Table 2. Summary of Baseline and Residual Risks APS-TD Non-accelerator Facilities

Risk Tables Description		Baseline Risk	Residual Risk
2,1	Radiological – Onsite-1 Facility Worker	R: I	R: IV
2.2	Radiological – Onsite-2 Co-located Worker	R: I	R: IV
2.3	Radiological – MOI Offsite	R: IV	R: IV
2.4	Toxic Materials – Onsite 1 Facility Worker	R: I	R: III, IV
2.5	Toxic Materials – Onsite 2 Co-located Worker	R: I	R: III, IV
2.6	Toxic Materials – MOI Offsite	R: III	R: IV
2.7	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: I	R: IV
2.8	Flammable & Combustible Materials – Onsite-2 Co-located worker	R: I	R: IV
2.9	Flammable & Combustible Materials – MOI Offsite	R: III	R: IV
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: I	R: IV
2.14	Thermal Energy – Onsite-2 Co-located Worker	R: I	R: IV
2.15	Thermal Energy – MOI Offsite	R: III	R: IV
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: I	R: III, IV
2.23	Magnetic Fields – Onsite-2 Co-located Worker	R: I	R: III, IV
2.24	Magnetic Fields – MOI Offsite	R: I	R: III, IV
2.25	Other Hazards – Onsite-1 Facility Worker	R: I	R: III, IV
2.26	Other Hazards – Onsite-2 Co-located Worker	R: I	R: III
2.27	Other Hazards – MOI Offsite	R: *	R: *
2.28	Access & Egress – Onsite-1 Facility Worker	R: N/A	R: N/A
2.29	Access & Egress – Onsite-2 Co-located Worker	R: N/A	R: N/A
2.30	Access & Egress – MOI Offsite	R: N/A	R: N/A
2.31	Environmental Hazards	R: *	R: *

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

NOTE:
Per DOE-HDBK-1163-2020, Appendix C, "Risk Assessment Methodology":
"Events with an unmitigated risk value of III or IV would not require additional control assignments to provide reasonable assurance of adequate protection. Whereas, for events with an unmitigated risk value of I or II, controls would need to be assigned to either reduce the likelihood or the consequence, and therefore the overall mitigated risk. Generally, preventive controls are applied prior to a loss event – reflecting a likelihood reduction and mitigative controls are applied after a loss event – reflecting a consequence reduction. Each control is credited for a single "bin drop" either in likelihood or consequence; not both. Following a standard hierarchy of controls, controls are applied until the residual risk is acceptable – reflecting a mitigated risk value of III or IV. After controls are credited, events with a remaining unacceptable residual risk (i.e., I or II) are candidates for additional analyses and additional controls, often quantitative in nature." For Fermilab, these controls for accelerator-specific hazards are identified as Credited Controls and further summarized in the Accelerator Safety Envelope (ASE).

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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: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. The residual activated material poses a health and safety hazard.*	L: A C: H R: I	P: All staff are required to take GERT training P: All staff working on radioactive materials are required to be Radiation Worker trained P: All impacted materials are surveyed and tagged with appropriate class P: "Invasive" work on a radioactive device is often performed in a separate building (IB2A) P: Class 2, or higher, devices require ALD approval before being moved into APS-TD facilities M: Materials are surveyed upon arrival at the "next facility", and if something is identified as radioactive that wasn't previously known, we can trace its history and perform any necessary cleanup	L: BEU C: M R: IV
Radioactive waste	*Hazard: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. Work to repair such devices generates radioactive waste, which poses a health and safety hazard.*	L: A C: H R: I	P: All staff are required to take GERT training P: All staff working on radioactive materials are required to be Radiation Worker trained P: All impacted materials are surveyed and tagged with appropriate class P: "Invasive" work on a radioactive device is often performed in a separate building (IB2A) P: Class 2, or higher, devices require ALD approval before being moved into APS-TD facilities P: All staff managing radioactive waste are identified and trained as Waste Generators M: before it leaves the site all waste is surveyed and anything that is found to be radioactive but was placed into the incorrect waste stream is traced back to its source and remediation is performed	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: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. The residual activated material can spread and cause contamination, which poses a health and safety hazard.*	L: A C: H R: I	P: All staff are required to take GERT training P: All staff working on radioactive materials are required to be Radiation Worker trained P: All impacted materials are surveyed and tagged with appropriate class P: "Invasive" work on a radioactive device is often performed in a separate building (IB2A) P: Class 2, or higher, devices require ALD approval before being moved into APS-TD facilities M: Materials are surveyed upon arrival at the "next facility", and if something is identified as radioactive that wasn't previously known, we can trace its history and perform any necessary cleanup	L: BEU C: M R: IV
Radiation Generating Devices (RDGs)	*Hazard: APS-TD operates several RGDs (e.g. SEM, XRF alloy analyzer).*	L: A C: L R: III	P: all staff operating RGDs are required to be formally trained on their safe operation P: All staff operating RGDs are required to be Radiation Workers P: All RGDs have RWPs P: All RGDs in operation in APS-TD are commercial products with built-in shielding M: Rad Workers wear dosimetry when operating the RGD	L: BEU C: N R: IV
Non-ionizing Radiation - Lasers	*Hazard: Three pieces of equipment in APS-TD generate lasers: laser cutter in IB3A (class 4), laser tracker operated by QC (class 2), SQMS laser in ICB (class 3B)*	L: C: R:	See Section I Chapter 04	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Non-ionizing Radiation – RF and UV	*Hazard: RF Sources (SRF plasma processing, SQMS quantum labs)* *Two pieces of equipment in APS-TD generate UV: a source in the cleanrooms to detect organics, and a source in the ultra-pure water system in IB4*	RF sources: L: EU C: L R: III UV sources: L: EU C: L R: III	RF Sources: P: Both RF sources use very low power RF, and so neither pose any RF risk P: Both RF sources went through the ORC process prior to being operated UV sources: M: the UV source in the cleanroom is very low power (like a flashlight), and requires no special PPE or procedures M: the UV source in the UPW system is enclosed and cannot expose individuals when it is operating, and it is only serviced by an outside company	RF Sources: L: BEU C: L R: IV UV sources: L: EU 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** ≥ 25.0 rem	**C** ≥ 100 rem	**C** ≥ 100 rem
M	25.0 rem > **C** ≥ 5 rem	100 rem > **C** ≥ 25 rem	100 rem > **C** ≥ 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 2.2 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: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. The residual activated material poses a health and safety hazard.*	L: A C: H R: I	P: All staff are required to take GERT training P: All buildings are identified at their entrances regarding the radioactive status P: Specific areas where work on radioactive materials is being performed are usually identified and chained off P: All impacted materials are surveyed and tagged with appropriate class P: "Invasive" work on a radioactive device is often performed in a separate building (IB2A) P: Class 2, or higher, devices require ALD approval before being moved into APS-TD facilities M: Materials are surveyed upon arrival at the "next facility", and if something is identified as radioactive that wasn't previously known, we can trace its history and perform any necessary cleanup	L: BEU C: M R: IV
Radioactive waste	*Hazard: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. Work to repair such devices generates radioactive waste, which poses a health and safety hazard.*	L: A C: H R: I	P: All staff are required to take GERT training P: All buildings are identified at their entrances regarding the radioactive status; all radioactive waste is identified/tagged as such P: All impacted materials are surveyed and tagged with appropriate class; "invasive" work on a radioactive device is often performed in a separate building (IB2A) P: Class 2, or higher, devices require ALD approval before being moved into APS-TD facilities P: All staff managing radioactive waste are identified and trained as Waste Generators M: before it leaves the site all waste is surveyed and anything that is found to be radioactive but was placed into the incorrect waste stream is traced back to its source and remediation is performed	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: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. The residual activated material can spread and cause contamination, which poses a health and safety hazard.*	L: A C: H R: I	P: All staff are required to take GERT training P: All buildings are identified at their entrances regarding the radioactive status P: All impacted materials are surveyed and tagged with appropriate class P: "Invasive" work on a radioactive device is often performed in a separate building (IB2A) P: Class 2, or higher, devices require ALD approval before being moved into APS-TD facilities M: Materials are surveyed upon arrival at the "next facility", and if something is identified as radioactive that wasn't previously known, we can trace its history and perform any necessary cleanup	L: BEU C: M R: IV
Radiation Generating Devices (RDGs)	*Hazard: APS-TD operates several RGDs (e.g. SEM, XRF alloy analyzer).*	L: U C: M R: I	P: all staff operating RGDs are required to be formally trained on their safe operation P: All staff operating RGDs are required to be Radiation Workers P: All RGDs have RWPs P: All RGDs in operation in APS-TD are commercial products with built-in shielding P: All trained operators inform those around to maintain proper distance when the RGD is being operated	L: BEU C: M R: IV
Non-ionizing Radiation - Lasers	*Hazard:* *Three pieces of equipment in APS-TD generate lasers: laser cutter in IB3A (class 4), laser tracker operated by QC (class 2), SQMS laser in ICB (class 3B)*	L: C: R:	See Section I Chapter 04	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Non-ionizing Radiation – RF and UV	*Hazard: RF Sources (SRF plasma processing, SQMS quantum labs)* *Two pieces of equipment in APS-TD generate UV: a source in the cleanrooms to detect organics, and a source in the ultra-pure water system in IB4*	RF sources: L: EU C: L R: III UV sources: L: EU C: L R: III	RF Sources: P: Both RF sources use very low power RF, and so neither pose any RF risk P: Both RF sources went through the ORC process prior to being operated UV sources: M: the UV source in the cleanroom is very low power (like a flashlight), and requires no special PPE or procedures M: the UV source in the UPW system is enclosed and cannot expose individuals when it is operating, and it is only serviced by an outside company	RF Sources: L: BEU C: L R: IV UV sources: L: EU 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** ≥ 25.0 rem	**C** ≥ 100 rem	**C** ≥ 100 rem
M	25.0 rem > **C** ≥ 5 rem	100 rem > **C** ≥ 25 rem	100 rem > **C** ≥ 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: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. The residual activated material poses a health and safety hazard.*	L: EU C: L R: IV	The public cannot access areas where there is residual activation, and so no further analysis is necessary.	L: EU C: L R: IV
Radioactive waste	*Hazard: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. Work to repair such devices generates radioactive waste, which poses a health and safety hazard.*	L: EU C: L R: IV	The public cannot access areas where there is radioactive waste, and so no further analysis is necessary.	L: EU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	*Hazard: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. The residual activated material can spread and cause contamination, which poses a health and safety hazard.*	L: EU C: L R: IV	P: Impacted materials are not taken offsite P: Individuals who are working in areas where there may be contamination are surveyed upon exiting the work area to ensure there is no contamination on them M: Any contamination found on an individual or their clothing is removed and cannot be taken offsite	L: BEU C: N R: IV
Radiation Generating Devices (RDGs)	*Hazard: APS-TD operates several RGDs (e.g. SEM, XRF alloy analyzer).*	L: EU C: L R: IV	P: All buildings are secured, and members of the public cannot access the area where the SEM is P: All RGDs in operation in APS-TD are commercial products with built-in shielding M: trained operators inform those around to maintain proper distance when the RGD (in this case the alloy analyzer in the extremely unlikely event it's being used outside in a public area) is being operated	L: BEU C: N R: IV
Non-ionizing Radiation - Lasers	*Hazard:* *Three pieces of equipment in APS-TD generate lasers: laser cutter in IB3A (class 4), laser tracker operated by QC (class 2), SQMS laser in ICB (class 3B)*	L: C: R:	See Section I Chapter 04	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Non-ionizing Radiation – RF and UV	*Hazard: RF Sources (SRF plasma processing, SQMS quantum labs)* *Two pieces of equipment in APS-TD generate UV: a source in the cleanrooms to detect organics, and a source in the ultra-pure water system in IB4*	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** ≥ 25.0 rem	**C** ≥ 100 rem	**C** ≥ 100 rem
M	25.0 rem > **C** ≥ 5 rem	100 rem > **C** ≥ 25 rem	100 rem > **C** ≥ 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)
Lead	*Hazard: Potential exposure to lead dust during manual handling of un-encased lead bricks, lead shot, and lead sheets.* *The only lead shielding in use in APS-TD is on the very rare occasion when we use lead-lined blankets to shield a Class 2, or higher, magnet while it is being repaired.* *Lead-based solder is used to make electrical connections.* *Lead Paint (old magnets)*	L: U C: M R: II	P: FESHM 4200 controls the use of lead-based materials; when needed, lead-lined blankets used for shielding are fully enclosed and so there is no personnel exposure. P: Lead handling training P: Lead-based soldering is done in well-ventilated areas. M: Lead-based solder continues to be used less frequently M: XRF alloy analyzer is used to confirm presence of lead in paint in old magnets, which is followed up by official sampling by IH M: PPE for the grit blast booth operator prevents any chance of inhalation in the event there is any lead present	L: EU C: L R: IV
Beryllium	*Hazard: Potential exposure to beryllium dust during manual handling of un-encased, or machining dusts from fabrication shop activities.*	L: U C: M R: I	P: FESHM 4190 controls the use of Beryllium and its alloys P: All staff who handle Beryllium are required to be formally trained P: No machining or welding of Beryllium or its alloys is allowed M: All Beryllium alloy components used in APS-TD are “articles”, and so present no risk for airborne contamination and are outside the DOE program requirements	L: BEU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hydrofluoric Acid	*Hazard: HF is used in both the IB4 Cavity Processing Lab (CPL) and in the MDTL*	L: A C: H R: I	P: all operations involving HF are tightly controlled with written procedures, formal training and qualifications (including on emergency response), and must be pre-authorized M: the amount of HF is limited to ~ one 30-gallon drum of electrolyte being received and sent for waste each month for CPL, and only liters for MDTL M: safety showers and eyewash stations are in each facility M: All staff using HF must wear PPE; safety showers and eyewash stations are in each facility	L: U C: L I: III
Nanoparticle Exposures	*Hazard: Airborne exposure*	L: C: R:	See Section I Chapter 04	L: C: R:

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** ≥ PAC-2	**C** ≥ PAC-3	**C** ≥ IDLH
M	PAC-2 > **C** ≥ PAC-1	PAC-3 > **C** ≥ PAC-2	IDLH > **C** ≥ 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 2.5 Toxic Materials – Onsite 2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	*Hazard: Potential exposure to lead dust during manual handling of un-encased lead bricks, lead shot, and lead sheets.* *The only lead shielding in use in APS-TD is on the very rare occasion when we use lead-lined blankets to shield a Class 2, or higher, magnet while it is being repaired.* *Lead-based solder is used to make electrical connections.* *Lead Paint (old magnets)*	L: U C: H R: I	P: FESHM 4200 controls the use of lead-based materials; when needed, lead-lined blankets used for shielding are fully enclosed and so there is no personnel exposure. P: Lead-based soldering is done in well-ventilated areas. M: Lead-based solder continues to be used less frequently M: XRF alloy analyzer is used to confirm presence of lead in paint in old magnets, which is followed up by official sampling by IH	L: EU C: M R: III
Beryllium	*Hazard: Potential exposure to beryllium dust during manual handling of un-encased, or machining dusts from fabrication shop activities.*	L: U C: L R: I	P: FESHM 4190 controls the use of Beryllium and its alloys P: All staff who handle Beryllium are required to be formally trained P: No machining or welding of Beryllium or its alloys is allowed M: All Beryllium alloy components used in APS-TD are “articles”, and so present no risk for airborne contamination and are outside the DOE program requirements	L: BEU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hydrofluoric Acid	*Hazard: HF is used in both the IB4 Cavity Processing Lab (CPL) and in the MDTL*	L: U C: M R: I	P: all operations involving HF are tightly controlled with written procedures, formal training and qualifications (including on emergency response), and must be pre-authorized P: No co-located workers are allowed in areas when HF is in use M: the amount of HF is limited to ~ one 30-gallon drum of electrolyte being received and sent for waste each month for CPL, and only liters for MDTL M: safety showers and eyewash stations are in each facility	L: BEU C: L I: IV
Nanoparticle Exposures	*Hazard: Airborne exposure*	L: C: R:	See Section I Chapter 04	L: C: R:

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** ≥ PAC-2	**C** ≥ PAC-3	**C** ≥ IDLH
M	PAC-2 > **C** ≥ PAC-1	PAC-3 > **C** ≥ PAC-2	IDLH > **C** ≥ 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 2.6 Toxic Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	*Hazard: Potential exposure to lead dust during manual handling of un-encased lead bricks, lead shot, and lead sheets.* *The only lead shielding in use in APS-TD is on the very rare occasion when we use lead-lined blankets to shield a Class 2, or higher, magnet while it is being repaired.* *Lead-based solder is used to make electrical connections.* *Lead Paint (old magnets)*	L: C: R:	See Section I Chapter 04	L: C: R:
Beryllium	*Hazard: Potential exposure to beryllium dust during manual handling of un-encased, or machining dusts from fabrication shop activities.*	L: C: R:	See Section I Chapter 04	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hydrofluoric Acid	*Hazard: HF is used in both the IB4 Cavity Processing Lab (CPL) and in the MDTL*	L: U C: L R: III	P: all buildings are secured, and guests are only allowed with an escort; all operations involving HF are tightly controlled with written procedures, formal training and qualifications (including on emergency response), and must be pre-authorized P: no members of the public are allowed in areas where HF is used M: the amount of HF is limited to ~ one 30-gallon drum of electrolyte being received and sent for waste each month for CPL, and only liters for MDTL M: Safety showers and eyewash stations are in each facility	L: BEU C: N I: IV
Nanoparticle Exposures	*Hazard:* *Airborne exposure*	L: C: R:	See Section I Chapter 04	L: C: R:

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** ≥ PAC-2	**C** ≥ PAC-3	**C** ≥ IDLH
M	PAC-2 > **C** ≥ PAC-1	PAC-3 > **C** ≥ PAC-2	IDLH > **C** ≥ 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.)	*Hazard: Combustible materials can ignite under certain circumstances*	L: A C: H R: I	P: regular housekeeping P: area inspections M: smoke detectors M: fire suppression systems M: onsite Fire Department; M: employee evacuation training/drills M: all staff know to call x3131 in an emergency	L: EU C: N R: IV
Flammable Materials (Flammable gas, cleaning materials, etc.)	*Hazard: Fire under certain circumstances*	L: A C: H R: I	P: flammable materials are stored in flame-proof cabinets when not in use P: area inspections P: Hot Work program administered by the Fire Department M: smoke detectors M: fire suppression systems M: onsite Fire Department M employee evacuation training/drills M: all staff know to call x3131 in an emergency	L: EU C: N 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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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.)	*Hazard: Combustible materials can ignite under certain circumstances*	L: A C: H R: I	P: regular housekeeping P: area inspections M: smoke detectors M: fire suppression systems M: onsite Fire Department; M: employee evacuation training/drills M: all staff know to call x3131 in an emergency	L: EU C: N R: IV
Flammable Materials (Flammable gas, cleaning materials, etc.)	*Hazard: Fire under certain circumstances*	L: A C: H R: I	P: flammable materials are stored in flame-proof cabinets when not in use P: area inspections P: Hot Work program administered by the Fire Department M: smoke detectors M: fire suppression systems M: onsite Fire Department M employee evacuation training/drills M: all staff know to call x3131 in an emergency	L: EU C: N 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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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.)	Hazard: Combustible materials can ignite under certain circumstances	L: U C: L R: III	P: all buildings are secured and locked P: all guests must be escorted P: regular housekeeping P: area inspections M: smoke detectors M: fire suppression systems M: onsite Fire Department	L: BEU C: N R: IV
Flammable Materials (Flammable gas, cleaning materials, etc.)	Hazard: Fire under certain circumstances	L: U C: L R: III	P: all buildings are secured and locked P: all guests must be escorted P: flammable materials are stored in flame-proof cabinets when not in use P: area inspections P: Hot Work program administered by the Fire Department P: EPHS demonstrates no risk of offsite releases to the public M: smoke detectors M: fire suppression systems M: onsite Fire Department	L: BEU C: N 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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: unexpected shock from capacitors/transformers/devices from infrastructure, testing equipment, and energized magnets.*	L: C: R:	See Section I Chapter 04 (non-interlocked enclosures)	L: C: R:
High Voltage Exposure	*Hazard: arc flash, electrocution, or burns from infrastructure, testing equipment, and energized magnets*	L: C: R:	See Section I Chapter 04 (non-interlocked enclosures)	L: C: R:
Low Voltage, High Current Exposure.	*Hazard: arc flash, electrocution, or burns from infrastructure, testing equipment, and energized magnets*	L: C: R:	See Section I Chapter 04 (non-interlocked enclosures)	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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 2.11 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	*Hazard: unexpected shock from capacitors/transformers/devices from infrastructure, testing equipment, and energized magnets.*	L: C: R:	See Section I Chapter 04 (non-interlocked enclosures)	L: C: R:
High Voltage Exposure	*Hazard: arc flash, electrocution, or burns from infrastructure, testing equipment, and energized magnets*	L: C: R:	See Section I Chapter 04 (non-interlocked enclosures)	L: C: R:
Low Voltage, High Current Exposure.	*Hazard: arc flash, electrocution, or burns from infrastructure, testing equipment, and energized magnets*	L: C: R:	See Section I Chapter 04 (non-interlocked enclosures)	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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 2.12 Electrical Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy Exposure	*Hazard: unexpected shock from capacitors/transformers/devices from infrastructure, testing equipment, and energized magnets.*	L: C: R:	See Section I Chapter 04	L: C: R:
High Voltage Exposure	*Hazard: arc flash, electrocution, or burns from infrastructure, testing equipment, and energized magnets*	L: C: R:	See Section I Chapter 04	L: C: R:
Low Voltage, High Current Exposure.	*Hazard: arc flash, electrocution, or burns from infrastructure, testing equipment, and energized magnets*	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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 2.13 Thermal Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Bakeout	*Hazard: in the context of APS-TD, bakeouts may be done on individual magnets (e.g. Lambertsons), using heaters, power supplies, and insulating materials. This presents electrical and heat-related hazards. It is not performed very often (perhaps once every few years).*	L: U C: M R: II	P: bakeouts are performed using approved procedures through WPC/ORC; equipment approved by electrical safety; equipment has overcurrent protection M: the area where the bakeout is occurring is roped off, with signage stating not to enter	L: BEU C: L R: IV
Hot Work	*Hazard: Welding, brazing, torch cutting, and grinding can produce thermal burns or fire from sparks or slag.* *Welding also produces UV radiation, and also risk of exposure to Hexavalent Chromium when welding stainless steels.* *Fuels used in brazing and torch cutting can be explosive.*	L: A C: M R: I	P: Hot Work Permits are required for all welding, brazing, torch cutting, and grinding activities (FESHM 6020.2) P: only qualified welders perform welding; P: PPE is required for all hot work activities; P: proper ventilation is required and verified when welding stainless, and this includes environmental monitoring M: flash-back arrestors are required for oxyacetylene tanks; M: onsite emergency services	L: EU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenics	*Hazard: Liquid Nitrogen and Liquid Helium in cryogenic vessels/dewars and systems*	L: A C: H R: I	P: Pressure, piping, and vacuum systems require Engineering Notes per various FESHM chapters; P: all in-house systems are fabricated using BPVC Section IX qualified welding procedures and welders; P: all dewars are commercially-made; P: all new or modified cryogenic systems require an ORC to be operated; P: personnel handling cryogens have formal training; P: personnel must be medically qualified to enter ODH spaces M: all systems have relief valves; M: all ODH areas have Oxygen monitors/alarms; M: onsite emergency services	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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 2.14 Thermal Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Bakeouts	Hazard: in the context of APS-TD, bakeouts may be done on individual magnets (e.g. Lambertsons), using heaters, power supplies, and insulating materials. This presents electrical and heat-related hazards. It is not performed very often (perhaps once every few years).	L: U C: M R: II	P: bakeouts are performed using approved procedures through WPC/ORC P: equipment approved by electrical safety P: equipment has overcurrent protection M: the area where the bakeout is occurring is roped off, with signage stating not to enter	L: BEU C: L R: IV
Hot Work	Hazard: Welding, brazing, torch cutting, and grinding can produce thermal burns or fire from sparks or slag. Welding also produces UV radiation, and also risk of exposure to Hexavalent Chromium when welding stainless steels. Fuels used in brazing and torch cutting can be explosive.	L: A C: M R: I	P: Hot Work Permits are required for all welding, brazing, torch cutting, and grinding activities (FESHM 6020.2) P: only qualified welders perform welding P: PPE is required for all hot work activities P: proper ventilation is required and verified when welding stainless, and this includes environmental monitoring P: welding screens are used to protect personnel outside the welding area M: flash-back arrestors are required for oxyacetylene tanks M: onsite emergency services	L: BEU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenic Liquids	Hazard: Liquid Nitrogen and Liquid Helium in cryogenic vessels/dewars and systems	L: A C: H R: I	P: Pressure, piping, and vacuum systems require Engineering Notes per various FESHM chapters P: all in-house systems are fabricated using BPVC Section IX qualified welding procedures and welders P: all dewars are commercially-made P: all new or modified cryogenic systems require an ORC to be operated P: personnel handling cryogens have formal training M: all systems have relief valves M: all ODH areas have Oxygen monitors/alarms M: onsite emergency services	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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)
Bakeouts	*Hazard: in the context of APS-TD, bakeouts may be done on individual magnets (e.g. Lambertsons), using heaters, power supplies, and insulating materials. This presents electrical and heat-related hazards. It is not performed very often (perhaps once every few years).*	L: U C: L R: III	P: all buildings are secured, and all guests are required to be escorted P: bakeouts are performed using approved procedures through WPC/ORC P: equipment approved by electrical safety P: equipment has overcurrent protection M: the area where the bakeout is occurring is roped off, with signage stating not to enter	L: BEU C: N R: IV
Hot Work	*Hazard: Welding, brazing, torch cutting, and grinding can produce thermal burns or fire from sparks or slag.* *Welding also produces UV radiation, and also risk of exposure to Hexavalent Chromium when welding stainless steels.* *Fuels used in brazing and torch cutting can be explosive.*	L: U C: L R: III	P: all buildings are secured, and all guests are required to be escorted P: Hot Work Permits are required for all welding, brazing, torch cutting, and grinding activities (FESHM 6020.2) P: only qualified welders perform welding P: proper ventilation is required and verified when welding stainless, and this includes environmental monitoring P: welding screens are used to protect personnel outside the welding area M: flash-back arrestors are required for oxyacetylene tanks M: onsite emergency services	L: BEU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenics	*Hazard: Liquid Nitrogen and Liquid Helium in cryogenic vessels/dewars and systems*	L: U C: L R: III	P: all buildings are secured, and all guests are required to be escorted P: pressure, piping, and vacuum systems require Engineering Notes per various FESHM chapters P: all in-house systems are fabricated using BPVC Section IX qualified welding procedures and welders P: all dewars are commercially-made P: all new or modified cryogenic systems require an ORC to be operated P: personnel handling cryogens have formal training M: all systems have relief valves M: all ODH areas have Oxygen monitors/alarms M: onsite emergency services	L: BEU C: N 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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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 2.16 Kinetic Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power tools	Hazard: Various hand tools used in assembly of magnets, cavities, and cryoassemblies. Various machine tools (mills, lathes) used in Tech and Machine Shops. All have potential to injure people if not being used properly.	L: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors	Hazard: Various pumps and motors used in the assembly of magnets, cavities, and cryoassemblies.	L: C: R:	See Section I Chapter 04	L: C: R:
Motion Tables	Hazard: Motion tables used in the assembly of coils for magnets can create pinch points and crushing hazards.	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: Various hand tools used in assembly of magnets, cavities, and cryoassemblies.* *Various machine tools (mills, lathes) used in Tech and Machine Shops.* *All have potential to injure people if not being used properly.*	L: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors	*Hazard: Various pumps and motors used in the assembly of magnets, cavities, and cryoassemblies.*	L: C: R:	See Section I Chapter 04	L: C: R:
Motion Tables	*Hazard: Motion tables used in the assembly of coils for magnets can create pinch points and crushing hazards.*	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: Various hand tools used in assembly of magnets, cavities, and cryoassemblies.* *Various machine tools (mills, lathes) used in Tech and Machine Shops.* *All have potential to injure people if not being used properly.*	L: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors	*Hazard: Various pumps and motors used in the assembly of magnets, cavities, and cryoassemblies.*	L: C: R:	See Section I Chapter 04	L: C: R:
Motion Tables	*Hazard: Motion tables used in the assembly of coils for magnets can create pinch points and crushing hazards.*	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: Most APS-TD buildings have overhead cranes, either rail or jib.*	L: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses	*Hazard: Compressed gases are used throughout APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.*	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum/ Pressure Vessels	*Hazard: Vacuum/pressure vessels are used throughout APS-TD, and are fabricated by APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.*	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	*Hazard: Vacuum pumps are used throughout APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.*	L: C: R:	See Section I Chapter 04	L: C: R:

Material Handling	*Hazard: Materials are moved almost constantly throughout APS-TD, using vehicles, forklift trucks, pallet jacks, and by hand. Hazards include injury from falling objects, crushing hands or feet, driving accidents, physical strain.*	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: Most APS-TD buildings have overhead cranes, either rail or jib.*	L: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses	*Hazard: Compressed gases are used throughout APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.*	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum/ Pressure Vessels	*Hazard: Vacuum/pressure vessels are used throughout APS-TD, and are fabricated by APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.*	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	*Hazard: Vacuum pumps are used throughout APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.*	L: C: R:	See Section I Chapter 04	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Material Handling	*Hazard: Materials are moved almost constantly throughout APS-TD, using vehicles, forklift trucks, pallet jacks, and by hand. Hazards include injury from falling objects, crushing hands or feet, driving accidents, physical strain.*	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: N/A*	L: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses	*Hazard: Compressed gases are used throughout APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.*	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum/ Pressure Vessels	*Hazard: Vacuum/pressure vessels are used throughout APS-TD, and are fabricated by APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.*	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	*Hazard: N/A*	L: C: R:	See Section I Chapter 04	L: C: R:
Material Handling	*Hazard: N/A*	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: Exposure to fringe fields beyond allowable limits (worker **with** ferromagnetic or electronic medical device(s))*	L: A C: H R: I	P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, helping to prevent workers from accessing the hazard. P: Electromagnets are de-energized prior to worker entry using LOTO procedure. M: Employees self-identify (to their supervisor and Medical) as having an implanted medical device, and are provided information regarding how to protect themselves from fringe fields.	L: EU C: M R: III
	*Exposure to fringe fields beyond allowable limits (worker **without** ferromagnetic or electronic medical device(s))*	L: A C: L R: III	P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, to prevent workers from accessing the hazard. P: Electromagnets are de-energized prior to worker entry using LOTO procedure.	L: EU C: L R: IV
	Exposure to flying metallic objects causing potential injury. Ferromagnetic bricks used in the assembly of permanent magnets can pose a pinching or crushing hazard.	L: A C: M R: II	P: WPC P: SOP P: OJT P: Use of nonmagnetic tooling when necessary M: PPE	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: Exposure to fringe fields beyond allowable limits (worker **with** ferromagnetic or electronic medical device(s))*	L: A C: H R: I	P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, to prevent workers from accessing the hazard. P: Electromagnets are de-energized prior to worker entry using LOTO procedure. M: Employees self-identify (to their supervisor and Medical) as having an implanted medical device, and are provided information regarding how to protect themselves from fringe fields.	L: EU C: M R: III
	*Exposure to fringe fields beyond allowable limits (worker **without** ferromagnetic or electronic medical device(s))*	L: A C: L R: III	P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, to prevent workers from accessing the hazard. P: Magnets are de-energized prior to worker entry using LOTO procedure.	L: EU C: L R: IV
	Exposure to flying metallic objects causing potential injury. Ferromagnetic bricks used in the assembly of permanent magnets can pose a pinching or crushing hazard.	L: U C: M R: II	P: Use of nonmagnetic tooling when necessary P: Co-located workers are not handling permanent magnets, and so have no risk of being pinched/crushed.	L: EU C: M R: III

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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: Exposure to fringe fields beyond allowable limits (worker **with** ferromagnetic or electronic medical device(s))*	L: U C: H R: I	P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, to prevent workers from accessing the hazard. P: Electromagnets are de-energized prior to worker entry using LOTO procedure.	L: BEU C: H R: III
	*Exposure to fringe fields beyond allowable limits (worker **without** ferromagnetic or electronic medical device(s))*	L: U C: L R: III	P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, to prevent workers from accessing the hazard. P: Magnets are de-energized prior to worker entry using LOTO procedure.	L: BEU C: L R: IV
	Exposure to flying metallic objects causing potential injury. Ferromagnetic bricks used in the assembly of permanent magnets can pose a pinching or crushing hazard.	L: U C: M R: II	P: Use of nonmagnetic tooling when necessary P: MOI individuals are not handling permanent magnets, and so have no risk of being pinched/crushed.	L: BEU C: M 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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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 2.25 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	*Hazard: Toxic atmosphere* *Limited egress* *Poor quality walking surface*	L: C: R:	See Section I Chapter 04	L: C: R:
Noise	*Hazard: facility infrastructure (e.g. motors, pumps, HVAC), and various machinery (e.g. water jet machines, grinding operations) can generate loud noises which pose a hazard for hearing damage.*	L: C: R:	See Section I Chapter 04	L: C: R:
Silica	*Hazard: Airborne exposure above OEL via concrete (or similar material) machining, moving dirt or gravel* *In APS-TD Fumed Silica is used in very small quantities, on very rare occasions, as part of making a small batch of epoxy for magnet repairs.* *Note: the water jet machines in the Machine Shop use garnet, and the grit blast booth in IB2 uses Aluminum Oxide (i.e. neither use Silica).*	L: A C: H R: I L: U C: M R: II	Concrete: P: Silica Awareness Training, Respiratory Protection Training P: Work Planning (HA, SOP) M: Engineering Controls (HEPA, wet method) M: PPE (respirator, PAPR) Fumed Silca: M: N95 masks are worn when mixing in fumed silica	L: EU C: N R: IV L: U C: L R: III

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Ergonomics	*Hazard: with all the material moving, assembly and testing work, and computer-based work in APS-TD, ergonomics (or lack thereof) poses a risk for injury from repetitive motion, improper alignment, reaching/straining, etc.*	L: C: R:	See Section I Chapter 04	L: C: R:
Working at Heights	*Hazard: Falls, dropped tools/material*	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: Toxic atmosphere* *Accidental entry*	L: C: R:	See Section I Chapter 04	L: C: R:
Noise	*Hazard: facility infrastructure (e.g. motors, pumps, HVAC), and various machinery (e.g. water jet machines, grinding operations) can generate loud noises which pose a hazard for hearing damage.*	L: C: R:	See Section I Chapter 04	L: C: R:
Silica	*Hazard: Airborne exposure above OEL via concrete (or similar material) machining, moving dirt or gravel* *In APS-TD Fumed Silica is used in very small quantities, on very rare occasions, as part of making a small batch of epoxy for magnet repairs.* *Note: the water jet machines in the Machine Shop use garnet, and the grit blast booth in IB2 uses Aluminum Oxide (i.e. neither use Silica).*	L: A C: H R: I L: U C: M R: II	Concrete: P: Work Planning (HA, SOP) P: Work oversite (Work planner, ESH) M: Engineering Controls (HEPA, wet method) Fumed Silica: M: Co-located workers are not near enough the mixing to be exposed	L: EU C: M R: III L: U C: L R: III
Ergonomics	*Hazard: N/A*	L: C: R:	See Section I Chapter 04	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Working at Heights	*Hazard: Struck by dropped tools/material*	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: N/A (all confined spaces in APS-TD are inside secured buildings)*	L: C: R:	N/A	L: C: R:
Noise	*Hazard: facility infrastructure (e.g. motors, pumps, HVAC), and various machinery (e.g. water jet machines, grinding operations) can generate loud noises which pose a hazard for hearing damage.*	L: C: R:	See Section I Chapter 04	L: C: R:
Silica	*Hazard:* *Airborne exposure above OEL via concrete (or similar material) machining, moving dirt or gravel*	L: C: R:	See Section I Chapter 04	L: C: R:
Ergonomics	*Hazard: N/A*	L: C: R:	See Section I Chapter 04	L: C: R:
Working at Heights	*Hazard: Struck by dropped tools/material*	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** ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	**C** ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
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 > **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	*Hazard: Airborne release of radionuclides beyond permitted limits.* *Airborne release of chemicals beyond permitted limits* *(Consequences based on Onsite Worker qualitative consequence matrix)*	L: C: R: L: C: R:	Radionuclide release: N/A Chemical release: See Section I Chapter 04	L: C: R: L: C: R:
Water	*Hazard: Discharge of radionuclides into onsite surface waters beyond permitted limits.* *Discharge of chemicals into onsite surface waters beyond permitted limits. (Consequence based on Onsite worker qualitative consequence matrix)*	L: C: R: L: C: R:	Radionuclide release: N/A Chemical release: See Section I Chapter 04	L: C: R: L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Soil	*Hazard: Radioactive soil in beam loss areas beyond allowable concentrations of radionuclides above Fermilab limits.*	L: C: R:	Radionuclide release: N/A	L: C: R:
	Discharge of chemicals into onsite soils beyond permitted limits.	L: C: R:	Chemical release: See Section I Chapter 04	L: C: R: