

Table 9. Summary of Baseline and Residual Risks - NOvA Near Detector

Risk Tables Description		Baseline Risk	Residual Risk
9.1	Toxic Materials – Onsite 1 Facility Worker	R: III	R: IV
9.2	Toxic Materials – Onsite 2 Co-located Worker	R: III	R: IV
9.3	Toxic Materials – MOI Offsite	R: IV	R: IV
9.4	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: *	R: *
9.5	Flammable & Combustible Materials – Onsite-2 Co-located worker	R: *	R: *
9.6	Flammable & Combustible Materials – MOI Offsite	R: *	R: *
9.7	Electrical Energy – Onsite-1 Facility Worker	R: *	R: *
9.8	Electrical Energy – Onsite-2 Co-located Worker	R: *	R: *
9.9	Electrical Energy – MOI Offsite	R: *	R: *
9.10	Thermal Energy – Onsite-1 Facility Worker	R: *	R: *
9.11	Thermal Energy – Onsite-2 Co-located Worker	R: *	R: *
9.12	Thermal Energy – MOI Offsite	R: *	R: *
9.13	Kinetic Energy – Onsite-1 Facility Worker	R: *	R: *
9.14	Kinetic Energy – Onsite-2 Co-located Worker	R: *	R: *
9.15	Kinetic Energy – MOI Offsite	R: *	R: *
9.16	Potential Energy- Onsite-1 Facility Worker	R: *	R: *
9.17	Potential Energy – Onsite-2 Co-located Worker	R: *	R: *
9.18	Potential Energy – MOI Offsite	R: *	R: *
9.19	Other Hazards – Onsite-1 Facility Worker	R: *	R: *
9.20	Other Hazards – Onsite-2 Co-located Worker	R: *	R: *
9.21	Other Hazards – MOI Offsite	R: *	R: *
9.22	Access & Egress – Onsite-1 Facility Worker	R: I	R: IV
9.23	Access & Egress – Onsite-2 Co-located Worker	R: I	R: IV
9.24	Access & Egress – MOI Offsite	R: IV	R: IV
9.25	Environmental Hazards	R: *	R: *
<p>* 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.</p> <p>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).</p>			

Table 9.1 Toxic Materials – Onsite 1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Liquid Scintillator	<p><i>Hazard: NOVA's liquid scintillator oil contains 5.35% pseudocumene. The pseudocumene is an eyes, skin and respiratory irritant, central nervous system depressant, and is toxic to marine life.</i></p> <p><i>Physical contact via handling or airborne exposure via outgassing oil</i></p>	L: A C: L R: III	<p>P - A job-specific hazard analysis and procedure govern filling the detector and prescribe Personal Protective Equipment (PPE) to prevent worker contact with the liquid scintillator.</p> <p>P - The PVC modules, once filled, completely contain the pseudocumene, resulting in no further exposure.</p> <p>P - The entire detector is inside of a secondary containment membrane that has the capacity to contain 100% of the liquid scintillator oil and prevent a release to the environment.</p> <p>M - Emergency spill equipment, an eye wash and PPE are stationed near the detector in the event of a release.</p>	L: BEU C: N 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		Risk Matrix <table border="1"> <thead> <tr> <th colspan="2" rowspan="2"></th> <th colspan="4">Likelihood</th> </tr> <tr> <th>A</th> <th>U</th> <th>EU</th> <th>BEU</th> </tr> </thead> <tbody> <tr> <th rowspan="4">Consequences</th> <th>H</th> <td>I</td> <td>I</td> <td>II</td> <td>III</td> </tr> <tr> <th>M</th> <td>II</td> <td>II</td> <td>III</td> <td>IV</td> </tr> <tr> <th>L</th> <td>III</td> <td>III</td> <td>IV</td> <td>IV</td> </tr> <tr> <th>N</th> <td>IV</td> <td>IV</td> <td>IV</td> <td>IV</td> </tr> </tbody> </table>			Likelihood				A	U	EU	BEU	Consequences	H	I	I	II	III	M	II	II	III	IV	L	III	III	IV	IV	N	IV	IV	IV	IV
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Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences)	C H M L N	Offsite (MOI) C ≥ PAC-2 PAC-2 > C ≥ PAC-1 PAC-1 > C Consequences less than those for Low Consequence Level	Onsite-2 (co-located worker) C ≥ PAC-3 PAC-3 > C ≥ PAC-2 PAC-2 > C Consequences less than those for Low Consequence Level	Onsite-1 (facility worker) C ≥ IDLH IDLH > C ≥ PEL or TLV _c PEL or TLV _c > C Consequences less than those for Low Consequence Level																																
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)																																				

Table 9.2 Toxic Materials – Onsite 2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Liquid Scintillator	<p><i>Hazard: NOVA's liquid scintillator oil contains 5.35% pseudocumene. The pseudocumene is an eyes, skin and respiratory irritant, central nervous system depressant, and is toxic to marine life.</i></p> <p><i>Airborne exposure via outgassing oil</i></p>	<p>L: A C: L R: III</p>	<p>P - A job-specific hazard analysis and procedure govern filling the detector to prevent spilling and exposing the liquid scintillator.</p> <p>P - The PVC modules, once filled, completely contain the pseudocumene, resulting in no further exposure.</p> <p>P - The entire detector is inside of a secondary containment membrane that has the capacity to contain 100% of the liquid scintillator oil and prevent a release to the environment.</p> <p>M - Emergency spill equipment, an eye wash and PPE are stationed near the detector in the event of a release.</p>	<p>L: BEU C: N R: IV</p>

Chemical Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.																																				
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	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)																																
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)	H	C ≥ PAC-2	C ≥ PAC-3	C ≥ IDLH	<table border="1"> <thead> <tr> <th colspan="2" rowspan="2"></th> <th colspan="4">Likelihood</th> </tr> <tr> <th>A</th> <th>U</th> <th>EU</th> <th>BEU</th> </tr> </thead> <tbody> <tr> <th rowspan="4">Consequences</th> <th>H</th> <td>I</td> <td>I</td> <td>II</td> <td>III</td> </tr> <tr> <th>M</th> <td>II</td> <td>II</td> <td>III</td> <td>IV</td> </tr> <tr> <th>L</th> <td>III</td> <td>III</td> <td>IV</td> <td>IV</td> </tr> <tr> <th>N</th> <td>IV</td> <td>IV</td> <td>IV</td> <td>IV</td> </tr> </tbody> </table>			Likelihood				A	U	EU	BEU	Consequences	H	I	I	II	III	M	II	II	III	IV	L	III	III	IV	IV	N	IV	IV	IV	IV
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		M	II	II		III	IV																													
L		III	III	IV	IV																															
N		IV	IV	IV	IV																															
M	PAC-2 > C ≥ PAC-1	PAC-3 > C ≥ PAC-2	IDLH > C ≥ PEL or TLV _c																																	
L	PAC-1 > C	PAC-2 > C	PEL or TLV _c > C																																	
N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level																																	

Table 9.3 Toxic Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Liquid Scintillator	<p><i>Hazard: NOVA's liquid scintillator oil contains 5.35% pseudocumene. The pseudocumene is an eyes, skin and respiratory irritant, central nervous system depressant, and is toxic to marine life.</i></p> <p><i>Airborne</i></p>	<p>L: EU C: N R: IV</p>	<p>P – Access controls to area prevent contact.</p> <p>P - The PVC modules, once filled, completely contain the pseudocumene, resulting in no further exposure.</p> <p>P - The entire detector is inside of a secondary containment membrane that has the capacity to contain 100% of the liquid scintillator oil and prevent a release to the environment.</p>	<p>L: BEU C: N R: IV</p>

Chemical Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
<p>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)</p>	<p>Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible</p>		<p>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</p>		<p>Risk Matrix</p> <table border="1" data-bbox="1637 914 2042 1134"> <thead> <tr> <th colspan="2" rowspan="2"></th> <th colspan="4">Likelihood</th> </tr> <tr> <th>A</th> <th>U</th> <th>EU</th> <th>BEU</th> </tr> </thead> <tbody> <tr> <th rowspan="4">Consequences</th> <th>H</th> <td>I</td> <td>I</td> <td>II</td> <td>III</td> </tr> <tr> <th>M</th> <td>II</td> <td>II</td> <td>III</td> <td>IV</td> </tr> <tr> <th>L</th> <td>III</td> <td>III</td> <td>IV</td> <td>IV</td> </tr> <tr> <th>N</th> <td>IV</td> <td>IV</td> <td>IV</td> <td>IV</td> </tr> </tbody> </table>			Likelihood				A	U	EU	BEU	Consequences	H	I	I	II	III	M	II	II	III	IV	L	III	III	IV	IV	N	IV	IV	IV	IV
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<p>Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences)</p> <p>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)</p>	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)																																
	H	C ≥ PAC-2	C ≥ PAC-3	C ≥ IDLH																																
	M	PAC-2 > C ≥ PAC-1	PAC-3 > C ≥ PAC-2	IDLH > C ≥ PEL or TLV _c																																
	L	PAC-1 > C	PAC-2 > C	PEL or TLV _c > C																																
N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level																																	

Table 9.4 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.)	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Flammable Materials (Flammable gas, cleaning materials, etc.)	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)																																
	H	C ≥ Irreversible, other serious effects, or symptoms which could impair an individual’s ability to take protective action.	C ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.																																
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no	C ≥ Serious injury, no immediate loss of life no																																

			permanent disabilities; hospitalization required.	permanent disabilities; hospitalization required.	
	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C	
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.5 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.)	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Flammable Materials (Flammable gas, cleaning materials, etc.)	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
Likelihood (L, of event)/year 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		Risk (R, Qualitative Ranking)		Risk Matrix <table border="1"> <thead> <tr> <th colspan="2" rowspan="2"></th> <th colspan="4">Likelihood</th> </tr> <tr> <th>A</th> <th>U</th> <th>EU</th> <th>BEU</th> </tr> </thead> <tbody> <tr> <th rowspan="4">Consequences</th> <th>H</th> <td>I</td> <td>I</td> <td>II</td> <td>III</td> </tr> <tr> <th>M</th> <td>II</td> <td>II</td> <td>III</td> <td>IV</td> </tr> <tr> <th>L</th> <td>III</td> <td>III</td> <td>IV</td> <td>IV</td> </tr> <tr> <th>N</th> <td>IV</td> <td>IV</td> <td>IV</td> <td>IV</td> </tr> </tbody> </table>			Likelihood				A	U	EU	BEU	Consequences	H	I	I	II	III	M	II	II	III	IV	L	III	III	IV	IV	N	IV	IV	IV	IV
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Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)																																
	H	C ≥ Irreversible, other serious effects, or symptoms which could impair an individual’s ability to take protective action.	C ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.																																
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no	C ≥ Serious injury, no immediate loss of life no																																

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	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C	
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.6 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.)	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Flammable Materials (Flammable gas, cleaning materials, etc.)	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no	C ≥ Serious injury, no immediate loss of life no																																

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	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.7 Electrical Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
High Voltage Exposure	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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Table 9.8 Electrical Energy Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
High Voltage Exposure	<i>Hazard:</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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Table 9.9 Electrical Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
High Voltage Exposure	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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Table 9.10 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	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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Table 9.11 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	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

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Table 9.12 Thermal Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hot Work	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

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Table 9.13 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	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Pumps and Motors	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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	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	
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Table 9.14 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	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Pumps and Motors	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.										
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02 > L > 1.0E-04) EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06 > L)	Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible	Risk (R, Qualitative Ranking) I = situation (event) of major concern II = situation (event) of concern III = situation (event) of minor concern IV = situation (event) of minimal concern			Risk Matrix					
						Likelihood				
		A	U	EU	BEU					
		H	I	I	II	III				
		M	II	II	III	IV				
		L	III	III	IV	IV				
		N	IV	IV	IV	IV				
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)						
	H	C ≥ Irreversible, other serious effects, or symptoms which could impair an individual’s ability to take protective action.	C ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately life-threatening or permanently disabling.						
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C						

Table 9.15 Kinetic Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power Tools	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Pumps and Motors	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

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Table 9.16 Potential Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Compressed Gasses	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Vacuum / Pressure Vessel/ Piping	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Material Handling	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

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	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.17 Potential Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Compressed Gasses	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Vacuum / Pressure Vessels/ Piping	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Material Handling	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

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	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C	
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.18 Potential Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Compressed Gasses	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Vacuum / Pressure Vessels/ Piping	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Material Handling	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

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	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C	
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.19 Other hazards – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Noise	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Silica	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Ergonomics	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Working at Heights	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

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	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C	
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.20 Other hazards – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Noise	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Silica	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Ergonomics	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Working at Heights	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.21 Other hazards – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Noise	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Silica	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Ergonomics	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Working at Heights	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																				
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	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C	
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.22 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	<i>Hazard: Inability to leave hazardous area in case of an emergency. In the MINOS Underground, this would be an ODH or fire alarm. In the MINOS Surface Building, this would be a fire alarm or tornado warning.</i>	L: A C: H R: I	<p>P- All MINOS Underground workers must take MINOS Underground Training. The most important part of this training concerns Life Safety Egress.</p> <p>P- In the case of a power outage, all Life Safety systems are powered by a large diesel generator: emergency lights, elevators, cranes (so the personnel basket to underground can be used), and air handling units (AHUs).</p> <p>M- First action on hearing an ODH or fire alarm underground is to exit to the Positive Pressure Emergency Passageway which should prevent smoke or toxic fumes from entering the area.</p> <p>M- Normally, workers should exit the underground via the main elevator. In the event the elevator is not working, the group should first call the emergency number X3131. If instructed to do so, the group should use the Secondary Escape Route explained in the MINOS Underground training and indicated with signs. The group may also be instructed to carry or use EEBDs.</p> <p>M- In the MINOS Surface Building, workers should go to the Assembly Area in the parking lot in the case of a fire alarm and go to the Tornado Shelter in the mechanical room in the case of a tornado warning.</p>	L: EU C: N R: IV

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.																																				
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Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms	C H	Offsite (MOI) C ≥ Irreversible, other serious effects, or symptoms which	Onsite-2 (co-located worker) C ≥ Prompt worker fatality or acute injury that is immediately life-	Onsite-1 (facility worker) C ≥ Prompt worker fatality or acute injury that is immediately life-																																

MOI = Maximally-exposed Offsite Individual		could impair an individual's ability to take protective action.	threatening or permanently disabling.	threatening or permanently disabling.	
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	
	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C	
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.23 Access & Egress – Onsite-2 Co-located Worker

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Life Safety Egress	<i>Hazard: Inability to leave hazardous area in case of an emergency. In the MINOS Underground, this would be an ODH or fire alarm. In the MINOS Surface Building, this would be a fire alarm or tornado warning.</i>	L: A C: H R: I	<p>P- All MINOS Underground workers must take MINOS Underground Training. All tourists must receive a Safety Briefing, and sign a tour sheet to indicate they received this. The most important part of these concern Life Safety Egress.</p> <p>P- In the case of a power outage, all Life Safety systems are powered by a large diesel generator: emergency lights, elevators, cranes (so the personnel basket to underground can be used), and air handling units (AHUs).</p> <p>M- First action on hearing an ODH or fire alarm underground is to exit to the Positive Pressure Emergency Passageway which should prevent smoke or toxic fumes from entering the area.</p> <p>M- Normally, workers should exit the underground via the main elevator. In the event the elevator is not working, the group should first call the emergency number X3131. If instructed to do so, the group should use the Secondary Escape Route explained in the MINOS Underground training or the Safety Briefing for tourists and indicated with signs. The group may also be instructed to carry or use EEBDs.</p> <p>M- In the MINOS Surface Building, workers should go to the Assembly Area in the parking lot in the case of a fire alarm, and go to the Tornado Shelter in the mechanical room in the case of a tornado warning</p>	L: EU C: N R: IV

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.										
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02 > L > 1.0E-04) EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06 > L)	Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible	Risk (R, Qualitative Ranking) I = situation (event) of major concern II = situation (event) of concern III = situation (event) of minor concern IV = situation (event) of minimal concern			Risk Matrix					
					Likelihood					
					Consequences	A	U	EU	BEU	
						H	I	I	II	III
						M	II	II	III	IV
						L	III	III	IV	IV
					N	IV	IV	IV	IV	
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences)		C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)					
		H	C ≥ Irreversible, other serious effects,	C ≥ Prompt worker fatality or acute injury that is	C ≥ Prompt worker fatality or acute injury that					

Acronyms MOI = Maximally-exposed Offsite Individual		or symptoms which could impair an individual's ability to take protective action.	immediately life-threatening or permanently disabling.	is immediately life-threatening or permanently disabling.	
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	
	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C	
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	

Table 9.24 Access & Egress – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress	<i>Hazard: There are no life safety egress hazards outside the MINOS Surface Building.</i>	L: BEU C: N R: IV	No further analysis required.	L: BEU C: N R: IV

Other Hazard Consequences, derived from Figure C-1, “Example Qualitative Consequence Matrix”, DOE-HDBK-1163-2020.																																					
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02 > L > 1.0E-04) EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06 > L)	Consequence (C, of event)/year H = High M = Moderate L = Low N = Negligible		Risk (R, Qualitative Ranking) I = situation (event) of major concern II = situation (event) of concern III = situation (event) of minor concern IV = situation (event) of minimal concern		Risk Matrix																																
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Table 9.25 Environmental Hazards

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hazard to Air	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Hazard to Water	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:
Hazard to Soil	<i>Hazard: N/A</i>	L: C: R:	See Section 1, Chapter 4.	L: C: R:

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