Table 28. Summary of Baseline and Residual Risks – Neutrino Switchyard 120 Experimental Areas

	Risk Tables Description	Baseline Risk	Residual Risk
28,1	Radiological – Onsite-1 Facility Worker	R: I	R: IV
28.2	Radiological – Onsite-2 Co-located Worker	R: I	R: IV
28.3	Radiological – MOI Offsite	R: IV	R: IV
28.4	Toxic Materials – Onsite 1 Facility Worker	R: II	R: IV
28.5	Toxic Materials – Onsite 2 Co-located Worker	R: III	R: IV
28.6	Toxic Materials – MOI Offsite	R: *	R: *
28.7	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: *	R: *
28.8	Flammable & Combustible Materials – Onsite-2 Co-located worker	R: *	R: *
28.9	Flammable & Combustible Materials – MOI Offsite	R: *	R: *
28.10	Electrical Energy – Onsite-1 Facility Worker	R: *	R: *
28.11	Electrical Energy – Onsite-2 Co-located Worker	R: *	R: *
28.12	Electrical Energy – MOI Offsite	R: *	R: *
28.13	Thermal Energy – Onsite-1 Facility Worker	R: I	R: IV
28.14	Thermal Energy – Onsite-2 Co-located Worker	R: I	R: IV
28.15	Thermal Energy – MOI Offsite	R: *	R: *
28.16	Kinetic Energy – Onsite-1 Facility Worker	R: I	R: IV
28.17	Kinetic Energy – Onsite-2 Co-located Worker	R: I	R: IV
28.18	Kinetic Energy – MOI Offsite	R: *	R: *
28.19	Potential Energy- Onsite-1 Facility Worker	R: I	R: IV
28.20	Potential Energy – Onsite-2 Co-located Worker	R: *	R: *
28.21	Potential Energy – MOI Offsite	R: *	R: *
28.22	Magnetic Fields – Onsite-1 Facility Worker	R: I	R: III, IV
28.23	Magnetic Fields – Onsite-2 Co-located Worker	R: I	R: III, IV
28.24	Magnetic Fields – MOI Offsite	R: IV	R: IV
28.25	Other Hazards – Onsite-1 Facility Worker	R: III	R: IV
28.26	Other Hazards – Onsite-2 Co-located Worker	R: III	R: IV
28.27	Other Hazards – MOI Offsite	R: *	R: *
28.28	Access & Egress – Onsite-1 Facility Worker	R: *	R: *
28.29	Access & Egress – Onsite-2 Co-located Worker	R: *	R: *
28.30	Access & Egress – MOI Offsite	R: *	R: *
28.31	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 28.1 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: • NM4 target station (ammonia, liquid helium, liquid nitrogen) and front face of the absorber magnet have activation potential.	L: A C: H R: I	 P – General And/Or Job Specific RWP: A Radiological Work Permit is written by ES&H that specifies the work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure. P – Use Of A LSM: Use of a log survey monitor is specified by a RWP. The LSM allows for real time monitoring of radiation levels during work. P – Radiological Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. P – Keyed entry to enclosure M – Radiological Signage And Decay Time Requirements: Signs located in various places throughout the accelerator complex warn of various hazards and occupancy restrictions prior to entry. Furthermore, work may be restricted or prevented until sufficient time has passed such that radiation levels are sufficiently low to allow for safer work to proceed. This mitigation has passive and active components. 	L: BEU C: M R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Groundwater Activation	Hazard: • Radionuclides in groundwater exceed regulatory levels.	L: A C: L R: III	 P- Sump pump sampling M - Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment. M - Facility designs employ shielding to mitigate the production of activation products in groundwater M - Run Conditions to ensure total radiation levels are within expected parameters 	L: U C: N R: IV
Surface Water Activation	Hazard: • Radionuclides in surface water exceed regulatory levels.	L: A C: L R: III	 P – Sump pump sampling M - Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment. M – Facility designs employ shielding to mitigate the production of activation products in surface water M – Run Conditions to ensure total radiation levels are within expected parameters 	L: U C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Water (RAW) Systems	 Hazard: RAW system present in NM4 for cooling of absorber magnet and target cave has exposure potential if system ruptures. 	L: A C: L R: III	 P – Interlock system preventing access to beam enclosure while beam is present. P – Enclosure keys linked to radiological and controlled access training to enter enclosure P – Training M – Design of water system M – Labeling of hazard 	L: BEU C: N R: IV
Air Activation	Hazard: • Scattered 120 GeV beam in NM4 target system can activate air.	L: A C: H R: I	 P – Interlock system preventing access to beam enclosure while beam is present. P – Air monitoring system P – Beam loss monitoring system P – Cool off time imposed at discretion of RSO after beam operations M – The existing ventilation system in NM4 slows transit time adequately to allow for radioactive decay of short-lived positron emitters M – Run conditions 	L: BEU C: L R: IV
Soil Interactions	 Hazard: Scattered beam has potential to activate soil at low levels calculated in the shield assessment. 	L: A C: L R: III	 P – No excavation work without an RWP M - Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment. M – Run Conditions to ensure total radiation levels are within expected parameters M – Beam dump to contain radiation 	L: U C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive waste	 Hazard: Activation potential is low in these spaces and experiments typically remove equipment upon completion. Any materials that cannot be cleared and removed by an experiment are subject to the labs radioactive waste program. 	L: A C: L R: III	 P – Radiological worker training P - Locked gates P – Key control progream M – Any item in a beam enclosure during beam-on conditions is removed and surveyed by radiological workers and classified appropriately. M – Any item identified for disposal is surveyed and processed by Radiological Control organization personnel in accordance with FRCM chapter 4. 	L: BEU C: N R: IV
Contamination	Hazard: . • Potential contamination from beam activation	L: A C: H R: I	 P – Locked gates P – Key control program M - Radiological worker training M – RCT coverage and job specific RWP as determined by the RSO M – Contamination wipes to monitor space and equipment 	L: EU C: N R: IV
⁷ Be	Hazard: • Potential radiation exposure to 7Be (uptake/committed dose).	L: A C: N R: IV	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive	Hazard:	L: A	P – All low activity sealed sources are kept in a lock box and	L: U
Sources	Various low activity sealed	C: N	registered through Radiological Control.	C: N
	sources (Sr-90, Co-60, CS- 137, Fe-55, Ru-106, etc.)	R: IV	M – Radiological training is required for source handling.	R: IV

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	Co	nsequence (C, of event)/	year	Risk (R, Qualitative F	Ranking)	Risk	x Matri	ix			
$\mathbf{A} = \text{Anticipated} (L > 1.0\text{E-}02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = \text{situation}$ (even	t) of major concern				Like	lihood	
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation}$ (even	nt) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = Low$ $\mathbf{N} = Negligible$		III = situation (eve	III = situation (event) of minor concern		Н	Ι	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)				IV = situation (event) of minimal concern		ences	М	Π	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	equ					
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ 25.0 rem		C ³ 100 rem	C ³ 100 rem	ons	L	III	Ш	IV	IV
M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	Μ	25.0 rem > C ³ 5 rem	10	00 rem > C ³ 25 rem	100 rem > C ³ 25 rem	0	Ν	IV	IV	IV	IV
	L	5 rem > C		25 rem > C	25 rem > C	1					
	Ν	0.5 rem > C		5 rem > C	5 rem > C	1					

	1		
rem = Roentgen equivalent man			

Table 28.2 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	 NM4 target station NM4 target station (ammonia, liquid helium, liquid nitrogen) and front face of the absorber magnet have activation potential. 	L: A C: H R: I	 P – General and/or Job Specific RWP: A Radiological Work Permit is written by ES&H that specifies the work that is permitted to be performed, requirements to perform the work, and limitations of radiological exposure. P – Use Of A LSM: Use of a log survey monitor is specified by a RWP. The LSM allows for real time monitoring of radiation levels during work. P – Radiological Training: An educational system managed by ES&H that establishes basic worker knowledge through presentations and testing. P – Keyed entry to enclosure M – Radiological Signage And Decay Time Requirements: Signs located in various places throughout the accelerator complex warn of various hazards and occupancy restrictions prior to entry. Furthermore, work may be restricted or prevented until sufficient time has passed such that radiation levels are sufficiently low to allow for safer work to proceed. This mitigation has passive and active components. 	L: BEU C: M R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Groundwater Activation	Hazard: • Radionuclides in groundwater exceed regulatory levels.	L: A C: L R: III	 P- Sump pump sampling M - Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment. M - Facility designs employ shielding to mitigate the production of activation products in groundwater M - Run Conditions to ensure total radiation levels are within expected parameters 	L: U C: N R: IV
Surface Water Activation	Hazard: • Radionuclides in surface water exceed regulatory levels.	L: A C: L R: III	 P – Sump pump sampling M - Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment. M – Facility designs employ shielding to mitigate the production of activation products in surface water M – Run Conditions to ensure total radiation levels are within expected parameters 	L: U C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Water (RAW) Systems	 Hazard: RAW system present in NM4 for cooling of absorber magnet and target cave has exposure potential if system ruptures. 	L: A C: L R: III	 P – Interlock system preventing access to beam enclosure while beam is present. P – Enclosure keys linked to radiological and controlled access training to enter enclosure P – Training M – Design of water system 	L: BEU C: N R: IV
Air Activation	Hazard: • Scattered 120 GeV beam in NM4 target system can activate air.	L: A C: H R: I	 P – Interlock system preventing access to beam enclosure while beam is present. P – Air monitoring system P – Beam loss monitoring system P – Cool off time imposed at discretion of RSO after beam operations M – The existing ventilation system in NM4 slows transit time adequately to allow for radioactive decay of short-lived positron emitters M – Run conditions 	L: BEU C: L R: IV
Soil Interactions	 Hazard: Scattered beam has potential to activate soil at low levels calculated in the shield assessment. 	L: A C: L R: III	 P – No excavation work without an RWP M - Sensing equipment (chipmunks) to shut off beam if it exceeds the operating parameters (defense in depth) determined by the shield assessment. M – Run Conditions to ensure total radiation levels are within expected parameters M – Beam dump to contain radiation 	L: U C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive waste	 Hazard: Activation potential is low in these spaces and experiments typically remove equipment upon completion. Any materials that cannot be cleared and removed by an experiment are subject to the labs radioactive waste program. 	L: A C: L R: III	 P – Radiological worker training P - Locked gates P – Key control program M – Any item in a beam enclosure during beam-on conditions is removed and surveyed by radiological workers and classified appropriately. M – Any item identified for disposal is surveyed and processed by Radiological Control organization personnel in accordance with FRCM chapter 4. 	L: BEU C: N R: IV
Contamination	Hazard: . • Potential contamination from beam activation	L: A C: H R: I	 P – Locked gates P – Key control program M - Radiological worker training M – RCT coverage and job specific RWP as determined by the RSO M – Contamination wipes to monitor space and equipment 	L: EU C: N R: IV
⁷ Be	Hazard: • Potential radiation exposure to 7Be (uptake/committed dose).	L: A C: N R: IV	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't hazardous in this pattern of use by facility.	L: A C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Sources	Hazard: • Various low activity sealed	L: A C: N	P – All low activity sealed sources are kept in a lock box and registered through Radiological Control.	L: U C: N
	sources (Sr-90, Co-60, CS- 137, Fe-55, Ru-106, etc.)	R: IV	M – GERT provides recognition that source training is required	R: IV

Likelihood (L, of event)/year	Сог	sequence (C, of event)/y	vear	Risk (R, Qualitative R	Risk (R, Qualitative Ranking)		Risk Matrix				
$\mathbf{A} = \text{Anticipated} (L > 1.0\text{E-}02)$	$\mathbf{H} = \mathrm{High}$			\mathbf{I} = situation (event) of major concern					Like	lihood	
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation (event) of concern}$				Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (eve	ent) of minor concern	es	Н	Ι	Ι	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)	$\mathbf{N} = $ Negligible			IV = situation (event) of minimal concern		enc	М	II	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	edn	т		ш	117	
P = Preventive (reduce event occurrence likelihood)	Н	C ³ 25.0 rem		C ³ 100 rem	C ³ 100 rem	ons	L	III	III	IV	IV
$\mathbf{M} = $ Mitigative (reduces event consequences)	Μ	25.0 rem > C ³ 5 rem	10	00 rem > C ³ 25 rem	100 rem > C ³ 25 rem	C	Ν	IV	IV	IV	IV
Acronyms	L	5 rem > C		25 rem > C	25 rem > C						
MOI = Maximally-exposed Offsite Individual rem = Roentgen equivalent man	Ν	0.5 rem > C		5 rem > C	5 rem > C	1					

 Table 28.3 Radiological – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)	
Residual Hazard: activation • NM4 target station (ammonia, liquid helium, liquid nitrogen) and front face of the absorber magnet have activation potential.		L: BEU C: N R: IV	No further analysis required; this hazard is not accessible to the public in this segments pattern of use	L: BEU C: N R: IV	
Groundwater Activation	Hazard: • Scattered beam has potential to activate ground water at low levels calculated in the shield assessment.	L: BEU C: N R: IV	No further analysis required	L: BEU C: N R: IV	
Surface Water Activation	Hazard: • Scattered beam has potential to activate surface water at low levels calculated in the shield assessment.	L: BEU C: N R: IV	No further analysis required	L: BEU C: N R: IV	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Water (RAW) Systems	 Hazard: (NM4 Only) RAW system present in NM4 for cooling of absorber magnet and target cave has exposure 	L: BEU C: N R: IV	No further analysis required; this hazard is not accessible to the public in this segments pattern of use	L: BEU C: N R: IV
Air Activation	potential if system ruptures. Hazard: (NM4 Only) • Scattered 120 GeV beam in NM4 target system can activate air.	L: BEU C: N R: IV	No further analysis required	L: BEU C: N R: IV
Soil Interactions	Hazard: • Scattered beam has potential to activate soil at low levels calculated in the shield assessment.	L: BEU C: N R: IV	No further analysis required	L: BEU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive waste	 Hazard: Activation potential is low in these spaces and experiments typically remove equipment upon completion. Any materials that cannot be cleared and removed by an experiment are subject to the labs radioactive waste program. 	L: BEU C: N R: IV	No further analysis required; this hazard is not accessible to the public in this segments pattern of use	L: BEU C: N R: IV
Contamination	Hazard: • Potential contaminated items brought into facility by experimenters.	L: BEU C: N R: IV	No further analysis required; this hazard is not accessible to the public in this segments pattern of use	L: BEU C: N R: IV
⁷ Be	Hazard: • Potential radiation exposure to 7Be (uptake/committed dose).	L: BEU C: N R: IV	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't hazardous in this pattern of use by facility.	L: BEU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Sources	 Hazard: Various low activity sealed sources (Sr-90, Co-60, CS-137, Fe-55, Ru-106, etc.) 	L: BEU C: N R: IV	No further analysis required; this hazard is not accessible to the public in this segments pattern of use	L: BEU C: N R: IV

Likelihood (L, of event)/year	Co	nsequence (C, of event)/y	year	Risk (R, Qualitative Ranking)			Risk Matrix				
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \text{High}$		$\mathbf{I} = \text{situation (event) of major concern}$					Like	lihood	-
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation (event) of concern}$				Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathrm{Low}$		III = situation (eve	ent) of minor concern	es	Н	Ι	Ι	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$		IV = situation (event) of minimal concern		enc	М	Π	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsi	te-2 (co-located worker)	Onsite-1 (facility worker)	equ	т	TTT	ш	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ³ 25.0 rem		C ³ 100 rem	C ³ 100 rem	ous	L	Ш	ш	IV	IV
$\mathbf{M} = $ Mitigative (reduces event consequences)	Μ	25.0 rem > C ³ 5 rem	1	00 rem > C ³ 25 rem	100 rem > C ³ 25 rem	C	Ν	IV	IV	IV	IV
Acronyms	L	5 rem > C		25 rem > C	25 rem > C						
MOI = Maximally-exposed Offsite Individual rem = Roentgen equivalent man	Ν	0.5 rem > C		5 rem > C	5 rem > C						

 Table 28.4 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:	L: C: R:	See Section I, Chapter 4	L: C: R:

Beryllium*	Hazard:		L:	See Section I, Chapter 4	L:
			C:		C:
			R:		R:
Ammonia	Hazard:	• Toxicity hazard from exposure to target material when in a gaseous state above -77 C	NM3 Target Cave L: A C: M R: II	NM3 Target Cave P: Standard Operating Procedures for handling P: Training M: PPE (dermal) M: Engineering control (Room ventilation) M: Ammonia kept in solid form in cryogens	NM3 Target Cave L: EU C: N R: IV
			NM4 handling areas L: A C: M R: II External	NM4 handling areas P: Standard Operating Procedures for handling P: Training M: PPE (dermal) M: Room ventilation M: Ammonia kept in solid form in cryogens External Storage shed P: Standard Operating Procedures for handling	NM4 handling areas L: EU C: N R: IV External storage shed
			storage shed L: A C: M R: II	 P: Training M: PPE (dermal) M: Air sampling before entry M: Room ventilation M: Ammonia kept in solid form in cryogens 	L: EU C: N R: IV
			Transportatio n L: A C: L R: III	Transportation P: Standard Operating Procedures for transportation before and after beam exposure P: Training M: Certified packaging, labeling, and tamper proof seals M: Ammonia kept in solid form in cryogens	Transportatio n L: EU C: N R: IV

Likelihood (L, of event)/year	Co	onsequence (C, of event)/year	Risk (R, Qualitative Ranking)			Risk Matrix				
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = \text{situation (event) of major concern}$					Like	lihood	
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation}$ (ev	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathrm{Low}$		III = situation (event) of minor concern		es	Н	Ι	Ι	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$		IV = situation (ev	vent) of minimal concern	enc	М	П	П	ш	IV
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	_				
P = Preventive (reduce event occurrence likelihood)	н	C ³ PAC-2		C ³ PAC-3	C ³ IDLH	suo	L	III	III	IV	IV
$\mathbf{M} = \mathbf{M}$ itigative (reduces event consequences)	М	$PAC-2 > C^{3}PAC-1$	P	$AC-3 > C^{3} PAC-2$	$IDLH > C^{3} PEL \text{ or } TLV_{c}$	Ŭ	Ν	IV	IV	IV	IV
Acronyms	L	PAC-1 > C		PAC-2 > C	PEL or $TLV_c > C$						
IDLH = Immediately Dangerous to Life and Health MOI = Maximally-exposed Offsite Individual	N	Consequences less than those for Low		sequences less than for Low Consequence	Consequences less than those for Low						
PAC = Protective Action Criteria PEL = Permissible Exposure Limit		Consequence Level		Level	Consequence Level						
TLV_c = Threshold Limit Value (ceiling)											

Table 28.5 Toxic Materials – Onsite 2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead *	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Beryllium*	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Ammonia	 Hazard: Toxicity hazard from exposure to target material when in a gaseous state above -77 C 	NM3 Target Cave L: U C: L R: III	NM3 Target CaveP: No access during target changeoutsM: Facility hazard awareness training to recognize hazardM: Ammonia alarmM: Engineering control (Room ventilation)M: Ammonia kept in solid form in cryogens	NM3 Target Cave L: EU C: N R: IV
		NM4 handling areas L: U C: L R: III	NM4 handling areas P: Distance from handling activity M: Facility hazard awareness training to recognize hazard M: Room ventilation M: Ammonia kept in solid form in cryogens	NM4 handling areas L: EU C: N R: IV
		External storage shed L: U C: N R: IV	External Storage shed P: Shed is locked M: Ammonia kept in solid form in cryogens	External storage shed L: EU C: N R: IV

Transportatio	Transportation	Transportatio
n L: U C: N R: IV	P: Distance from packageM: Certified packaging, labeling, and tamper proof sealsM: Ammonia kept in solid form in cryogens	n L: EU 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	Co	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk	Matri	X			
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = \text{situation}$ (eve	nt) of major concern						
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}\mathbf{O}\mathbf{O}\mathbf{P}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}O$		$\mathbf{II} = \text{situation}$ (even	ent) of concern	<u></u>		Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (ev	vent) of minor concern	es	Н	Ι	Ι	п	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = $ Negligible		IV = situation (ev	vent) of minimal concern	duence	М	Π	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbə					
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ PAC-2		C ³ PAC-3	C ³ IDLH	ous	L	III	III	IV	IV
$\mathbf{M} = $ Mitigative (reduces event consequences)	М	PAC-2 > C ³ PAC-1	PA	AC-3 > C ³ PAC-2	IDLH > C^{3} PEL or TLV _c		Ν	IV	IV	IV	IV
Acronyms	L	PAC-1 > C		PAC-2 > C	PEL or $TLV_c > C$						
IDLH = Immediately Dangerous to Life and Health MOI = Maximally-exposed Offsite Individual	Ν	Consequences less	Cor	nsequences less than	Consequences less than						
		than those for Low	those	for Low Consequence	those for Low						
PAC = Protective Action Criteria		Consequence Level		Level	Consequence Level						
PEL = Permissible Exposure Limit TLV _c = Threshold Limit Value (ceiling)		_									

Table 28.6 Toxic Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead*	Hazard:	L:	See Section I, Chapter 4	L:
		C:		C:
		R:		R:
Beryllium*	Hazard:	L:	See Section I, Chapter 4	L:
		C:		C:
		R:		R:
Ammonia	Hazard:	L:	See Section I, Chapter 4	L:
		C:	-	C:
		R:		R:

Chemical Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Co	Consequence (C, of event)/year R		Risk (R, Qualitative Ranking)		Risk	Matri	x				
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \text{High}$		$\mathbf{I} = \text{situation}$ (even	nt) of major concern			Likelihood				
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation}$ (eve	ent) of concern		1	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (ev	vent) of minor concern	ces	Н	Ι	Ι	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = $ Negligible		IV = situation (ev	vent) of minimal concern	nenc	М	II	II	ш	IV	
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn	Ţ		ш	IV	IV	
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ PAC-2		C ³ PAC-3	C ³ IDLH	Cons	L	III	ш	IV	IV	
$\mathbf{M} = $ Mitigative (reduces event consequences)	М	PAC-2 > C ³ PAC-1	PA	AC-3 > C ³ PAC-2	IDLH > C^{3} PEL or TLV _c	0	Ν	IV	IV	IV	IV	
Acronyms	L	PAC-1 > C		PAC-2 > C	PEL or $TLV_c > C$							
IDLH = Immediately Dangerous to Life and Health MOI = Maximally-exposed Offsite Individual PAC = Protective Action Criteria PEL = Permissible Exposure Limit	N	Consequences less than those for Low Consequence Level		nsequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level							
TLV_c = Threshold Limit Value (ceiling)												

Table 28.7 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	Hazard:	L:	See Section I, Chapter 4	L:
materials		C:		C:
(cables, Boxes,		R:		R:
Paper, wood				
cribbing, etc.)				
Flammable	Hazard:	L:	See Section I, Chapter 4	L:
Materials		C:		C:
(Flammable gas,		R:		R:
cleaning				
materials, etc.)				

Other Hazard Consequences, derived from Figure C-	1, "E	Example Qualitative Conse	equence Matrix", DOE-HI	DBK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	ear Risk (R, Qualitative	e Ranking)	Risk	Matr	ix			
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = situation (ev$	situation (event) of major concern				Like	lihood	
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (e	vent) of concern	<u> </u>		А	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	$\mathbf{III} = \text{situation} (\mathbf{e})$	event) of minor concern	es	Н	I	Ι	Π	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$	IV = situation (e	event) of minimal concern	enc	М	Π	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	suo	L	111	ш	1V	IV
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	C	Ν	IV	IV	IV	IV
Acronyms		symptoms which	immediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or permanently	threatening or						
		individual's ability to	disabling.	permanently disabling.						
		take protective								
		action.								
	Μ	C ³ Mild, transient	C ³ Serious injury, no	C ³ Serious injury, no						
		adverse effects.	immediate loss of life no	immediate loss of life no						
			permanent disabilities;	permanent disabilities;						
			hospitalization required.	hospitalization required.						
	L	Mild, transient	Minor injuries; no	Minor injuries; no						
		adverse effects $> C$	hospitalization > C	hospitalization $> C$						
	Ν	Consequences less	Consequences less than	Consequences less than						
		than those for Low t	hose for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 28.8 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	Hazard:	L:	See Section I, Chapter 4	L:
materials		C:		C:
(cables, Boxes,		R:		R:
Paper, wood				
cribbing, etc.)				
Flammable	Hazard:	L:	See Section I, Chapter 4	L:
Materials		C:		C:
(Flammable gas,		R:		R:
cleaning				
materials, etc.)				

Other Hazard Consequences, derived from Figure C-	1, "E	Example Qualitative Conse	quence Matrix", DOE-HD	BK-1163-2020.							
Likelihood (L, of event)/year	С	onsequence (C, of event)/ye	ear Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	\mathbf{I} = situation (event) of major concern				Likelihood			
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (ev	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	III = situation (ev	vent) of minor concern	es	Н	I	Ι	Π	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$	IV = situation (ev	vent) of minimal concern	enc	М	П	II	III	IV	
Control(s) Type	С	Offsite (MOI) 0	Insite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV	
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L	m	ш	11	1 V	
\mathbf{M} = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV	
Acronyms		symptoms which	immediately life-	immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an t	hreatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective									
		action.									
	М	C ³ Mild, transient	C 3 Serious injury, no	C ³ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects $> C$	hospitalization > C	hospitalization > C							
	Ν	Consequences less	Consequences less than	Consequences less than							
		than those for Low the	nose for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 28.9 Flammable and Combustible Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible	Hazard:	L:	See Section I, Chapter 4	L:
materials		C:		C:
(cables, Boxes,		R:		R:
Paper, wood				
cribbing, etc.)				
Flammable	Hazard:	L:	See Section I, Chapter 4	L:
Materials		C:		C:
(Flammable gas,		R:		R:
cleaning				
materials, etc.)				

Other Hazard Consequences, derived from Figure C-	1, "E	Example Qualitative Conse	quence Matrix", DOE-HD	BK-1163-2020.							
Likelihood (L, of event)/year	C	onsequence (C, of event)/ye	ear Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	tion (event) of major concern				Like	lihood		
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (ev	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	III = situation (ev	vent) of minor concern	es	Н	I	I	Π	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = $ Negligible	IV = situation (ev	vent) of minimal concern	enc	М	Π	Π	III	IV	
Control(s) Type	С	Offsite (MOI) 0	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV	
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L	m	m	11	1 V	
\mathbf{M} = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV	
Acronyms		symptoms which	immediately life-	immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an t	hreatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective									
		action.									
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects $> C$	hospitalization > C	hospitalization > C							
	Ν	Consequences less	Consequences less than	Consequences less than							
		than those for Low the	nose for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 28.10 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	Hazard:	L:	See Section I, Chapter 4	L:
Exposure		C:		C :
		R:		R:
High Voltage	Hazard:	L:	See Section I, Chapter 4	L:
Exposure		C:		C:
		R:		R:
Low Voltage,	Hazard:	L:	See Section I, Chapter 4	L:
High Current		C:	_	C:
Exposure.		R:		R:

Other Hazard Consequences, derived from Figure C-	1, "E	Example Qualitative Conse	quence Matrix", DOE-HD	BK-1163-2020.							
Likelihood (L, of event)/year	С	onsequence (C, of event)/ye	ear Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	\mathbf{I} = situation (event) of major concern				Likelihood			
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (ev	ent) of concern			А	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	III = situation (ev	vent) of minor concern	es	Н	I	Ι	Π	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$	IV = situation (ev	vent) of minimal concern	enc	М	Π	II	III	IV	
Control(s) Type	С	Offsite (MOI) 0	Insite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV	
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L	m	ш	11	1 V	
\mathbf{M} = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV	
Acronyms		symptoms which	immediately life-	immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an t	hreatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective									
		action.									
	М	C ³ Mild, transient	C 3 Serious injury, no	C ³ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects $> C$	hospitalization > C	hospitalization > C							
	Ν	Consequences less	Consequences less than	Consequences less than							
		than those for Low the	nose for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 28.11 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	Hazard:	L:	See Section I, Chapter 4	L:
Exposure		C:		C :
		R:		R:
High Voltage	Hazard:	L:	See Section I, Chapter 4	L:
Exposure		C:		C:
		R:		R:
Low Voltage,	Hazard:	L:	See Section I, Chapter 4	L:
High Current		C:	_	C:
Exposure.		R:		R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	Consequence (C, of event)/year Risk (R, Qualitative Ranking)					Matr	ix				
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E-}02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	nt) of major concern				Likelihood			
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (even	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	$\mathbf{III} = \text{situation}$ (ev	vent) of minor concern	es	Н	I	Ι	II	III	
BEU = Beyond Extremely Unlikely $(1.0E-06>L)$		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	М	П	II	Ш	IV	
Control(s) Type	С	Offsite (MOI) 0	onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV	
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L	ш		1 V	1 V	
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV	
Acronyms MOI = Maximally-exposed Offsite Individual		symptoms which could impair an t individual's ability to	immediately life- hreatening or permanently disabling.	immediately life- threatening or permanently disabling.							
		take protective action.	0								
	Μ	C ³ Mild, transient	C ³ Serious injury, no	C ³ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects > C	hospitalization > C	hospitalization > C							
	Ν	Consequences less	Consequences less than	Consequences less than							
		than those for Low the	nose for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 28.12 Electrical Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy	Hazard:	L:	See Section I, Chapter 4	L:
Exposure		C:		C:
		R:		R:
High Voltage	Hazard:	L:	See Section I, Chapter 4	L:
Exposure		C:		C:
		R:		R:
Low Voltage,	Hazard:	L:	See Section I, Chapter 4	L:
High Current		C:		C:
Exposure.		R:		R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event)/ye	ear Risk (R, Qualitative	Ranking)	Risk Matrix							
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	nt) of major concern				Likelihood				
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (ev	ent) of concern			Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	III = situation (ev	vent) of minor concern	es	Н	I	Ι	Π	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = $ Negligible	IV = situation (ev	vent) of minimal concern	enc	М	Π	II	III	IV		
Control(s) Type	С	Offsite (MOI) 0	onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV		
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L	m		11	1 V		
\mathbf{M} = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV		
Acronyms		symptoms which	immediately life-	immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an the	hreatening or permanently	threatening or								
		individual's ability to	disabling.	permanently disabling.								
		take protective										
		action.										
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ Serious injury, no								
		adverse effects.	immediate loss of life no	immediate loss of life no								
			permanent disabilities;	permanent disabilities;								
			hospitalization required.	hospitalization required.								
	L	Mild, transient	Minor injuries; no	Minor injuries; no								
		adverse effects $> C$	hospitalization > C	hospitalization > C								
	Ν	Consequences less	Consequences less than	Consequences less than								
		than those for Low the	nose for Low Consequence	those for Low								
		Consequence Level	Level	Consequence Level								

Table 28.13 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	Hazard:	L:	See Section I, Chapter 4	L:
		C:		C:
		R:		R:
Cryogenics	Hazard:	L: A	ODH	L: BEU
		C:H	P – SMEs produce engineering notes on piping and vessel system and ODH	C: N
	Cryogenics are inherently a low risk on	R: I	calculations.	R: IV
	their own as they are non-flammable and		P – ORC process has SMEs review installed system and documentation prior to	
	non-toxic.		operation.	
			P - Fire Safety and Life Safety Inspections are performed by Fire Protection Group	
	However, if exposed to the cryogenic		and the Fire Department.	
liquids, they have the potential of	liquids, they have the potential of burning		P – ODH alarm systems are tested and maintained.	
	skin and creating an oxygen deficient		M – ODH system of oxygen sensors triggers high volume mixing fans in NM4 and	
atmosp	atmosphere which can lead to death.		NM3 and is tested and calibrated at prescribed intervals.	
			M – ODH alarms are monitored by a sitewide monitoring system with notification	
	The exposure of the hazard to the facility		to the emergency dispatch center that is constantly staffed, 24/7, 365 days.	
	worker is of major concern.		M – Area/fixed oxygen monitoring provided in areas where cryogenic liquids are stored.	
			M – Onsite Emergency services are provided.	
			M – NM4 Credited Controls: two (2) oxygen monitors (one high, one low), one	
			(1) strobe, and one (1) horn.	Burns
		Burns	M – NM3 Credited Controls: two (2) oxygen monitors (one high, one low)	L: BEU
		L: A	sampling from NM3 Target Cave, one (1) light, and one (1) horn.	C:M
		C: H		R: IV
		R: I	Burns	
			P – Cryogenic system designed and reviewed by qualified personnel	
			P – WPC process provides instructions for use	
			P - Protective clothing rules are enforced when working in areas with exposure to	
			cryogenic liquids.	
			P- Training required for all personnel handling cryogenics	
			M – Onsite Emergency services are provided	

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020. Likelihood (L, of event)/year Consequence (C, of event)/year Risk (R, Qualitative Ranking) Risk Matrix										
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	Risk	Matri	ix					
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E-}02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (ev	ent) of major concern					lihood	
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}\mathbf{O}\mathbf{d}\mathbf{e}\mathbf{r}\mathbf{a}\mathbf{t}\mathbf{e}$	$\mathbf{II} = \text{situation}$ (e	vent) of concern	<u></u>	<u> </u>	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	$\mathbf{III} = \text{situation} (\mathbf{e})$	event) of minor concern	ses	Н	I	I	П	III
BEU = Beyond Extremely Unlikely $(1.0E-06>L)$		$\mathbf{N} = \mathbf{Negligible}$	IV = situation (e)	event) of minimal concern	ienc	М	II	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	jons	L	m	- 111	11	1 V
\mathbf{M} = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	0	Ν	IV	IV	IV	IV
Acronyms		symptoms which	immediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an t	threatening or permanently	threatening or						
		individual's ability to	disabling.	permanently disabling.						
		take protective								
		action.								
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ Serious injury, no						
		adverse effects.	immediate loss of life no	immediate loss of life no						
			permanent disabilities;	permanent disabilities;						
			hospitalization required.	hospitalization required.						
	L	Mild, transient	Minor injuries; no	Minor injuries; no						
	adverse effects $> C$ hosp		hospitalization > C	hospitalization > C						
	Ν	Consequences less	Consequences less than	Consequences less than						
			hose for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 28.14 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	Hazard:	L:	See Section I, Chapter 4	L:
		C:		C:
		R:		R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenics	 Hazard: Cryogenics are inherently a low risk on their own as they are non-flammable and non-toxic. However, if exposed to the cryogenic liquids, they have the potential of burning skin and creating an oxygen deficient atmosphere which can lead to death. The exposure of the hazard to the facility worker is of major concern. 	L: A C:H R: I	 ODH P – SMEs produce engineering notes on piping and vessel system and ODH calculations. P – ORC process has SMEs review installed system and documentation prior to operation. P - Fire Safety and Life Safety Inspections are performed by Fire Protection Group and the Fire Department. P – ODH alarm systems are tested and maintained. M – ODH system of oxygen sensors triggers high volume mixing fans in NM4 and NM3 and is tested and calibrated at prescribed intervals. M – ODH alarms are monitored by a sitewide monitoring system with notification to the emergency dispatch center that is constantly staffed, 24/7, 365 days. M – Area/fixed oxygen monitoring provided in areas where cryogenic liquids are stored. M – NM4 Credited Controls: two (2) oxygen monitors (one high, one low), one (1) strobe, and one (1) horn. M – NM3 Target Cave, one (1) light, and one (1) horn. 	L: BEU C: N R: IV
		Burns L: A C: H R: I	 P – Cryogenic system designed and reviewed by qualified personnel P – WPC process provides instructions for use P - Protective clothing rules are enforced when working in areas with exposure to cryogenic liquids. P- Training required for all personnel handling cryogenics M – Onsite Emergency services are provided 	Burns L: BEU C:M R: IV

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

Likelihood (L, of event)/year	С	onsequence (C, of event))/year	Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = \text{situation}$ (even	nt) of major concern			I				
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation}$ (eve	ent) of concern		-	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = Low$		III = situation (ev	vent) of minor concern	es	Н	Ι	Ι	Π	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$		IV = situation (ev	vent) of minimal concern	enc	М	II	II	III	IV	
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	Ŧ					
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ P	Prompt worker fatality	C ³ Prompt worker fatality	suo	L	III	III	IV	IV	
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or		acute injury that is or acute injury that is			Ν	IV	IV	IV	IV	
Acronyms		symptoms which	-	immediately life-	immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair anthreatening or permanentlyindividual's ability todisabling.		threatening or								
				permanently disabling.								
		take protective										
		action.										
	М	C ³ Mild, transient	С	³ Serious injury, no	C ³ Serious injury, no							
		adverse effects.	imn	nediate loss of life no	immediate loss of life no							
			per	manent disabilities;	permanent disabilities;							
			hos	pitalization required.	hospitalization required.							
	L	Mild, transient	I	Minor injuries; no	Minor injuries; no							
	adverse effects $> C$		h	ospitalization > C	hospitalization > C							
	Ν	Consequences less	Cor	nsequences less than	Consequences less than							
		than those for Low	those	for Low Consequence	those for Low							
		Consequence Level		Level	Consequence Level							

Table 28.15 Thermal Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hot Work	Hazard:	L:	See Section I, Chapter 4	L:
		C:		C:
		R:		R:
Cryogenics	Hazard:	L:	See Section I, Chapter 4	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020. Likelihood (L. of event)/year Consequence (C. of event)/year Risk (R. Qualitative Ranking) Risk Matrix										
Likelihood (L, of event)/year	C	onsequence (C, of event)/ye	Sequence (e), or event)/year rush (ri, Quantative running)							
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	nt) of major concern			Likelihood			
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (ev	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	III = situation (ev	vent) of minor concern	es	Н	I	Ι	II	III
BEU = Beyond Extremely Unlikely $(1.0E-06>L)$		$\mathbf{N} = \mathbf{Negligible}$	IV = situation (ev	vent) of minimal concern	enc	М	Π	Π	III	IV
Control(s) Type	С	Offsite (MOI) 0	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L	m	m	11	1 V
$\mathbf{M} = \mathbf{M}$ itigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV
Acronyms		symptoms which	immediately life- immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an t	hreatening or permanently	threatening or						
		individual's ability to	disabling.	permanently disabling.						
		take protective								
		action.								
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ Serious injury, no						
		adverse effects.	immediate loss of life no	immediate loss of life no						
			permanent disabilities;	permanent disabilities;						
			hospitalization required.	hospitalization required.						
	L	Mild, transient	Minor injuries; no	Minor injuries; no						
		adverse effects $> C$	hospitalization > C	hospitalization > C						
	Ν	Consequences less	Consequences less than	Consequences less than						
		than those for Low the	nose for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 28.16 Kinetic Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power tools	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Pumps and Motors	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Motion Tables	 Hazard: Personnel injury due to pinch points, tip-overs, caught in between, crushing. 	L: A C: H R: I	 P – Engineering notes/ORC procedure P – Safety stops P – Physical isolation of system M – Emergency stop as determined by SME M – Speed restrictions on motor 	L: BEU C: L R: IV

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020. Likelihood (L, of event)/year Consequence (C, of event)/year Risk (R, Qualitative Ranking) Risk Matrix										
Likelihood (L, of event)/year	C	onsequence (C, of event)/ye	Risk	Matri	ix					
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	nt) of major concern			Likelihood			
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (even	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	$\mathbf{III} = \text{situation}$ (ev	vent) of minor concern	es	Н	I	Ι	Π	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$	IV = situation (ev	vent) of minimal concern	enc	М	Π	II	III	IV
Control(s) Type	С	Offsite (MOI) 0	Offsite (MOI) Onsite-2 (co-located worker)		Consequences	т	ш	ш	IV	IV
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L	m		11	1 V
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV
Acronyms		symptoms which	immediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an threatening or permanently		threatening or						
		individual's ability to	disabling.	permanently disabling.						
		take protective								
		action.								
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ Serious injury, no						
		adverse effects.	immediate loss of life no	immediate loss of life no						
			permanent disabilities;	permanent disabilities;						
			hospitalization required.	hospitalization required.						
	L	Mild, transient	Minor injuries; no	Minor injuries; no						
		adverse effects $> C$	hospitalization > C	hospitalization $> C$						
	Ν	Consequences less	Consequences less than	Consequences less than						
		than those for Low th	nose for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 28.17 Kinetic Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power tools	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Pumps and Motors	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Motion Tables	 Hazard: Personnel injury due to pinch points, tip-overs, caught in between, crushing. 	L: A C: H R: I	 P – Engineering Notes/ORC procedure evaluates the tables for stability and user safety P – Safety stops (where applicable) prevent injury due to pinch points and getting caught in between events P – Physical isolation of system M – Speed restrictions on motor M – General facility HA training to recognize hazard 	L: BEU C: L R: IV

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

Likelihood (L, of event)/year	С	onsequence (C, of event)/2	year R	Risk (R, Qualitative)	Ranking)	Risk	Matri	x			
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = situation$ (eve	tuation (event) of major concern				Like	lihood	-
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation}$ (eve	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathrm{Low}$	$\mathbf{L} = Low$		vent) of minor concern	es	Н	Ι	Ι	II	III
BEU = Beyond Extremely Unlikely (1.0E-06>L)		$\mathbf{N} = $ Negligible	$\mathbf{N} = $ Negligible		vent) of minimal concern	enc	М	II	II	III	IV
Control(s) Type	С	Offsite (MOI)	Offsite (MOI) Onsite-2 (co-		Onsite-1 (facility worker)	nbə	_				
P = Preventive (reduce event occurrence likelihood)	н	C ³ Irreversible, other	Irreversible, other C ³ Prompt v		C ³ Prompt worker fatality	Consequences	L	III	III	IV	IV
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	, I		or acute injury that is	Ŭ	Ν	IV	IV	IV	IV
Acronyms		symptoms which		mediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		~ 1		ing or permanently	threatening or						
		individual's ability to		disabling.	permanently disabling.						
		take protective		disuoling.	permanentity ansubting.						
		action.									
	М	C ³ Mild, transient	C ³ Se	erious injury, no	C ³ Serious injury, no						
		adverse effects.		liate loss of life no	immediate loss of life no						
				anent disabilities;	permanent disabilities;						
			-	alization required.	hospitalization required.						
	L	Mild, transient		nor injuries; no	Minor injuries; no						
		adverse effects > C		pitalization > C	hospitalization > C						

Table 28.18 Kinetic Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power tools	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Pumps and Motors	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Motion Tables	Hazard:	L: C: R:	See Section I, 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	С	onsequence (C, of event)/y	year	Risk (R, Qualitative	Ranking)	Risk	Matr	ix	(
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \text{High}$		$\mathbf{I} = \text{situation}$ (eve	nt) of major concern				Likelihood				
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation}$ (ev	ent) of concern		r	Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		$\mathbf{III} = \text{situation}$ (ev	vent) of minor concern	ces	Н	Ι	Ι	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$		IV = situation (ev	vent) of minimal concern	enc	М	Π	II	III	IV		
Control(s) Type	С	Offsite (MOI)	Onsite-	-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	L	ш	ш	IV	IV		
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	н	C ³ Irreversible, other serious effects, or		compt worker fatality acute injury that is	C ³ Prompt worker fatality or acute injury that is	Con	N	IV	IV	IV	IV		
Acronyms MOI = Maximally-exposed Offsite Individual		symptoms which	ir	mmediately life- ening or permanently	immediately life- threatening or		1						
		individual's ability to	uneau	disabling.	permanently disabling.								
		take protective action.											
	Μ	C ³ Mild, transient	C 3	Serious injury, no	C ³ Serious injury, no								
		adverse effects.	imme	ediate loss of life no	immediate loss of life no								
			permane		permanent disabilities;								
			hospitaliz		hospitalization required.								
	L	Mild, transient	М	linor injuries; no	Minor injuries; no								
		adverse effects $> C$	ho	ospitalization > C	hospitalization > C								

Table 28.19 Potential Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Compressed Gasses	 Hazard: Personnel injury due to unexpected release, or unsecure tanks. May also present flammability and ODH concerns 	K. L: A C: H R: I	 P – Engineering notes to evaluate ODH for gases brought to facility. New or modified piping/manifolds similarly evaluated. P – NM4 is an engineered ODH 0 space with monitoring/alarms/ventilation discussed further under cryogenic liquid hazards P: All personnel handling compressed gasses have to take Pressure Safety orientation training. P: All personnel handling compressed gasses have to take compressed gas cylinder safety training P: All personnel have to be familiar with FESHM 5000 series and apply requirements. P: Gas cylinders are secured and capped when not in use. M: Personal Protective Equipment mitigates severity of injury. 	L: BEU C: M R: IV
Vacuum/ Pressure Vessels/ Piping	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Vacuum Pumps	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Material Handling	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:

Other Hazard Consequences, derived from Figure C-	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.										
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk	Matri	X			
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = \text{situation}$ (eve	nt) of major concern				Likelihood		
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation}$ (ev	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = Low$		III = situation (ev	vent) of minor concern	es	Н	Ι	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$		IV = situation (ev	vent) of minimal concern	enc	М	II	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	T		ш	TV.	IV
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C 3 P	rompt worker fatality	C ³ Prompt worker fatality	suo	L	III	Ш	IV	IV
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or		acute injury that is	or acute injury that is	C	Ν	IV	IV	IV	IV
Acronyms		symptoms which		immediately life-	immediately life-				•	•	
MOI = Maximally-exposed Offsite Individual		could impair an		tening or permanently	threatening or						
		individual's ability to		disabling.	permanently disabling.						
		take protective		C C							
		action.									
	Μ	C ³ Mild, transient	С	³ Serious injury, no	C ³ Serious injury, no						
		adverse effects.	imm	nediate loss of life no	immediate loss of life no						
			per	manent disabilities;	permanent disabilities;						
			hos	pitalization required.	hospitalization required.						

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

Table 28.20 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	Hazard:	L:	See Section I, Chapter 4	L:
Operations		C:		C:
		R:		R:
Compressed	Hazard:	L:	See Section I, Chapter 4	L:
Gasses		C:	-	C:
		R:		R:
Vacuum/	Hazard:	L:	See Section I, Chapter 4	L:
Pressure		C:		C:
Vessels/		R:		R:
Piping				
Vacuum Pumps	Hazard:	L:	See Section I, Chapter 4	L:
_		C:		C:
		R:		R:
Material	Hazard:	L:	See Section I, Chapter 4	L:
Handling		C:	-	C:
-		R:		R:

Other Hazard Consequences, derived from Figure C-	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.										
Likelihood (L, of event)/year	C	onsequence (C, of event)/ye	ear Risk (R, Qualitative	Ranking)	Risk	Matri	ix				
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (ev	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	III = situation (ev	vent) of minor concern	es	Н	I	Ι	Π	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = $ Negligible	IV = situation (ev	vent) of minimal concern	enc	М	Π	II	III	IV	
Control(s) Type	С	Offsite (MOI) 0	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV	
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L			1.		
\mathbf{M} = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV	
Acronyms		symptoms which	immediately life-	immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an t	hreatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective									
		action.									
	М	C ³ Mild, transient	C 3 Serious injury, no	C ³ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects $> C$	hospitalization > C	hospitalization > C							
	Ν	Consequences less	Consequences less than	Consequences less than							
		than those for Low the	nose for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 28.21 Potential Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane	Hazard:	L:	See Section I, Chapter 4	L:
Operations		C:		C:
_		R:		R:
Compressed	Hazard:	L:	See Section I, Chapter 4	L:
Gasses		C:		C:
		R:		R:
Vacuum/	Hazard:	L:	See Section I, Chapter 4	L:
Pressure		C:		C:
Vessels/		R:		R:
Piping				
Vacuum Pumps	Hazard:	L:	See Section I, Chapter 4	L:
_		C:		C:
		R:		R:
Material	Hazard:	L:	See Section I, Chapter 4	L:
Handling		C:		C:
-		R:		R:

Other Hazard Consequences, derived from Figure C-	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.										
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	ear Risk (R, Qualitative	Ranking)	Risk	Matr	ix				
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (ev	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	III = situation (ev	vent) of minor concern	es	Н	I	Ι	Π	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$	IV = situation (ev	vent) of minimal concern	enc	М	Π	II	III	IV	
Control(s) Type	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV	
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L	m	ш	11	1 V	
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV	
Acronyms MOI = Maximally-exposed Offsite Individual		symptoms which could impair an t individual's ability to take protective action.	immediately life- hreatening or permanently disabling.	immediately life- threatening or permanently disabling.							
	М	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	Minor injuries; no	Minor injuries; no							
		adverse effects $> C$	hospitalization > C	hospitalization > C							
	Ν	Consequences less	Consequences less than	Consequences less than							
		than those for Low the	hose for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 28.22 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	ge Fields Hazard: • Exposure to fringe fields beyond allowable limits (worker with ferromagnetic or electronic medical device(s))		 P- Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P- Access control points and individual components of concern (e.g., experiment permanent magnet) have postings to notify workers of magnetic hazard. P – Facility specific hazard awareness training alerting to fringe fields 	L: BEU C: H R: III
	• Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic medical device(s))	L: A C: L R: III	 P- Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P- Access control points and individual components of concern (e.g., experiment permanent magnet) have postings to notify workers of magnetic hazard. P - Facility specific hazard awareness training alerting to fringe fields 	L: BEU C: L R: IV
	• Exposure to flying metallic objects causing potential injury.	L: A C: M R: II	 P- Brass tools are used to prevent flying metallic objects from occurring, thereby preventing worker injury as prescribed by relevant magnet SOP P-Work Control procedure/SOP (ferromagnetic object control) requires that all ferromagnetic objects are removed prior to entry into a fringe field area (30G administrative limit). P-Work Control procedure/SOP requires worker training while in areas possessing fringe fields (300 G administrative limit). 	L: BEU C: M R: IV

Other Hazard Consequences, derived from Figure C-	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	С	onsequence (C, of event)/ye	ear Risk (R, Qualitative	Ranking)	Risk	Matri	ix					
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	nt) of major concern				Like	lihood			
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (ev	ent) of concern			А	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	III = situation (ev	vent) of minor concern	es	Н	I	Ι	Π	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = $ Negligible	IV = situation (ev	vent) of minimal concern	enc	М	Π	II	III	IV		
Control(s) Type	С	Offsite (MOI) 0	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV		
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L	m	m	11	1 V		
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV		
Acronyms		symptoms which	immediately life-	immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an t	hreatening or permanently	threatening or								
		individual's ability to	disabling.	permanently disabling.								
		take protective										
		action.										
	М	C ³ Mild, transient	C ³ Serious injury, no	C ³ Serious injury, no								
		adverse effects.	immediate loss of life no	immediate loss of life no								
			permanent disabilities;	permanent disabilities;								
			hospitalization required.	hospitalization required.								
	L	Mild, transient	Minor injuries; no	Minor injuries; no								
		adverse effects $> C$	hospitalization > C	hospitalization > C								
	Ν	Consequences less	Consequences less than	Consequences less than								
		than those for Low the	nose for Low Consequence	those for Low								
		Consequence Level	Level	Consequence Level								

Table 28.23 Magnetic Fields – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	Hazard: • Exposure to fringe fields beyond allowable limits (worker with ferromagnetic or electronic medical device(s))	L: A C: H R: I	 P- Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P- Access control points and individual components of concern (e.g., experiment permanent magnet) have postings to notify workers of magnetic hazard. P – Facility specific hazard awareness training alerting to fringe fields 	L: BEU C: H R: III
	• Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic medical device(s))	L: A C: L R: III	 P- Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P- Access control points and individual components of concern (e.g., experiment permanent magnet) have postings to notify workers of magnetic hazard. P - Facility specific hazard awareness training alerting to fringe fields 	L: BEU C: L R: IV
	• Exposure to flying metallic objects causing potential injury.	L: A C: M R: II	 P- Brass tools are used to prevent flying metallic objects from occurring, thereby preventing worker injury as prescribed by relevant magnet SOP P-Work Control procedure/SOP (ferromagnetic object control) requires that all ferromagnetic objects are removed prior to entry into a fringe field area (30G administrative limit). P-Work Control procedure/SOP requires worker training while in areas possessing fringe fields (300 G administrative limit). 	L: BEU C: M R: IV

Other Hazard Consequences, derived from Figure C-	Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.										
Likelihood (L, of event)/year	C	onsequence (C, of event)/ye	ear Risk (R, Qualitative	Ranking)	Risk	Matri	ix				
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$	$\mathbf{I} = \text{situation}$ (eve	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate	$\mathbf{II} = \text{situation}$ (ev	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$	III = situation (ev	vent) of minor concern	es	Н	I	I	Π	III	
BEU = Beyond Extremely Unlikely $(1.0E-06>L)$		$\mathbf{N} = \mathbf{Negligible}$	IV = situation (ev	vent) of minimal concern	enc	М	Π	II	III	IV	
Control(s) Type	С	Offsite (MOI) 0	onsite-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV	
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Prompt worker fatality	C ³ Prompt worker fatality	ons	L	m		11	1 V	
\mathbf{M} = Mitigative (reduces event consequences)		serious effects, or	or acute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV	
Acronyms		symptoms which	immediately life-	immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an the	hreatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective									
		action.									
	Μ	C ³ Mild, transient	C ³ Serious injury, no	C ³ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects $> C$	hospitalization > C	hospitalization > C							
	Ν	Consequences less	Consequences less than	Consequences less than							
		than those for Low the	nose for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 28.24 Magnetic Fields – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	Hazard:	L: BEU C: N R: IV	No fringe fields are accessible to the public, no further analysis required	L: BEU C: N R: IV

Other Hazard Consequences, derived from Figure C-1	, "E	Example Qualitative Conse	sequenc	ce Matrix", DOE-HD	BK-1163-2020.								
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	year]	Risk (R, Qualitative	Ranking)	Risk Matrix							
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \text{High}$		$\mathbf{I} = situation$ (eve	nt) of major concern				Likelihood				
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}\mathbf{O}\mathbf{O}\mathbf{P}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}\mathbf{O}O$		$\mathbf{II} = \text{situation}$ (eve	ent) of concern			Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (ev	vent) of minor concern	es	Н	Ι	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$		IV = situation (ev	vent) of minimal concern	enc	М	II	II	III	IV		
Control(s) Type	С	Offsite (MOI)	Onsite-2	2 (co-located worker)	Onsite-1 (facility worker)	Consequences	T		ш	117	13.7		
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ Pro	ompt worker fatality	C ³ Prompt worker fatality	suo	L	III	ш	IV	IV		
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or		cute injury that is	or acute injury that is	C	Ν	IV	IV	IV	IV		
Acronyms		symptoms which		nmediately life-	immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an	threater	ening or permanently	threatening or								
		individual's ability to		disabling.	permanently disabling.								
		take protective											
		action.											
	Μ	C 3 Mild, transient	C 3 S	Serious injury, no	C ³ Serious injury, no								
		adverse effects.	immee	diate loss of life no	immediate loss of life no								
			perm	nanent disabilities;	permanent disabilities;								
			hospit	italization required.	hospitalization required.								
	L	Mild, transient	Mi	inor injuries; no	Minor injuries; no								
		adverse effects $> C$	hos	spitalization > C	hospitalization $> C$								
	Ν	Consequences less	Conse	sequences less than	Consequences less than								
		than those for Low t	those for	or Low Consequence	those for Low								
		Consequence Level		Level	Consequence Level								

Table 28.25 Other hazards – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined Space	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Noise	Hazard: Exposure above OELs via use of machinery, tools, co- location w/ equipment, etc	L: A C: L R: III	M – IH surveys and follow up w/ workers- administrative controls M – Hearing conservation program	L: A C: N R: IV
Silica	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Ergonomics	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Working at Heights	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:

Other Hazard Consequences, derived from Figure C-1	, "E	Example Qualitative Cons	sequence	e Matrix", DOE-HDI	BK-1163-2020.								
Likelihood (L, of event)/year	C	onsequence (C, of event)/	/year R	Risk (R, Qualitative]	Ranking)	Risk Matrix							
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = \text{situation (event) of major concern}$					Likelihood				
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation}$ (eve	ent) of concern			Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (ev	vent) of minor concern	ses	Η	Ι	Ι	Π	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = $ Negligible		IV = situation (ev	vent) of minimal concern	ienc	М	II	II	III	IV		
Control(s) Type	С	Offsite (MOI)	Onsite-2	(co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	Ш	IV	IV		
\mathbf{P} = Preventive (reduce event occurrence likelihood)	H	C ³ Irreversible, other	C ³ Pron	mpt worker fatality	C ³ Prompt worker fatality	ons	L	m		11	1 V		
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or act	ute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV		
Acronyms		symptoms which	imn	mediately life-	immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an	threateni	ing or permanently	threatening or								
		individual's ability to		disabling.	permanently disabling.								
		take protective											
		action.											
	Μ	C 3 Mild, transient	C 3 Se	erious injury, no	C ³ Serious injury, no								
		adverse effects.	immedi	iate loss of life no	immediate loss of life no								
			perma	anent disabilities;	permanent disabilities;								
			hospita	alization required.	hospitalization required.								
	L	Mild, transient	Min	nor injuries; no	Minor injuries; no								
		adverse effects > C	hosp	pitalization > C	hospitalization > C								
	Ν	Consequences less		equences less than	Consequences less than								
		than those for Low	those for	r Low Consequence	those for Low								
		Consequence Level		Level	Consequence Level								

Table 28.26 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 Space	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Noise	Hazard: Exposure above OELs via use of machinery, tools, co- location w/ equipment, etc	L: A C: L R: III	M – IH surveys and follow up w/ workers- administrative controls M – Hearing conservation program	L: A C: N R: IV
Silica	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Ergonomics	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Working at Heights	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:

Other Hazard Consequences, derived from Figure C-1	, "E	Example Qualitative Cons	sequence	e Matrix", DOE-HDI	BK-1163-2020.								
Likelihood (L, of event)/year	C	onsequence (C, of event)/	/year R	Risk (R, Qualitative]	Ranking)	Risk Matrix							
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = \text{situation (event) of major concern}$					Likelihood				
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = situation (even$	ent) of concern			Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (ev	vent) of minor concern	ses	Η	Ι	Ι	Π	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = $ Negligible		IV = situation (ev	vent) of minimal concern	ienc	М	II	II	III	IV		
Control(s) Type	С	Offsite (MOI)	Onsite-2	(co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	Ш	IV	IV		
\mathbf{P} = Preventive (reduce event occurrence likelihood)	H	C ³ Irreversible, other	C ³ Pron	mpt worker fatality	C ³ Prompt worker fatality	ons	L	m		11	1 V		
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or act	ute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV		
Acronyms		symptoms which	imn	mediately life-	immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an	threateni	ing or permanently	threatening or								
		individual's ability to		disabling.	permanently disabling.								
		take protective											
		action.											
	Μ	C 3 Mild, transient	C 3 Se	erious injury, no	C ³ Serious injury, no								
		adverse effects.	immedi	iate loss of life no	immediate loss of life no								
			perma	anent disabilities;	permanent disabilities;								
			hospita	alization required.	hospitalization required.								
	L	Mild, transient	Min	nor injuries; no	Minor injuries; no								
		adverse effects > C	hosp	pitalization > C	hospitalization > C								
	Ν	Consequences less		equences less than	Consequences less than								
		than those for Low	those for	r Low Consequence	those for Low								
		Consequence Level		Level	Consequence Level								

Table 28.27 Other hazards – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined Space	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Noise	Hazard: Exposure above OELs via use of machinery, tools, co- location w/ equipment, etc	L: BEU C: N R: IV	No access to the public to this space.	L: BEU C: N R: IV
Silica	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Ergonomics	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:
Working at Heights	Hazard:	L: C: R:	See Section I, Chapter 4	L: C: R:

Other Hazard Consequences, derived from Figure C-1	l , "E	xample Qualitative Cons	sequenc	ce Matrix", DOE-HD	BK-1163-2020.								
Likelihood (L, of event)/year	C	onsequence (C, of event)/	/year	Risk (R, Qualitative	Ranking)	Risk Matrix							
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = \text{situation}$ (even	tion (event) of major concern								
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}\mathbf{O}\mathbf{d}\mathbf{e}\mathbf{r}\mathbf{a}\mathbf{t}\mathbf{e}$		$\mathbf{II} = \text{situation}$ (eve	ent) of concern			Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (ev	vent) of minor concern	ses	Η	Ι	I	П	III		
BEU = Beyond Extremely Unlikely $(1.0E-06>L)$		$\mathbf{N} = \mathbf{Negligible}$		IV = situation (ev	vent) of minimal concern	lenc	Μ	Π	II	III	IV		
Control(s) Type	С	Offsite (MOI)	Onsite-2	2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	Ш	ш	IV	IV		
\mathbf{P} = Preventive (reduce event occurrence likelihood)	H	C ³ Irreversible, other	C ³ Pro	ompt worker fatality	C ³ Prompt worker fatality	ons	L	III	- 111	1V	1 V		
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or a	cute injury that is	or acute injury that is	С	Ν	IV	IV	IV	IV		
Acronyms		symptoms which	in	nmediately life-	immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an	threate	ening or permanently	threatening or								
		individual's ability to		disabling.	permanently disabling.								
		take protective											
		action.											
	Μ	C ³ Mild, transient	C ³	Serious injury, no	C ³ Serious injury, no								
		adverse effects.	imme	ediate loss of life no	immediate loss of life no								
			pern	nanent disabilities;	permanent disabilities;								
			hospi	italization required.	hospitalization required.								
	L	Mild, transient	Μ	linor injuries; no	Minor injuries; no								
		adverse effects > C	ho	spitalization > C	hospitalization > C								
	Ν	Consequences less		sequences less than	Consequences less than								
		than those for Low	those for	or Low Consequence	those for Low								
		Consequence Level		Level	Consequence Level								

Table 28.28 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	Hazard:	L:	See Section I, Chapter 4	L:
Egress		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1	ι , " Ε	example Qualitative Cons	sequen	ce Matrix", DOE-HD	BK-1163-2020.								
Likelihood (L, of event)/year	C	onsequence (C, of event)/	/year	Risk (R, Qualitative	Ranking)	Risk Matrix							
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = \text{situation}$ (even	nt) of major concern								
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}\mathbf{O}\mathbf{e}\mathbf{r}\mathbf{a}\mathbf{t}\mathbf{e}$		$\mathbf{II} = \text{situation}$ (eve	ent) of concern			Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (ev	vent) of minor concern	ses	Н	Ι	Ι	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$		IV = situation (ev	vent) of minimal concern	lenc	М	п	II	III	IV		
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV		
\mathbf{P} = Preventive (reduce event occurrence likelihood)	H	C ³ Irreversible, other	C ³ P	rompt worker fatality	C ³ Prompt worker fatality	Suo	L	III	ш	1V	IV		
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or	acute injury that is	or acute injury that is	C	Ν	IV	IV	IV	IV		
Acronyms		symptoms which	i	mmediately life-	immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an	threat	ening or permanently	threatening or								
		individual's ability to		disabling.	permanently disabling.								
		take protective											
		action.											
	М	C ³ Mild, transient	C 3	⁹ Serious injury, no	C ³ Serious injury, no								
		adverse effects.	imm	ediate loss of life no	immediate loss of life no								
			peri	manent disabilities;	permanent disabilities;								
			hosp	bitalization required.	hospitalization required.								
	L	Mild, transient	Ν	/linor injuries; no	Minor injuries; no								
		adverse effects > C	ho	ospitalization > C	hospitalization > C								
	Ν	Consequences less		sequences less than	Consequences less than								
		than those for Low	those	for Low Consequence	those for Low								
		Consequence Level		Level	Consequence Level								

Table 28.29 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	Hazard:	L:	See Section I, Chapter 4	L:
Egress		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1	l , "E	Example Qualitative Cons	sequen	ce Matrix", DOE-HD	BK-1163-2020.								
Likelihood (L, of event)/year	C	onsequence (C, of event)/	/year	Risk (R, Qualitative	Ranking)	Risk Matrix							
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = $ situation (event) of major concern					Likelihood				
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation}$ (eve	ent) of concern			Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		$\mathbf{III} = \text{situation}$ (ev	vent) of minor concern	s	Н	Ι	Ι	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \mathbf{Negligible}$		IV = situation (ev	vent) of minimal concern	lenc	Μ	Π	II	III	IV		
Control(s) Type	С	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV		
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C 3 P1	rompt worker fatality	C ³ Prompt worker fatality	suo	L	- 111	ш	1 V	1 V		
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or	acute injury that is	or acute injury that is	0	Ν	IV	IV	IV	IV		
Acronyms		symptoms which	iı	mmediately life-	immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an	threat	ening or permanently	threatening or								
		individual's ability to		disabling.	permanently disabling.								
		take protective											
		action.											
	М	C ³ Mild, transient	C 3	³ Serious injury, no	C ³ Serious injury, no								
		adverse effects.	imm	ediate loss of life no	immediate loss of life no								
				manent disabilities;	permanent disabilities;								
			hosp	bitalization required.	hospitalization required.								
	L	Mild, transient	N	/linor injuries; no	Minor injuries; no								
		adverse effects > C	ho	ospitalization > C	hospitalization > C								
	Ν	Consequences less		sequences less than	Consequences less than								
		than those for Low	those f	for Low Consequence	those for Low								
		Consequence Level		Level	Consequence Level								

Table 28.30 Access & Egress – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety	Hazard:	L:	See Section I, Chapter 4	L:
Egress		C:		C:
_		R:		R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative Ranking)		Risk Matrix					
$\mathbf{A} = \text{Anticipated} (\text{L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathrm{High}$		$\mathbf{I} = $ situation (event) of major concern					-	lihood	
U = Unlikely (1.0E-02>L>1.0E-04)		$\mathbf{M} = \mathbf{M}$ oderate		$\mathbf{II} = \text{situation (event) of concern}$				Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathrm{Low}$		III = situation (ev	vent) of minor concern	s	Н	Ι	Ι	II	III
BEU = Beyond Extremely Unlikely $(1.0E-06>L)$		$\mathbf{N} = \mathbf{Negligible}$		IV = situation (ev	vent) of minimal concern	ienc	М	Π	II	III	IV
Control(s) Type	С	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	ш	IV	IV
\mathbf{P} = Preventive (reduce event occurrence likelihood)	Н	C ³ Irreversible, other	C ³ P	rompt worker fatality	C ³ Prompt worker fatality	suo	L	III	ш	IV	IV
$\mathbf{M} = $ Mitigative (reduces event consequences)		serious effects, or	or	acute injury that is	or acute injury that is	0	Ν	IV	IV	IV	IV
Acronyms		symptoms which	i	immediately life-	immediately life-						
MOI = Maximally-exposed Offsite Individual		could impair an	threat	tening or permanently	threatening or						
		individual's ability to		disabling.	permanently disabling.						
		take protective									
		action.									
	М	C ³ Mild, transient		³ Serious injury, no	C ³ Serious injury, no						
		adverse effects.	imm	nediate loss of life no	immediate loss of life no						
			-	manent disabilities;	permanent disabilities;						
				pitalization required.	hospitalization required.						
	L	Mild, transient	Ν	Minor injuries; no	Minor injuries; no						
		adverse effects > C		ospitalization > C	hospitalization > C						
	Ν	Consequences less		nsequences less than	Consequences less than						
		than those for Low	those	for Low Consequence	those for Low						
		Consequence Level		Level	Consequence Level						

Table 28.31 Environmental

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Airborne	Hazard:	L:	See Section I, Chapter 4	L:
		C:		C:
		R:		R:
Water	Hazard:	L:	See Section I, Chapter 4	L:
		C:		C:
		R:		R:
Soil	Hazard:	L:	See Section I, Chapter 4	L:
		C:	_	C:
		R:		R: