### Table 9. Summary of Baseline and Residual Risks-8 GeV Line

| Risk Tables Description | | Baseline Risk | Residual Risk |
|---|---|---|---|
| 9.1 | Radiological – Onsite-1 Facility Worker | R: I | R: IV |
| 9.2 | Radiological – Onsite-2 Co-located Worker | R: I | R: IV |
| 9.3 | Radiological – MOI Offsite | R:NA | R:NA |
| 9.4 | Toxic Materials – Onsite 1 Facility Worker | R: * | R: * |
| 9.5 | Toxic Materials – Onsite 2 Co-located Worker | R: * | R: * |
| 9.6 | Toxic Materials – MOI Offsite | R: * | R: * |
| 9.7 | Flammable & Combustible Materials – Onsite-1 Facility Worker | R: NA* | R: NA* |
| 9.8 | Flammable & Combustible Materials – Onsite-2 Co-located worker | R: * | R: * |
| 9.9 | Flammable & Combustible Materials – MOI Offsite | R: * | R: * |
| 9.10 | Electrical Energy – Onsite-1 Facility Worker | R: * | R: * |
| 9.11 | Electrical Energy – Onsite-2 Co-located Worker | R: * | R: * |
| 9.12 | Electrical Energy – MOI Offsite | R: NA* | R: NA* |
| 9.13 | Thermal Energy – Onsite-1 Facility Worker | R: * | R: * |
| 9.14 | Thermal Energy – Onsite-2 Co-located Worker | R: * | R: * |
| 9.15 | Thermal Energy – MOI Offsite | R: NA* | R: NA* |
| 9.16 | Kinetic Energy – Onsite-1 Facility Worker | R: * | R: * |
| 9.17 | Kinetic Energy – Onsite-2 Co-located Worker | R: * | R: * |
| 9.18 | Kinetic Energy – MOI Offsite | R: NA* | R: NA* |
| 9.19 | Potential Energy- Onsite-1 Facility Worker | R: * | R: * |
| 9.20 | Potential Energy – Onsite-2 Co-located Worker | R: * | R: * |
| 9.21 | Potential Energy – MOI Offsite | R: NA* | R: NA* |
| 9.22 | Magnetic Fields – Onsite-1 Facility Worker | R: * | R: * |
| 9.23 | Magnetic Fields – Onsite-2 Co-located Worker | R: * | R: * |
| 9.24 | Magnetic Fields – MOI Offsite | R: NA* | R: NA* |
| 9.25 | Other Hazards – Onsite-1 Facility Worker | R: * | R: * |
| 9.26 | Other Hazards – Onsite-2 Co-located Worker | R: * | R: * |
| 9.27 | Other Hazards – MOI Offsite | R: NA* | R: NA* |
| 9.28 | Access & Egress – Onsite-1 Facility Worker | R: * | R: * |
| 9.29 | Access & Egress – Onsite-2 Co-located Worker | R: * | R: * |
| 9.30 | Access & Egress – MOI Offsite | R: NA* | R: NA* |
| 9.31 | Environmental Hazards | R: * | R: * |

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

**NOTE:**
Per DOE-HDBK-1163-2020, Appendix C, "Risk Assessment Methodology":
"Events with an unmitigated risk value of III or IV would not require additional control assignments to provide reasonable assurance of adequate protection. Whereas, for events with an unmitigated risk value of I or II, controls would need to be assigned to either reduce the likelihood or the consequence, and therefore the overall mitigated risk. Generally, preventive controls are applied prior to a loss event – reflecting a likelihood reduction and mitigative controls are applied after a loss event – reflecting a consequence reduction. Each control is credited for a single "bin drop" either in likelihood or consequence; not both. Following a standard hierarchy of controls, controls are applied until the residual risk is acceptable – reflecting a mitigated risk value of III or IV. After controls are credited, events

with a remaining unacceptable residual risk (i.e., I or II) are candidates for additional analyses and additional controls, often quantitative in nature." For Fermilab, these controls for accelerator-specific hazards are identified as Credited Controls and further summarized in the Accelerator Safety Envelope (ASE).

**Table 9.1 Radiological – Onsite-1 Facility Worker**

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| Residual Activation | *Hazard: Exposure to residual activation* | L: A<br>C: H<br>R: I | P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates.<br>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.<br>P – 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.<br>P – Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions.<br>P – Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing.<br>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.<br>M – Local Component Shielding: Material placed between the local component and the area to be protected. The material is used to attenuate the radiation flux by a factor related to the radiation length of the material.<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. | L: BEU<br>C: L<br>R: IV |

| 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<br>C: H<br>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.<br>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.<br>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.<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. | L: EU<br>C: L<br>R: IV |

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| Surface Water Activation | *Hazard: Radionuclides in surface water exceed regulatory levels* | L: A<br>C: H<br>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.<br>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.<br>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.<br>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.<br>M – Pond Monitoring Program: Samples taken from the ponds and measured for activation. Sump water from the tunnel is discharged into these ponds.<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. | L: BEU<br>C: L<br>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<br>C: H<br>R: I | P – Air Monitoring: Air sampled from the enclosure for activation<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.<br>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.<br>M – Engineered Air Flow: Enclosure air flow design to give the activated air time to decay before exiting the enclosure. | L: EU<br>C: L<br>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<br>C: H<br>R: I | 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.<br>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.<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.<br>M – Beam position auto-tune program maintains desired beam position through the collimator region of the 8-GeV Line segment. | L: U<br>C: N<br>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<br>C: H<br>R: I | P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates.<br>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.<br>P – Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.<br>M – Distance to Stored Material: Barriers, such as ropes, that are used to increase the distance between the activated material and personnel. | L: BEU<br>C: L<br>R: IV |
| Contamination | *Hazard: Persons are exposed to ionizing radiation beyond regulatory levels* | L: A<br>C: H<br>R: I | P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates.<br>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.<br>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.<br>M – Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. | L:EU<br>C: L<br>R: IV |
| $^{7}$Be | *Hazard: Potential radiation exposure to $^{7}$Be (uptake/committed dose)* | L: A<br>C: N<br>R: IV | Not Applicable. No prevention or mitigation is required. $^{7}$Be isn't hazardous in this pattern of use by facility. | L: A<br>C: N<br>R: IV |
| | | | | |

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

**Likelihood (L, of event)/year**

- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

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

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

**Risk Matrix**

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

**Table 9.2 Radiological – Onsite-2 Co-located Worker**

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| Residual Activation | *Hazard: Exposure to residual activation* | L: A<br>C: H<br>R: I | P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates.<br>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.<br>P – 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.<br>P – Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions.<br>P – Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing.<br>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.<br>M – Local Component Shielding: Material placed between the local component and the area to be protected. The material is used to attenuate the radiation flux by a factor related to the radiation length of the material.<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. | L: BEU<br>C: L<br>R: IV |

| 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<br>C: H<br>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.<br>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.<br>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.<br>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.<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. | L: BEU<br>C: L<br>R: IV |

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| Surface Water Activation | *Hazard: Radionuclides in surface water exceed regulatory levels* | L: A<br>C: H<br>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.<br>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.<br>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.<br>M – Pond Monitoring program: Samples taken from the ponds and measured for activation. Sump water from the tunnel is discharged into these ponds.<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. | L: BEU<br>C: N<br>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<br>C: H<br>R: I | P – Air Monitoring: Air sampled from the enclosure for activation<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.<br>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.<br>M – Engineered Air Flow: Enclosure air flow design to give the activated air time to decay before exiting the enclosure. | L: BEU<br>C: L<br>R: IV |
| Soil Interactions | *Hazard: Radionuclides are produced which may contaminate ground water* | L: A<br>C: H<br>R: I | 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.<br>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.<br>M – Run conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.<br>M – Beam position auto-tune program maintains desired beam position through the collimator region of the 8-GeV Line segment. | L: EU<br>C: L<br>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<br>C: H<br>R: I | P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates.<br>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.<br>P – Postings: Signs located in various places throughout the accelerator warning of various hazards and occupancy restrictions<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered.<br>M – Distance to Stored Material: Barriers, such as ropes, that are used to increase the distance between the activated material and personnel. | L: U<br>C: N<br>R: IV |
| Contamination | *Hazard: Persons are exposed to ionizing radiation beyond regulatory levels* | L: A<br>C: H<br>R: I | P – Locked Gates: Barriers to entrances of areas that contain radioactive material. Keys are required to open these gates.<br>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.<br>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.<br>M – Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. | L: BEU<br>C: L<br>R: IV |
| $^{7}$Be | *Hazard: Potential radiation exposure to $^{7}$Be (uptake/committed dose)* | L: A<br>C: N<br>R: IV | Not Applicable. No prevention or mitigation is required. $^{7}$Be isn't hazardous in this pattern of use by facility. | L:EU<br>C: L<br>R: IV |

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| | | | | L: A<br>C: N<br>R: IV |

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

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

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

**Risk Matrix**

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

**Table 9.3 Radiological – MOI Offsite**

| 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: BEU<br>C: N<br>R: IV | Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate. | L: BEU<br>C: N<br>R: IV |

| 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<br>C: H<br>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.<br>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.<br>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.<br>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.<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. | L: BEU<br>C: L<br>R: IV |

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| Surface Water Activation | *Hazard: Radionuclides in surface water exceed regulatory levels* | L: A<br>C: H<br>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.<br>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.<br>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.<br>M – Pond Monitoring program: Samples taken from the ponds and measured for activation. Sump water from the tunnel is discharged into these ponds<br>M – Run Conditions: Operating parameters that reduce residual activation by limiting the total amount of beam that could be delivered. | L: BEU<br>C: L<br>R: IV |
| Air Activation | *Hazard: Radionuclides in air exceed regulatory levels* | L: BEU<br>C: N<br>R: IV | Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate. | L: BEU<br>C: N<br>R: IV |

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| Soil Interactions | *Hazard: Radionuclides are produced which may contaminate ground water* | L: BEU<br>C: N<br>R: IV | Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate. | L: BEU<br>C: N<br>R: IV |
| Radioactive Waste | *Hazard: Persons are exposed to ionizing radiation beyond regulatory levels* | L: BEU<br>C: N<br>R: IV | Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate. | L: BEU<br>C: N<br>R: IV |
| Contamination | *Hazard: Persons are exposed to ionizing radiation beyond regulatory levels* | L: BEU<br>C: N<br>R: IV | Not Applicable. No prevention or mitigation is required. The area is located beyond the public access gate. | L: BEU<br>C: N<br>R: IV |
| $^{7}$Be | *Hazard: Potential radiation exposure to $^{7}$Be (uptake/committed dose)* | L: A<br>C: N<br>R: I | Not Applicable. No prevention or mitigation is required. $^{7}$Be isn't hazardous in this pattern of use by facility. | L: A<br>C: N<br>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)

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

**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 |

| | | | | | |
|---|---|---|---|---|---|
| **Acronyms**<br>**MOI =** Maximally-exposed Offsite Individual<br>**rem =** Roentgen equivalent man | **L** | 5 rem > **C** | 25 rem **> C** | 25 rem **> C** | |
| | **N** | 0.5 rem > **C** | 5 rem **> C** | 5 rem **> C** | |

**Table 9.4 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:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

**Acronyms**
- **IDLH** = Immediately Dangerous to Life and Health
- **MOI =** Maximally-exposed Offsite Individual
- **PAC** = Protective Action Criteria
- **PEL** = Permissible Exposure Limit
- **$TLV_c$ =** Threshold Limit Value (ceiling)

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

**Risk Matrix**

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

**Table 9.5 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 Shielding | *Hazard: Potential exposure to lead dust during manual handling of un-encased lead bricks, lead shot, and lead sheets* | L: A<br>C: H<br>R: I | See Section I Chapter 04. | L: BEU<br>C: L<br>R: IV |

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

**Acronyms**
- **IDLH** = Immediately Dangerous to Life and Health
- **MOI =** Maximally-exposed Offsite Individual
- **PAC** = Protective Action Criteria
- **PEL** = Permissible Exposure Limit
- **$TLV_c$ =** Threshold Limit Value (ceiling)

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

**Risk Matrix**

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

**Table 9.6 Toxic Materials – MOI Offsite**

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| Lead Shielding | *Hazard: Potential exposure to lead dust during manual handling of un-encased lead bricks, lead shot, and lead sheets* | L:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

**Acronyms**
- **IDLH** = Immediately Dangerous to Life and Health
- **MOI =** Maximally-exposed Offsite Individual
- **PAC** = Protective Action Criteria
- **PEL** = Permissible Exposure Limit
- **$TLV_c$ =** Threshold Limit Value (ceiling)

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

**Risk Matrix**

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

**Table 9.7 Flammable and Combustible Materials – Onsite -1 Facility Worker**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.8 Flammable and Combustible Materials – Onsite -2 Co-located Worker**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.9 Flammable and Combustible Materials – MOI Offsite**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.10 Electrical Energy – Onsite-1 Facility Worker**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.11 Electrical Energy 1 Onsite-2 Co-located Worker**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.12 Electrical Energy – MOI Offsite**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.13 Thermal Energy – Onsite-1 Facility Worker**

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

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

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

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

**Risk Matrix**

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

**Table 9.14 Thermal Energy – Onsite-2 Co-located Worker**

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

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

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

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

**Risk Matrix**

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

**Table 9.15 Thermal Energy – MOI Offsite**

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

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

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

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

**Risk Matrix**

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

**Table 9.16 Kinetic Energy – Onsite-1 Facility Worker**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.17 Kinetic Energy – Onsite-2 Co-located Worker**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.18 Kinetic Energy – MOI Offsite**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.19 Potential Energy – Onsite-1 Facility Worker**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.20 Potential Energy – Onsite-2 Co-located Worker**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.21 Potential Energy – MOI Offsite**

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

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.22 Magnetic Fields – Onsite-1 Facility Worker**

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

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

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

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

**Risk Matrix**

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

**Table 9.23 Magnetic Fields – Onsite-2 Co-located Worker**

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

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

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

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

**Risk Matrix**

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

**Table 9.24 Magnetic Fields – MOI Offsite**

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

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

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

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

**Risk Matrix**

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

**Table 9.25 Other hazards – Onsite-1 Facility Worker**

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| Confined Spaces | | L:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |
| Silica | | L:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |
| Ergonomics | | L:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.26 Other hazards – Onsite-2 Co-located Worker**

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| Confined Spaces | | L:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |
| Silica | | L:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |
| Ergonomics | | L:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.27 Other hazards – MOI Offsite**

| Hazard | Hazard Description | Baseline Qualitative Risk (without controls) | Preventative (P)/ Mitigative (M) | Residual Qualitative Risk (with controls) |
|---|---|---|---|---|
| Confined Spaces | | L:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |
| Silica | | L:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |
| Ergonomics | | L:<br>C:<br>R: | See Section I Chapter 04. | L:<br>C:<br>R: |

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

**Likelihood (L, of event)/year**

**A** = Anticipated (L > 1.0E-02)
**U** = Unlikely (1.0E-02> L >1.0E-04)
**EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
**BEU** = Beyond Extremely Unlikely (1.0E-06> L)

**Consequence (C, of event)/year**

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

**Risk (R, Qualitative Ranking)**

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

**Control(s) Type**

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

**Acronyms**

**MOI =** Maximally-exposed Offsite Individual

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

**Risk Matrix**

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

**Table 9.28 Access & Egress – Onsite-1 Facility Worker**

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

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

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

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

**Risk Matrix**

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

**Table 9.29 Access & Egress – Onsite-2 Co-located Worker**

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

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

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

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

**Risk Matrix**

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

**Table 9.30 Access & Egress – MOI Offsite**

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

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

**Likelihood (L, of event)/year**
- **A** = Anticipated (L > 1.0E-02)
- **U** = Unlikely (1.0E-02> L >1.0E-04)
- **EU** = Extremely Unlikely (1.0E-04 > L >1.0E-06)
- **BEU** = Beyond Extremely Unlikely (1.0E-06> L)

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

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

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

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

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

**Risk Matrix**

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

**Table 9.31 Environmental**

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

| | | | | |
|---|---|---|---|---|
| | *Discharge of chemicals into onsite soils beyond permitted limits* | | | |