitigative (reduces event consequences)

Acronyms

MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses		L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum/ Pressure Vessels		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, "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)
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)
BEU = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year

H = High
M = Moderate
L = Low
N = Negligible

Risk (R, Qualitative Ranking)

I = situation (event) of major concern
II = situation (event) of concern
III = situation (event) of minor concern
IV = situation (event) of minimal concern

Control(s) Type

P = Preventive (reduce event occurrence likelihood)
M = Mitigative (reduces event consequences)

Acronyms

MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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: 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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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, "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)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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: 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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low 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: 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 – 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

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)

Consequence (C, of event)/year

H = High
M = Moderate
L = Low
N = Negligible

Risk (R, Qualitative Ranking)

I = situation (event) of major concern
II = situation (event) of concern
III = situation (event) of minor concern
IV = situation (event) of minimal concern

Control(s) Type

P = Preventive (reduce event occurrence likelihood)
M = Mitigative (reduces event consequences)

Acronyms

MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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: 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 – 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

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)

Consequence (C, of event)/year

H = High
M = Moderate
L = Low
N = Negligible

Risk (R, Qualitative Ranking)

I = situation (event) of major concern
II = situation (event) of concern
III = situation (event) of minor concern
IV = situation (event) of minimal concern

Control(s) Type

P = Preventive (reduce event occurrence likelihood)
M = Mitigative (reduces event consequences)

Acronyms

MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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	L: BEU C: L R: IV

			M – The Fermilab fire department is trained on the lithium hazard at AP0 and the response to an incident.	

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)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	**Offsite (MOI)**	**Onsite-2 (co-located worker)**	**Onsite-1 (facility worker)**
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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: 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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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: 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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences \ Likelihood	A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

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: 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
- **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)

Consequence (C, of event)/year
- **H** = High
- **M** = Moderate
- **L** = Low
- **N** = Negligible

Risk (R, Qualitative Ranking)
- **I** = situation (event) of major concern
- **II** = situation (event) of concern
- **III** = situation (event) of minor concern
- **IV** = situation (event) of minimal concern

Control(s) Type
- **P** = Preventive (reduce event occurrence likelihood)
- **M** = Mitigative (reduces event consequences)

Acronyms
- **MOI =** Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** [3] Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** [3] Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
M	**C** [3] Mild, transient adverse effects.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	**C** [3] Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization **> C**	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 those for Low Consequence Level

Risk Matrix

Consequences	Likelihood: A	U	EU	BEU
H	I	I	II	III
M	II	II	III	IV
L	III	III	IV	IV
N	IV	IV	IV	IV

Table 2.31 Environmental

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