Table 2. Summary of Baseline and Residual Risks – 400 MeV Test Area (MTA)/ITA

	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: III
2.3	Radiological – MOI Offsite	R: I	R: III
2.4	Toxic Materials – Onsite 1 Facility Worker	R: *	R: *
2.5	Toxic Materials – Onsite 2 Co-located Worker	R: *	R: *
2.6	Toxic Materials – MOI Offsite	R: *	R: *
2.7	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: *	R: *
2.8	Flammable & Combustible Materials – Onsite-2 Co-located worker	R: *	R: *
2.9	Flammable & Combustible Materials – MOI Offsite	R: *	R: *
2.10	Electrical Energy – Onsite-1 Facility Worker	R: *	R: *
2.11	Electrical Energy – Onsite-2 Co-located Worker	R: *	R: *
2.12	Electrical Energy – MOI Offsite	R: *	R: *
2.13	Thermal Energy – Onsite-1 Facility Worker	R: I	R: IV
2.14	Thermal Energy – Onsite-2 Co-located Worker	R: I	R: IV
2.15	Thermal Energy – MOI Offsite	R: I	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	Other Hazards – Onsite-1 Facility Worker	R: *	R: *
2.23	Other Hazards – Onsite-2 Co-located Worker	R: *	R: *
2.24	Other Hazards – MOI Offsite	R: *	R: *
2.25	Access & Egress – Onsite-1 Facility Worker	R: *	R: *
2.26	Access & Egress – Onsite-2 Co-located Worker	R: *	R: *
2.27	Access & Egress – MOI Offsite	R: *	R: *
2.28	Environmental Hazards	R: *	R: *

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

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

Table 2.1 Radiological – Onsite-1 Facility Worker

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

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Groundwater Activation	*Hazard: exposure to radionuclides in ground water exceed regulatory levels*	L: A C: H R: I	P – Monitoring Wells: Wells that are drilled near accelerator enclosures in areas that are sensitive to potential aquifer contamination. These wells are periodically sampled and analyzed by ES&H to ensure the aquifer is not becoming contaminated from accelerator operations. P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated. P – Beam loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components. M – Machine Protection System: An accelerator system that monitors devices such as beam loss monitors, power supplies, vacuum valves, etc. If these devices are not within their specified limits, the beam is aborted and further injections into the accelerator are inhibited until the system is reset by an operator. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered	L: BEU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Surface Water Activation	*Hazard: exposure to radionuclides in surface water exceed regulatory levels*	L: A C: H R: I	P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated prior to removing the water from the enclosure. P – Sump Monitoring Program; Sump water samples are periodically collected and measured for radiological activation. If activation is found in the sump sample, we have the ability to look for the root cause before additional water is pumped to the surface. P– Beam Loss Monitoring Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components. M – Machine Protection System: An accelerator system that monitors devices such as beam loss monitors, power supplies, vacuum valves, etc. If these devices are not within their specified limits, the beam is aborted and further injections into the accelerator are inhibited until the system is reset by an operator. M – Pond Monitoring Program: Samples taken from the ponds and measured for activation. Sump water from the tunnel is discharged into these ponds. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	L: BEU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Air Activation	*Hazard: radionuclides in air exceed regulatory levels*	L: A C: H R: I	P – Air Monitoring: Air sampled from the enclosure for activation P– Beam loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components. M – Engineered air flow to dilute activated air and provide cool off (decay) time prior to release M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. M – Engineered Air Flow: Enclosure air flow design to give the activated air time to decay before exiting the enclosure.	L: EU C: N R: IV
Soil Interactions	*Hazard: radionuclides are produced by beam interactions which may contaminate ground water*	L: A C: N R: IV	P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components. M – Engineered Beam Dump: Design of a beam absorber that minimizes the radiological leakage through the use of shielding. M – Beamline Design: Design of beamline optics to ensure that the actual beam size is smaller than the beam pipe to prevent scraping, beam loss, prompt dose, and residual activation. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	L: U C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive waste	*Hazard: persons are exposed to ionizing radiation beyond regulatory levels*	L: A C: L R: III	P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates. P – Key Control Program: A program that checks the worker's training prior to issuing them a key to the accelerator enclosure. Also keeps track of worker accountability. P – Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. M – Distance to Stored Material: Barriers, such as ropes, that are used to increase the distance between the activated material and personnel.	L: BEU C: N R: IV
Contamination	*Hazard: persons are exposed to ionizing radiation beyond regulatory levels*	L: A C: H R: I	P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates. P – Key Control Program: A program that checks the worker's training prior to issuing them a key to the accelerator enclosure. Also keeps track of worker accountability. M – Radiological Work Permit: A permit written by Safety that specifies the work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure. M – Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing.	L:EU C: L R: IV
^{7}Be	*Hazard: Potential radiation exposure to 7Be (uptake/committed dose).*	L: A C: N R: IV	No prevention or mitigation is required. ^{7}Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Sources	*Hazard: Persons exposed to ionizing radiation beyond regulatory levels*	L: A C: H R: I	P – Radiological Signage on or Near Source Cabinets: Signs give warning of the presence of radioactive sources. P – Radiological Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. P – Kept Under Lock-and-key: Radioactive sources are kept in locked storage, where key issuance is a controlled process. M – Kept In Storage: Unused radioactive sources are kept in storage, which prevents the close proximity of these sources and people. M – Shielded Containers: Unused high activity sources are stored within shielded containers.	L: BEU C: L R: IV
Non-Ionizing Radiation Hazards	*Hazard: Hazard: Exposure to Class 3B and 4 lasers*	L: A C: H R: I	P: Class 1 (light tight) enclosures P: Locked/Interlocked system or administrative control approved by the LSO P: LOTO procedure or other procedure approved by the LSO P: Affected areas are posted	L: BEU C: N R: IV
	Exposure to Class 3R lasers	L: A C: L R: III	No analysis required	L: A C: L R: III
	Exposure to Class 1 and 2 Lasers	L: A C: N R: IV	No analysis required	L: A C: N R: IV

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type

  P = Preventive (reduce event occurrence likelihood)

  M = Mitigative (reduces event consequences)

Acronyms

  MOI = Maximally-exposed Offsite Individual

  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

Table 2.2 Radiological – Onsite-2 Co-located Worker

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

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Groundwater Activation	*Hazard: exposure to radionuclides in ground water exceed regulatory levels*	L: A C: H R: I	P – Monitoring Wells: Wells that are drilled near accelerator enclosures in areas that are sensitive to potential aquifer contamination. These wells are periodically sampled and analyzed by ES&H to ensure the aquifer is not becoming contaminated from accelerator operations. P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated. P – Beam loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components. M – Machine Protection System: An accelerator system that monitors devices such as beam loss monitors, power supplies, vacuum valves, etc. If these devices are not within their specified limits, the beam is aborted and further injections into the accelerator are inhibited until the system is reset by an operator. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered	L: BEU C: M\L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Surface Water Activation	*Hazard: exposure to radionuclides in surface water exceed regulatory levels*	L: A C: H R: I	P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated prior to removing the water from the enclosure. P – Sump Monitoring Program; Sump water samples are periodically collected and measured for radiological activation. If activation is found in the sump sample, we have the ability to look for the root cause before additional water is pumped to the surface. P– Beam Loss Monitoring Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	L: BEU C: M R: IV
Air Activation	*Hazard: radionuclides in air exceed regulatory levels*	L: A C: H R: I	P – Air Monitoring: Air sampled from the enclosure for activation P– Beam loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. M – Engineered Air Flow: Enclosure air flow design to give the activated air time to decay before exiting the enclosure.	L: EU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Soil Interactions	*Hazard: radionuclides are produced which may contaminate ground water*	L: A C: N R: IV	P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components. M – Engineered Beam Dump: Design of a beam absorber that minimizes the radiological leakage through the used of shielding. M – Beamline Design: Design of beamline optics to ensure that the actual beam size is smaller than the beam pipe to prevent scraping, beam loss, prompt dose, and residual activation. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	L: U C: N R: IV
Radioactive waste	*Hazard: persons are exposed to ionizing radiation beyond regulatory levels*	L: A C: L R: III	P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates. P – Key Control Program: A program that checks the worker's training prior to issuing them a key to the accelerator enclosure. Also keeps track of worker accountability. P – Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. M – Distance to Stored Material: Barriers, such as ropes, that are used to increase the distance between the activated material and personnel.	L:BEU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	*Hazard: persons are exposed to ionizing radiation beyond regulatory levels*	L: A C: H R: I	P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates. P – Key Control Program: A program that checks the worker's training prior to issuing them a key to the accelerator enclosure. Also keeps track of worker accountability. M – Radiological Work Permit: A permit written by Safety that specifies the work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure. M – Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing.	L:EU C: L R: IV
^{7}Be	*Hazard: Potential radiation exposure to 7Be (uptake/committed dose).*	L: A C: N R: IV	No prevention or mitigation is required. ^{7}Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV
Radioactive Sources	*Hazard: Persons are* exposed to ionizing radiation beyond regulatory levels	L: A C: H R: I	P – Radiological Signage On Or Near Source Cabinets: Signs give warning of the presence of radioactive sources. P – Radiological Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. P – Kept Under Lock-and-key: Radioactive sources are kept in locked storage, where key issuance is a controlled process. M – Kept In Storage: Unused radioactive sources are kept in storage, which prevents the close proximity of these sources and people. M – Shielded Containers: Unused high activity sources are stored within shielded containers.	L: BEU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Non-Ionizing Radiation Hazards	*Hazard: Exposure to Class 3B and 4 lasers*	L: A C: H R: I	P: Class 1 (light tight) enclosures P: ORC and work planning processes P: Locked/Interlocked system P: LOTO procedure or other procedure approved by the LSO P: Affected areas are posted M: Use of PPE	L: BEU C: L R: IV
	Exposure to Class 3R lasers	L: A C: L R: III	No analysis required	L: A C: L R: III
	Exposure to Class 1 and 2 Lasers	L: A C: N R: IV	No analysis required	L: A C: N R: IV

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)

Control(s) Type
  P = Preventive (reduce event occurrence likelihood)
  M = Mitigative (reduces event consequences)
Acronyms
  MOI = Maximally-exposed Offsite Individual
  rem = Roentgen equivalent man

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

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)
Prompt Ionizing Radiation	*Hazard: exposure to ionizing radiation*	L: BEU C: H R: III	P – Facility is locked and not accessible to the unescorted public. P – Shielding in place around the beam line and experiment enclosures per the relevant shield assessments P – Interlock system preventing access to beam enclosure while beam is present. P – Enclosure keys linked to radiological and controlled access training to enter enclosure	L: BEU C: H R: III
Residual activation	*Hazard: exposure to residual activation*	L: BEU C: H R: III	P – Facility is locked and not accessible to the unescorted public. P – Shielding in place around the beam line and experiment enclosures per the relevant shield assessments P – Interlock system preventing access to beam enclosure while beam is present. P – Enclosure keys linked to radiological and controlled access training to enter enclosure	L: BEU C: H R: III

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Groundwater Activation	*Hazard: radionuclides in ground water exceed regulatory levels*	L: A C: H R: I	P – Monitoring Wells: Wells that are drilled near accelerator enclosures in areas that are sensitive to potential aquifer contamination. These wells are periodically sampled and analyzed by ES&H to ensure the aquifer is not becoming contaminated from accelerator operations. P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated. P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated whit adjustment to the accelerators to prevent activation of tunnel components. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	L: BEU C: M R: IV
Surface Water Activation	*Hazard: radionuclides in surface water exceed regulatory levels*	L: A C: H R: I	P – Sump Pumps: Pumps located in the accelerator enclosure that have an underdrain network. The water is pumped to the surface, so it does not stagnate in the accelerator and becomes activated prior to removing the water from the enclosure. P – Sump Monitoring Program; Sump water samples are periodically collected and measured for radiological activation. If activation is found in the sump sample, we have the ability to look for the root cause before additional water is pumped to the surface. P– Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated whit adjustment to the accelerators to prevent activation of tunnel components. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	L: BEU C: M R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Air Activation	*Hazard: radionuclides in air exceed regulator levels*	L: BEU C: N R: IV	P – Facility is locked and not accessible to the unescorted public. P – Interlock system preventing access to beam enclosure while beam is present. P – Enclosure keys linked to radiological and controlled access training to enter enclosure	L: BEU C: N R: IV
Soil Interactions	*Hazard: radionuclides are produced which may contaminate ground water*	L: BEU C: N R: IV	P – Beam Loss Monitoring: Electronic Beam Loss Monitors are used to convert radiation created by prompt dose due to beam loss into electrical signals. This information is then made available to the accelerator control system where the data can be logged and monitored with alarms and limits. Losses can be reduced or eliminated with adjustment to the accelerators to prevent activation of tunnel components. M – Beamline Design: Design of beamline optics to ensure that the actual beam size is smaller than the beam pipe to prevent scraping, beam loss, prompt dose, and residual activation. M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.	L: BEU C: N R: IV
Radioactive waste	*Hazard: Persons are exposed to ionizing radiation beyond regulatory levels*	L: BEU C: H R: III	P – Facility is locked and not accessible to the unescorted public. M – Radiological shielding to limit exposure to radioactive waste.	L:BEU C:M R: IV
Contamination	*Hazard: Persons are exposed to ionizing radiation beyond regulatory levels*	L: BEU C: H R: III	P – Facility is locked and not accessible to the unescorted public. P – Radiological control prescreens items with contamination potential prior to acceptance. If contamination exists the item is rejected.	L:BEU C:H RIII

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

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

Likelihood (L, of event)/year
- **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	$C \geq 25.0$ rem	$C \geq 100$ rem	$C \geq 100$ rem
M	25.0 rem > $C \geq 5$ rem	100 rem > $C \geq 25$ rem	100 rem > $C \geq 25$ 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.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Beryllium *	*Hazard: Potential exposure to beryllium dust during manual handling of un-encased, activities.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Pseudocumene in Liquid Scintillator Oil	*Hazard: Airborne exposure via outgassing oil-*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Pseudocumene Delete	*Hazard: N/A*	L: C: R:		L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

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

Acronyms
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	$C \geq PAC\text{-}2$	$C \geq PAC\text{-}3$	$C \geq IDLH$
M	$PAC\text{-}2 > C \geq PAC\text{-}1$	$PAC\text{-}3 > C \geq PAC\text{-}2$	$IDLH > C \geq PEL$ or TLV_c
L	$PAC\text{-}1 > C$	$PAC\text{-}2 > C$	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

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.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Beryllium *	*Hazard: Potential exposure to beryllium dust during manual handling of un-encased, activities.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Pseudocumene in Liquid Scintillator Oil	*Hazard: Airborne exposure via outgassing oil*-	L: C: R:	See Section 1, Chapter 4	L: C: R:
Pseudocumene Delete	*Hazard:*	L: C: R:		L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**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	$C \geq$ PAC-2	$C \geq$ PAC-3	$C \geq$ IDLH
M	PAC-2 > $C \geq$ PAC-1	PAC-3 > $C \geq$ PAC-2	IDLH > $C \geq$ 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

		Likelihood			
		A	U	EU	BEU
Consequences	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.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Beryllium *	*Hazard: Potential exposure to beryllium dust during manual handling of un-encased, activities.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Pseudocumene in Liquid Scintillator Oil	*Hazard: <u>Airborne exposure via outgassing oil</u>-*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Pseudocumene Delete	*Hazard:*	L: C: R:		L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
P = Preventive (reduce event occurrence likelihood)	**H**	$C \geq$ PAC-2	$C \geq$ PAC-3	$C \geq$ IDLH
M = Mitigative (reduces event consequences)	**M**	PAC-2 > $C \geq$ PAC-1	PAC-3 > $C \geq$ PAC-2	IDLH > $C \geq$ PEL or TLV_c
Acronyms	**L**	PAC-1 > C	PAC-2 > C	PEL or TLV_c > C
IDLH = Immediately Dangerous to Life and Health	**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
MOI = Maximally-exposed Offsite Individual				
PAC = Protective Action Criteria				
PEL = Permissible Exposure Limit				
TLV_c = Threshold Limit Value (ceiling)				

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

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

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

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
   P = Preventive (reduce event occurrence likelihood)
   M = Mitigative (reduces event consequences)
Acronyms
   MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ≥ 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

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: This hazard is a potential facility fire.* *The presence of excessive combustible materials can pose a hazard stemming from inadequate housekeeping practices.* *This hazard can add to the fuel load of a potential facility fire.* *Poor housekeeping can also lead to life safety concerns, such as egress obstructions and tripping hazards.* *The exposure of the hazard to the facility worker is of major concern.*	L: C: R:	See Section 1, Chapter 4	L: C: R:

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

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**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

		Likelihood			
		A	U	EU	BEU
Consequences	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: The presence of excessive combustible materials can pose a hazard stemming from inadequate housekeeping practices.* *This hazard can add to the fuel load of a potential fire.* *Poor housekeeping can also lead to life safety concerns, such as egress obstructions and tripping hazards.* *The exposure of the hazard to the public is of minimal concern.*	L: C: R:	See Section 1, Chapter 4	L: C: R:

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

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
  P = Preventive (reduce event occurrence likelihood)
  M = Mitigative (reduces event consequences)
Acronyms
  MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ≥ 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

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: Shock hazard, >50 V, Non-interlocked enclosures* *Arc Flash, Non-interlocked enclosures*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Stored Energy Exposure	*Hazard: Shock hazard,>50 V, Interlocked enclosure area*		See Section 1, Chapter 4	L: C: R:
High Voltage Exposure	*Hazard: Shock hazard, voltage > 50 V, Non-interlocked enclosures* *Arc Flash, Non-interlocked enclosures*	L: C: R:	See Section 1, Chapter 4	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
High Voltage Exposure	*Hazard: Shock hazard, voltage > 50 V, Interlocked enclosures* *Arc Flash, Interlocked enclosures*		See Section 1, Chapter 4	
Low Voltage, High Current Exposure.	*Hazard: Arc Flash, Non-interlocked enclosures~~service building areas~~* *Fire hazard from high current causing smoke inhalation and burns.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Low Voltage, High Current exposure	*Hazard: Arc Flash, Interlocked enclosures* *Fire hazard from high current causing smoke inhalation and burns.*	L: C: R:	See Section 1, Chapter 4	L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**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

		Likelihood			
		A	U	EU	BEU
Consequences	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: Shock hazard, >50 V, Non-interlocked enclosures* *Arc Flash, Non-interlocked enclosures*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Stored Energy Exposure	*Harard: Shock hazard, >50 V, Interlocked enclosures~~beam line enclosure areas~~* *Arc Flash, Interlocked enclosures~~beam line enclosure areas~~*	L: C: R:	See Section 1, Chapter 4	L: C: R:
High Voltage Exposure	*Hazard: Shock hazard, voltage > 50 V, Non-interlocked enclosures* *Arc Flash, Non-interlocked enclosures*	L: C: R:	See Section 1, Chapter 4	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
High Voltage Exposure	*Hazard: Shock hazard, voltage > 50 V, Interlocked enclosures* *Arc Flash, Interlocked enclosures*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Low Voltage, High Current Exposure.	*Hazard: Arc Flash Non-interlocked enclosures* *Fire hazard from high current causing smoke inhalation and burns service building areas.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Low Voltage, High Current Exposure	*Hazard: Arc Flash, Interlocked enclosures* *Fire hazard from high current causing smoke inhalation and burns, beam line enclosure areas*	L: C: R:	See Section 1, Chapter 4	L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
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)	**H** = High **M** = Moderate **L** = Low **N** = Negligible	**I** = situation (event) of major concern **II** = situation (event) of concern **III** = situation (event) of minor concern **IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type		Consequence columns		
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

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: Shock hazard, >50 V, Arc flash*	L: C: R:	See Section 1, Chapter 4	L: C: R:
High Voltage Exposure	*Hazard: Shock hazard, >50 V, Arc flash outside*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Low Voltage, High Current Exposure.	*Hazard: N/A*	L: C: R:	No Further analysis required	L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
  P = Preventive (reduce event occurrence likelihood)
  M = Mitigative (reduces event consequences)
Acronyms
  MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	C ≥ 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

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)
Cryogenic	*Hazard: Hazard: Cryogenics are inherently a low risk on their own as they are non-flammable and non-toxic.* *However, if exposed to the cryogenic liquids, they have the potential of burning skin and creating an oxygen deficient atmosphere which can lead to death.* *The exposure of the hazard to the facility worker is of major concern.*	L:A C:H R:I	P – Cryogenic system designed and reviewed by qualified personnel P – WPC process provides instructions for use P - Protective clothing rules are enforced when working in areas with exposure to cryogenic liquids. P- Training required for all personnel handling cryogenics M – Onsite Emergency services are provided	L: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	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
  P = Preventive (reduce event occurrence likelihood)
  M = Mitigative (reduces event consequences)
Acronyms
  MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ≥ 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

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)
Cryogenic Liquids	*Hazard: Cryogenic liquids, such as liquid helium and nitrogen are inherently a low risk on their own as they are non-flammable and non-toxic.* *However, if exposed to the cryogenic liquids, they have the potential of burning skin and creating an oxygen deficient atmosphere which can lead to death.* *The exposure of the hazard to the co-located worker is of minimal concern.*	L:A C:H R:I	P – Cryogenic system designed and reviewed by qualified personnel P – WPC process provides instructions for use P - Protective clothing rules are enforced when working in areas with exposure to cryogenic liquids. P- Training required for all personnel handling cryogenics M – Onsite Emergency services are provided	L: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	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
   P = Preventive (reduce event occurrence likelihood)
   M = Mitigative (reduces event consequences)
Acronyms
   MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ≥ 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

Table 2.15 Thermal Energy – MOI Offsite

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

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
 P = Preventive (reduce event occurrence likelihood)
 M = Mitigative (reduces event consequences)
Acronyms
 MOI = Maximally-exposed Offsite Individual

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

Table 2.16 Kinetic Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power tools	*Hazard: Personnel injury due to improper use of power tools.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Pumps and Motors	*Hazard: Personnel injury due to entrapment/entanglement.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Motion Tables	*Hazard: Personnel injury due to pinch points, tip-overs, caught in between.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Mobile Shielding	*Hazard: Personnel injury due to pinch points, tip -overs, caught in between, crushing.*	L: C: R:	See Section 1, Chapter 4	L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**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

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

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

Likelihood (L, of event)/year		**Consequence (C, of event)/year**	**Risk (R, Qualitative Ranking)**
A = Anticipated (L > 1.0E-02)		**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)		**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)		**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
  P = Preventive (reduce event occurrence likelihood)
  M = Mitigative (reduces event consequences)
Acronyms
  MOI = Maximally-exposed Offsite Individual

C	**Offsite (MOI)**	**Onsite-2 (co-located worker)**	**Onsite-1 (facility worker)**
H	**C** ≥ 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**

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

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
  P = Preventive (reduce event occurrence likelihood)
  M = Mitigative (reduces event consequences)
Acronyms
  MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	C ≥ 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

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)
Compressed Gasses	*Hazard: Personnel injury due to unexpected release, or unsecure tanks.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Vacuum Pressure Vessels/Piping	*Hazard: Personnel injury due to unexpected pressure release.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Vacuum Pumps	*Hazard: Personnel injury due to interaction with existing vacuum.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Material Handling	*Hazard: Personnel injury due to moving/handing material (rollovers, crush, etc.)*	L: C: R:	See Section 1, Chapter 4	L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type

   P = Preventive (reduce event occurrence likelihood)

   M = Mitigative (reduces event consequences)

Acronyms

   MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	C ≥ 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

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)
Compressed Gasses	*Hazard: Collocated personnel injury due to unexpected release, or unsecure tanks*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Vacuum Pressure Vessels	*Hazard: Collocated personnel injury due to unexpected pressure release* *Hazard: Beam pipes under vacuum*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Vacuum Pumps	*Hazard: Hazard: Personnel injury due to interaction with existing vacuum.*	L: C: R:	See Section 1, Chapter 4	L: C: R:
Material Handling	*Hazard: Collocated personnel injury due to moving/handing material (rollovers, crush, etc.)*	L: C: R:	See Section 1, Chapter 4j	L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
  P = Preventive (reduce event occurrence likelihood)
  M = Mitigative (reduces event consequences)
Acronyms
  MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ≥ 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

Table 2.21 Potential Energy – MOI Offsite

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

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
P = Preventive (reduce event occurrence likelihood) **M** = Mitigative (reduces event consequences) **Acronyms** **MOI =** Maximally-exposed Offsite Individual	**H**	$C \geq$ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	$C \geq$ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	$C \geq$ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.
	M	$C \geq$ Mild, transient adverse effects.	$C \geq$ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	$C \geq$ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.
	L	Mild, transient adverse effects > **C**	Minor injuries; no hospitalization > **C**	Minor injuries; no hospitalization > **C**
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level

Table 2.22 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))* *Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic medical device(s))* *Exposure to flying metallic objects causing potential injury.*	L: C: R:	See Section 1, Chapter 4	L: C R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type

  P = Preventive (reduce event occurrence likelihood)

  M = Mitigative (reduces event consequences)

Acronyms

  MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ≥ 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

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))* *Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic medical device(s))* *Exposure to flying metallic objects causing potential injury.*	L: C: R:	See Section 1, Chapter 4	L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
   P = Preventive (reduce event occurrence likelihood)
   M = Mitigative (reduces event consequences)
Acronyms
   MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ≥ 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

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: N/A*	L: C: R:	No further analysis required	L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
 P = Preventive (reduce event occurrence likelihood)
 M = Mitigative (reduces event consequences)
Acronyms
 MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	**C** ≥ 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

Table 2.22 Other hazards – Onsite-1 Facility Worker

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

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
   P = Preventive (reduce event occurrence likelihood)
   M = Mitigative (reduces event consequences)
Acronyms
   MOI = Maximally-exposed Offsite Individual

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

Table 2.23 Other hazards – Onsite-2 Co-located Worker

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

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
   P = Preventive (reduce event occurrence likelihood)
   M = Mitigative (reduces event consequences)
Acronyms
   MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	C ≥ 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

Table 2.24 Other hazards – MOI Offsite

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

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

Likelihood (L, of event)/year		Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)		**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)		**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)		**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
P = Preventive (reduce event occurrence likelihood) **M** = Mitigative (reduces event consequences) **Acronyms** **MOI =** Maximally-exposed Offsite Individual	**H**	C ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	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

Table 2.25 Access & Egress – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress	*Hazard: blocked egress would be of major life safety concern.* *An egress might be blocked due to construction work, poor housekeeping, or faulty doors.* *In the event of a fire or other life-threatening event, a blocked egress would be life threatening.* *The exposure of the hazard to the facility worker is of major concern.*	L: C: R:	See Section 1, Chapter 4	L: C: R:

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

Likelihood (L, of event)/year		Consequence (C, of event)/year		Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)		**H** = High		**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)		**M** = Moderate		**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		**L** = Low		**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)		**N** = Negligible		**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

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

Table 2.26 Access & Egress – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress	*Hazard: A blocked egress would be of major life safety concern.* *An egress might be blocked due to construction work, poor housekeeping, or faulty doors.* *In the event of a fire, a blocked egress would be life threatening.* *The exposure of the hazard to the co-located worker is of concern.*	L: C: R:	See Section 1, Chapter 4	L: C: R:

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

Likelihood (L, of event)/year	Consequence (C, of event)/year	Risk (R, Qualitative Ranking)
A = Anticipated (L > 1.0E-02)	**H** = High	**I** = situation (event) of major concern
U = Unlikely (1.0E-02> L >1.0E-04)	**M** = Moderate	**II** = situation (event) of concern
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)	**L** = Low	**III** = situation (event) of minor concern
BEU = Beyond Extremely Unlikely (1.0E-06> L)	**N** = Negligible	**IV** = situation (event) of minimal concern

Risk Matrix

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

Control(s) Type
  P = Preventive (reduce event occurrence likelihood)
  M = Mitigative (reduces event consequences)
Acronyms
  MOI = Maximally-exposed Offsite Individual

C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)
H	C ≥ 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

Table 2.27 Access & Egress – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress	*Hazard: N/A*	L: C: R:	No further analysis required	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

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

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

Table 2.28 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.* *Discharge of chemicals into onsite surface waters beyond permitted limits.*	L: C: R:	See Section 1, Chapter 4	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.*	L: C: R:	See Section 1, Chapter 4	L: C: **R:**
Soil	*Hazard:* *Radioactive soil in beam loss areas beyond allowable concentrations of radionuclides beyond calculated Fermilab limits.* *Discharge of chemicals into onsite soils beyond permitted limits.*	L: C: R:	See Section 1, Chapter 4	L: C: **R:**