Table 2. Summary of Baseline and Residual Risks – CMTS1

	Risk Tables Description	Baseline Risk	Residual Risk
2.1	Radiological – Onsite-1 Facility Worker	R: I	R: III
2.2	Radiological – Onsite-2 Co-located Worker	R: I	R: III
2.3	Radiological – MOI Offsite	R: I	R: IV
2.4	Toxic Materials – Onsite 1 Facility Worker	R: II	R: IV
2.5	Toxic Materials – Onsite 2 Co-located Worker	R: II	R: IV
2.6	Toxic Materials – MOI Offsite	R: I	R: III
2.7	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: *	R: *
2.8	Flammable & Combustible Materials – Onsite-2 Co-located worker	R: *	R: *
2.9	Flammable & Combustible Materials – MOI Offsite	R: *	R: *
2.10	Electrical Energy – Onsite-1 Facility Worker	R: *	R: *
2.11	Electrical Energy – Onsite-2 Co-located Worker	R: *	R: *
2.12	Electrical Energy – MOI Offsite	R: *	R: *
2.13	Thermal Energy – Onsite-1 Facility Worker	R: *	R: *
2.14	Thermal Energy – Onsite-2 Co-located Worker	R: *	R: *
2.15	Thermal Energy – MOI Offsite	R: *	R: *
2.16	Kinetic Energy – Onsite-1 Facility Worker	R: *	R: *
2.17	Kinetic Energy – Onsite-2 Co-located Worker	R: *	R: *
2.18	Kinetic Energy – MOI Offsite	R: *	R: *
2.19	Potential Energy- Onsite-1 Facility Worker	R: *	R: *
2.20	Potential Energy – Onsite-2 Co-located Worker	R: *	R: *
2.21	Potential Energy – MOI Offsite	R: *	R: *
2.22	Magnetic Fields – Onsite-1 Facility Worker	R: *	R: *
2.23	Magnetic Fields – Onsite-2 Co-located Worker	R: *	R: *
2.24	Magnetic Fields – MOI Offsite	R: *	R: *
2.25	Other Hazards – Onsite-1 Facility Worker	R: *	R: *
2.26	Other Hazards – Onsite-2 Co-located Worker	R: *	R: *
2.27	Other Hazards – MOI Offsite	R: *	R: *
2.28	Access & Egress – Onsite-1 Facility Worker	R: *	R: *
2.29	Access & Egress – Onsite-2 Co-located Worker	R: *	R: *
2.30	Access & Egress – MOI Offsite	R: *	R: *
2.31	Environmental Hazards	R: *	R: *

*See SAD Section I Chapter 04

NOTE:

Per DOE-HDBK-1163-2020, Appendix C, "Risk Assessment Methodology":

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

Table 2.1 Radiological – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radiation	by operation of SRF Cavities	C: M R: I	amplifiers being locked out, this is controlled procedurally. Without power to the cavities, there is no prompt ionizing radiation hazard. P — Enclosure is locked and keys are only obtained after verifying training credentials.	C: N R: IV
			 P – If a key is used to open the enclosure door, interlocks are dropped, preventing power from entering the cavities. M – Radiation detectors are stationed at strategic locations around the enclosure to limit dose to those outside the enclosure during 	
			operation. M – Concrete shielding in place according to the approved shielding assessment that is designed to prevent does to those outside the enclosure during operations. M – Entrants to the enclosure wear dosimetry and would notice dose being taken in the event all of the other steps were bypassed.	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive	Hazard: Possibly activated material	L: U	P – After test, all reachable surfaces of the cryomodule are surveyed for	L: EU
Waste	from accelerated dark current.	C: L	activation by the radiation safety group.	C: N
		R: III		R: IV
			P – The CMTS enclosure is considered an impacted area when RF is applied. Any item in the enclosure during RF powering must be surveyed upon exit from the cave and is at minimum class 0.	
			M – Class 0 material waiting to be declassified is kept in a special bin outside the enclosure.	
			M – Only qualified radiation workers can enter the cave to do work and they must be wearing dosimetry. Pocket dosimeter readings would notify of a large hazard.	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Generating Devices (RGDs)	by operation of SRF Cavities	C: M R: I	being locked out, although this is only controlled procedurally. Without power to the cavities, there is no prompt ionizing radiation hazard. P — Enclosure is locked and keys are only obtained after verifying training credentials. P — If a key is used to open the enclosure door, interlocks are dropped, preventing power from entering the cavities. M — Radiation detectors are stationed at strategic locations around the enclosure to limit dose to those outside the enclosure during	C: N R: IV
			operation. M – Concrete shielding in place according to the approved shielding assessment that is designed to prevent does to those outside the enclosure during operations. M – Entrants to the enclosure wear dosimetry and would notice dose being taken in the event all of the other steps were bypassed.	

Non-ionizing Radiation Hazards	Hazard: RF leakage	L: A C: M R: II	P — To prepare for an access, the amplifiers which provide power to the cavities are physically locked out, this is controlled procedurally. Without power to the cavities, there is no prompt ionizing radiation hazard.	L: BEU C: L R: IV
			P – If a key is used to open the enclosure door, interlocks are dropped, preventing RF power from being applied.	
			P – Enclosure acts as a shield to those outside the enclosure.	
			M – RF antennas are installed both in the enclosure and outside the enclosure near the amplifiers to detect stray RF. When stray RF signals received by any one of these antennas exceeds the preset threshold, the interlock system will shut off RF amplifiers. This detecting/interlocking system was tested and verified during the initial test (trial) operation of high-power RF system.	
			P – RF Distribution system (Coax line and Waveguides etc.) outside the enclosure is rarely disassembled. If a distribution system needs to be opened, amplifier connected to that system will be manually locked out first following LOTO procedure.	
			P – Trained RF technicians install RF distribution system and work on amplifiers.	
			P – Critical RF components (circulator, directional coupler, RF window) and amplifiers all have RF leakage specification and communicated with vendors during procurement process. The RF leakage of these components are measured and verified during acceptance tests to make sure they meet the specification.	
			P – Periodic RF surveys by ESH IH group.	

Likelihood (L, of event)/year	Coı	nsequence (C, of event)/	'year	Risk (R, Qualitative R	lanking)	Risk	Matri	X			
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (even	t) of major concern				Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ever	nt) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (eve	ent) of minor concern	es	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situat		IV = situation (event) of minimal concern		M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)] -		***	***	***	***
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	Ous	L	III	III	IV	IV
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	$00 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	$100 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	- D	N	IV	IV	IV	IV
Acronyms	-	5 rem > C	10	$\frac{25 \text{ rem} > \mathbf{C}}{25 \text{ rem} > \mathbf{C}}$	25 rem > C	-					
MOI = Maximally-exposed Offsite Individual	L					4					
rem = Roentgen equivalent man	N	$0.5 \text{ rem} > \mathbf{C}$		$5 \text{ rem } > \mathbf{C}$	5 rem > C						

Table 2.2 Radiological – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Prompt Ionizing Radiation	Hazard: Ionizing radiation generated by operation of SRF Cavities	L: A C: H R: I	 P — To prepare for an access, the amplifiers which provide power to the cavities are physically locked out, this is controlled procedurally. Without power to the cavities, there is no prompt ionizing radiation hazard. P — Enclosure is locked and keys cannot be issued to those without proper training. P — If a key is used to open the enclosure door, interlocks are dropped, which inhibits the amplifiers from applying power if they were not properly locked out. M — Radiation detectors are stationed at strategic locations around the enclosure to limit dose to those outside the enclosure during operation. M — Concrete shielding in place according to the approved shielding assessment that is designed to prevent does to those outside the enclosure during operations. 	L: EU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive	Hazard: Possibly activated material	L: U	P – After test, all reachable surfaces of the cryomodule are surveyed for	L: BEU
Waste	from accelerated dark current.	C: L	activation by the radiation safety group.	C: N
		R: III		R: IV
			P — The CMTS enclosure is considered an impacted area when RF is applied. Any item in the enclosure during RF powering must be surveyed upon exit from the cave and is at minimum class 0.	
			M – Class 0 material waiting to be declassified is kept in a special bin outside the enclosure.	
			M – Only qualified radiation workers can enter the cave to do work and they must be wearing dosimetry. Pocket dosimeter readings would notify of a large hazard.	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radiation	Hazard: Ionizing radiation generated	L: A	P - To prepare for an access, the amplifiers which provide power to the	L: EU
Generating	by operation of SRF Cavities	C: H	cavities are physically locked out, although this is only controlled	C: L
Devices (RGDs)		R: I	procedurally. Without power to the cavities, there is no prompt ionizing radiation hazard.	R: IV
			P – Enclosure is locked and keys cannot be issued to those without proper training.	
			P – If a key is used to open the enclosure door, interlocks are dropped, which inhibits the amplifiers from applying power if they were not properly locked out.	
			M – Radiation detectors are stationed at strategic locations around the enclosure to limit dose to those outside the enclosure during operation.	
			M – Concrete shielding in place according to the approved shielding assessment that is designed to prevent does to those outside the enclosure during operations.	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Non-ionizing Radiation Hazards	Hazard: RF leakage	L: A C: M R: II	 P - Enclosure access is generally not allowed to be accessed without amplifiers being locked out, although this is only controlled procedurally. Without RF power, there is no non-ionizing radiation hazard. P - If a key is used to open the enclosure door, interlocks are dropped, preventing RF power from being applied. P - Enclosure acts as a shield to those outside the enclosure. M - RF antennas are installed both in the enclosure and outside the enclosure near the amplifiers to detect stray RF. When stray RF signals received by any one of these antennas exceeds the preset threshold, the interlock system will shut off RF amplifiers. This detecting/interlocking system was tested and verified during the initial test (trial) operation of high-power RF system. P - RF Distribution system (Coax line and Waveguides etc.) outside the enclosure is rarely disassembled. If a distribution system needs to be opened, amplifier connected to that system will be manually locked out first following LOTO procedure. P - Trained RF technicians install RF distribution system and work on amplifiers. P - Critical RF components (circulator, directional coupler, RF window) and amplifiers all have RF leakage specification and communicated with vendors during procurement process. The RF leakage of these components are measured and verified during acceptance tests to make sure they meet the specification. 	L: BEU C: L R: IV

Radiological Hazard Consequences, derived from Figu	Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.													
Likelihood (L, of event)/year	Consequence (C, of event)/year		Risk (R, Qualitative Ranking)		Risl	Matri	X							
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (even	t) of major concern				Like	lihood				
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ever	nt) of concern		_	Α	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (eve	ent) of minor concern	es	Н	I	I	II	III			
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern		enc	M	II	II	III	IV			
Control(s) Type	C	Offsite (MOI)	Onsi	te-2 (co-located worker)	Onsite-1 (facility worker)	nbə	T	Ш	Ш	IV	IV			
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	Suo	L	111	111	1 V	1 V			
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	$00 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	100 rem > C ≥ 25 rem		N	IV	IV	IV	IV			
Acronyms MOI = Maximally-exposed Offsite Individual	L	5 rem > C		25 rem > C	25 rem > C									
rem = Roentgen equivalent man	N	0.5 rem > C		5 rem > C	5 rem > C									

Table 2.3 Radiological – MOI 1 Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Prompt Ionizing Radiation	Hazard: Ionizing radiation generated by operation of SRF Cavities	L: U C: H	P – Site access is prevented through security checkpoints.	L: BEU C: M
	oy eperanter system convents	R: I	P – Security presence on-site would identify people in non-public areas.	R: IV
			P – All doors to CMTF are locked and nearly all doors are opened using key cards preventing unwanted and untracked access.	
			P — Workers in the building do notice unusual guests and question why the person is in the building.	
			P – Enclosure is locked and keys are only issued through a locked system opened by the main control room.	
			P – If the enclosure door was to be forced open, interlocks would drop and the interlock system would inhibit power being applied to the cavities through the amplifiers.	
			M – MOI is unlikely to be able to operate the controls system to apply power to cavities.	
			P – Controls consoles are password protected.	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Radioactive Waste	from accelerated dark current. C: L R: III P - Security presence on-site would iden P - All doors to CMTF are locked and no key cards preventing unwanted and u P - Workers in the building do notice un the person is in the building.		 P - Security presence on-site would identify people in non-public areas. P - All doors to CMTF are locked and nearly all doors are opened using key cards preventing unwanted and untracked access. P - Workers in the building do notice unusual guests and question why 	L:BEU C: N R: IV
Radiation Generating Devices (RGDs)	Hazard: Ionizing radiation generated by operation of SRF Cavities	L: U C: H R: I	 P - Site access is prevented through security checkpoints. P - Security presence on-site would identify people in non-public areas. P - All doors to CMTF are locked and nearly all doors are opened using key cards preventing unwanted and untracked access. P - Workers in the building do notice unusual guests and question why the person is in the building. P - Enclosure is locked and keys are only issued through a locked system opened by the main control room. P - If the enclosure door was to be forced open, interlocks would drop and the interlock system would inhibit power being applied to the cavities through the amplifiers. M - MOI is unlikely to be able to operate the controls system to apply power to cavities. P - Controls consoles are password protected. 	L: BEU C: M R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Non-ionizing Radiation Hazards	Hazard: RF leakage	L: U C: M R: II	 P – Site access is prevented through security checkpoints. P – Security presence on-site would identify people in non-public areas. P – All doors to CMTF are locked and nearly all doors are opened using key cards preventing unwanted and untracked access. P – Workers in the building do notice unusual guests and question why the person is in the building. P – Enclosure is not allowed to be accessed without amplifiers being locked out. Without RF power, there is no non-ionizing radiation hazard. P – Enclosure is locked and keys are only obtained after verifying training credentials. P – If a key is used to open the enclosure door, interlocks are dropped, preventing RF power from being applied. P – Enclosure acts as a shield to those outside the enclosure. M – RF antennas are installed both in the enclosure and outside the enclosure near the amplifiers to detect stray RF. When stray RF signals received by any one of these antennas exceeds the preset threshold, the interlock system will shut off RF amplifiers. This detecting/interlocking system was tested and verified during the initial test (trial) operation of high-power RF system. P – RF Distribution system (Coax line and Waveguides etc.) outside the enclosure is rarely disassembled. If a distribution system needs to be opened, amplifier connected to that system will be manually locked out first following LOTO procedure. P – Qualified RF technicians install RF distribution system and work on amplifiers. P – Critical RF components (circulator, directional coupler, RF window) and amplifiers all have RF leakage specification and communicated with vendors during procurement process. The RF leakage of these components are measured and verified during acceptance tests to make sure they meet the specification. 	L: BEU C: L R: IV

Likelihood (L, of event)/year	Co	nsequence (C, of event)/y	year	Risk (R, Qualitative R	anking)	Risk Matrix					
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even)	t) of major concern			Likelihood			
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ever	nt) of concern		1	A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (eve	ent) of minor concern	es	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern		enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-	e-2 (co-located worker)	Onsite-1 (facility worker)	nbə		***			
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	ons	L	III	III	IV	IV
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	100	$0 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	100 rem > C ≥ 25 rem	0	N	IV	IV	IV	IV
Acronyms	L	5 rem > C		25 rem > C	25 rem > C						
MOI = Maximally-exposed Offsite Individual rem = Roentgen equivalent man	N	0.5 rem > C		5 rem > C	5 rem > C						

Table 2.4 Toxic Materials – Onsite 1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	Hazard: Potential exposure to lead dust during manual handling of unencased lead bricks, lead shot, and lead sheets.	L: A C: M R: II	 P – All lead used in the enclosure is encased. P – Lead is in two distinct spots, and those spots are covered by an additional sheet of herculite. Labels are attached to the sheet indicating lead shielding is beneath and not to be disturbed. M – Any work to move lead is planned, including a hazard analysis. P – All workers are lead handling trained. M – PPE is used when handling lead 	L: EU C: N R: IV

Chemical Hazard Consequences, derived from Figure	C-1,	"Example Qualitative	Conseq	quence Matrix", DOE-	HDBK-1163-2020.						
Likelihood (L, of event)/year	Co	onsequence (C, of event))/year	Risk (R, Qualitative	Ranking)	Risk Matrix					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern						
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	S	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn	т	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	ons	L	111	111	1 V	1 V
M = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P.A	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$		N	IV	IV	IV	IV
Acronyms IDLH = Immediately Dangerous to Life and Health	L	PAC-1 > C		PAC-2 > C	PEL or $TLV_c > C$						
MOI = Maximally-exposed Offsite Individual PAC = Protective Action Criteria PEL = Permissible Exposure Limit TLV _c = Threshold Limit Value (ceiling)	N	Consequences less than those for Low Consequence Level		nsequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level						

Table 2.5 Toxic Materials – Onsite 2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	Hazard: Potential exposure to lead	L: U	P – All lead used in the enclosure is encased.	L: EU
	dust during manual handling of un-	C: M		C: L
	encased lead bricks, lead shot, and	R: II	P – Lead is in two distinct spots, and those spots are covered by an	R: IV
	lead sheets.		additional sheet of herculite. Labels are attached to the sheet	
			indicating lead shielding is beneath and not to be disturbed.	
			M – Any work to move lead is planned, including a hazard analysis.	

Chemical Hazard Consequences, derived from Figure	C-1	, "Example Qualitative	Conseq	quence Matrix", DOE-	HDBK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk Matrix					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern						
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ex	vent) of minor concern	es	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ex	vent) of minimal concern	nences	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	edn		TTT	777	TX /	77.7
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C≥IDLH	ous	L	III	III	IV	IV
M = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P /	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$	Ö	N	IV	IV	IV	IV
Acronyms	Τ.	PAC-1 > C	1 1	PAC-2 > C	PEL or $TLV_c > C$		1				
IDLH = Immediately Dangerous to Life and Health	N	Consequences less	Cor	nsequences less than	Consequences less than						
MOI = Maximally-exposed Offsite Individual	1	than those for Low		for Low Consequence	those for Low						
PAC = Protective Action Criteria			mose	•							
PEL = Permissible Exposure Limit		Consequence Level		Level	Consequence Level						
TLV_c = Threshold Limit Value (ceiling)											

Table 2.6 Toxic Materials – MOI 1 Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)			
Lead	Hazard: Potential exposure to lead	L: A	P – Site access is prevented through security checkpoints.	L: BEU			
	dust during manual handling of un-	C: H	P – Security presence on-site would identify people in non-public areas.	C: H			
	encased lead bricks, lead shot, and	R: I	P – All doors to CMTF are locked and nearly all doors are opened using	R: III			
	lead sheets.		key cards preventing unwanted and untracked access.				
			P – Workers in the building do notice unusual guests and question why				
			the person is in the building.				
			P – Enclosure is locked and keys are only issued through a locked				
	system opened by the main control room.						
			P – All lead used in the enclosure is encased.				

Chemical Hazard Consequences, derived from Figure	C-1	, "Example Qualitative (Conseq	quence Matrix", DOE-	HDBK-1163-2020.							
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk Matrix						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Likelihood			
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	es	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	ences	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	ed n	_	***	***	***	***	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C≥IDLH	ons	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P /	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$	C	N	IV	IV	IV	IV	
Acronyms	T	PAC-1 > C	11	$\frac{\text{PAC-2} > \mathbf{C}}{\text{PAC-2} > \mathbf{C}}$	PEL or TLV _c $>$ C							
IDLH = Immediately Dangerous to Life and Health	N											
MOI = Maximally-exposed Offsite Individual	IN	Consequences less		nsequences less than	Consequences less than							
PAC = Protective Action Criteria		than those for Low	those	for Low Consequence	those for Low							
PEL = Permissible Exposure Limit		Consequence Level		Level	Consequence Level							
TLV _c = Threshold Limit Value (ceiling)												

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

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

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High	I = situation (eve	ent) of major concern	Risk	Matri		Likelihood A U EU		
U = Unlikely (1.0E-02 > L > 1.0E-04) EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06 > L)		 M = Moderate L = Low N = Negligible 	,	ent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I	I	II	BEU III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood)	C H	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	Conseque	L	III	III	IV	IV
 M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 		other serious effects, or symptoms which could impair an individual's ability to take protective action.	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life- threatening or permanently disabling.		N	IV	IV	IV	IV
	M	C ≥ Mild, transient adverse effects. Mild, transient	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	L	adverse effects > C	hospitalization > C	hospitalization > C						
	IN	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level						

Table 2.8 Flammable and Combustible Materials – Onsite -2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible materials (cables, Boxes, Paper, wood cribbing, etc.)		L: C: R:	See Section I Chapter 04	L: C: R:
Flammable Materials (Flammable gas, cleaning materials, etc.)		L: C: R:	See Section I Chapter 04	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 A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High	I = situation (eve	ent) of major concern	Risk	Matri	A	Like U	lihood EU	BEU			
U = Unlikely (1.0E-02 > L > 1.0E-04) EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06 > L)		 M = Moderate L = Low N = Negligible 	,	vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I	II	III IV			
Control(s) Type	C H	Offsite (MOI)	Onsite-2 (co-located worker) C ≥ Prompt worker fatality	Onsite-1 (facility worker) C ≥ Prompt worker	Conseque	L	III	III	IV	IV			
		other serious effects, or symptoms which could impair an individual's ability to take protective action.	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life- threatening or permanently disabling.		N	IV	IV	IV	IV			
	M	C ≥ Mild, transient adverse effects. Mild, transient	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.									
	L	adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C									
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level									

Table 2.9 Flammable and Combustible Materials – MOI 1 Offsite

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

Other Hazard Consequences, derived from Figure C-	1, "F	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							
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (event) of major concern					Like	lihood			
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (evolution)	ent) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	se	Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite-	2 (co-located worker)	Onsite-1 (facility worker)	Consequences	т .	TTT	TTT	TV.	13.7		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Pr	rompt worker fatality	C ≥ Prompt worker	ous	L	III	III	IV	IV		
M = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that		N	IV	IV	IV	IV		
Acronyms		or symptoms which		nmediately life-	is 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.											
	M	$C \ge Mild$, transient	C ≥	Serious injury, no	$C \ge Serious injury, no$								
		adverse effects.	imme	ediate loss of life no	immediate loss of life no								
			pern	nanent disabilities;	permanent disabilities;								
			hosp	italization required.	hospitalization required.								
	L	Mild, transient	M	Iinor injuries; no	Minor injuries; no								
		adverse effects > C	ho	spitalization > C	hospitalization > C								
	N	Consequences less	Cons	sequences less than	Consequences less than								
			those f	For Low Consequence	those for Low								
		Consequence Level		Level	Consequence Level								
	N	Consequences less		sequences less than	Consequences less than								
			those f	For Low Consequence	those for Low								
		Consequence Level		Level	Consequence Level								

Table 2.10 Electrical Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy Exposure	Hazards: Shock hazard, >50 V, <u>Non-interlocked enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
	Arc Flash, <u>Non-interlocked</u> <u>enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
Stored Energy Exposure	Hazards: Shock hazard, >50 V, <u>Interlocked</u> enclosures	L: C: R:	See Section I Chapter 04	L: C: R:
	Arc Flash, <u>Interlocked enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
High Voltage Exposure	Hazards: Shock hazard, voltage > 50 V, <u>Non-interlocked enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
	Arc Flash, <u>Non-interlocked</u> <u>enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
High Voltage Exposure	Hazards: Shock hazard, voltage > 50 V, Interlocked enclosures	L: C: R:	See Section I Chapter 04	L: C: R:
	Arc Flash, <u>Interlocked enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
Low Voltage, High Current Exposure.	Hazards: Arc Flash <u>Non-interlocked</u> <u>enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
	Fire hazard from high current causing smoke inhalation and burns service building areas.	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C	-1, "E	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.								
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L > 1.0E-04) EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)	H M L	onsequence (C, of event)/y = High [= Moderate = Low = Negligible	I = situation (event) o II = situation (event)	Risk (R, Qualitative Ranking) I = situation (event) of major concern II = situation (event) of concern III = situation (event) of minor concern		Risk Matrix						
Control(s) Type	C		Onsite-2 (co-located worker)	Onsite-1 (facility worker)			A	Like U	lihood EU	BEU		
P = Preventive (reduce event occurrence likelihood)M = Mitigative (reduces event consequences)	Н	C ≥ Irreversible, other serious effects,	C ≥ Prompt worker fatality or acute injury that is	C ≥ Prompt worker fatality or acute injury that	C	Н	I	I	II	III		
Acronyms MOI = Maximally-exposed Offsite Individual		or symptoms which	immediately life-	is immediately life-	n s	M	III	III	III IV	IV IV		
TAGE Prantally exposed of the marriage		could impair an individual's ability to take protective action.	threatening or permanently disabling.	threatening or permanently disabling.	e q u e	L						
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	n c e s	N	IV	IV	IV	IV		
	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C								
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level								

 Table 2.11 Electrical Energy 1 Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy Exposure	Hazards: Shock hazard, >50 V, <u>Non-interlocked enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
	Arc Flash, <u>Non-interlocked</u> <u>enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
Stored Energy Exposure	Hazards: Shock hazard, >50 V, <u>Interlocked</u> <u>enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
	Arc Flash, <u>Interlocked enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
High Voltage Exposure	Hazards: Shock hazard, voltage > 50 V, Non- interlocked enclosures	L: C: R:	See Section I Chapter 04	L: C: R:
	Arc Flash, <u>Non-interlocked</u> <u>enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
High Voltage Exposure	Hazards: Shock hazard, voltage > 50 V, Interlocked enclosures	L: C: R:	See Section I Chapter 04	L: C: R:
	Arc Flash, <u>Interlocked enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
Low Voltage, High Current Exposure.	Hazards: Arc Flash <u>Non-interlocked</u> <u>enclosures</u>	L: C: R:	See Section I Chapter 04	L: C: R:
	Fire hazard from high current causing smoke inhalation and burns service building areas.	L: C: R:	See Section I Chapter 04	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 A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L > 1.0E-04) EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		onsequence (C, of event) = High I = Moderate = Low = Negligible	I = situation II = situation III = situatio	Risk (R, Qualitative Ranking) I = situation (event) of major concern II = situation (event) of concern III = situation (event) of minor concern IV = situation (event) of minimal concern			Risk Matrix Likelihood						
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located v	e-2 (co-located worker) Onsite-1 (facility worker)				A	U	EU	BEU		
 P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) 	Н	C ≥ Irreversible,	C ≥ Prompt worker		C ≥ Prompt worker	C	Н	I	I	П	III		
Acronyms		other serious effects, or symptoms which	or acute injury th immediately lif		fatality or acute injury that is immediately life-	o n	M	II	II	III	IV		
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or perm		_	s	L	III	III	IV	IV		
		individual's ability to take protective action.	disabling.		disabling.	q u e							
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injur immediate loss of permanent disabil hospitalization req	life no lities;	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	n c e s	N	IV	IV	IV	IV		
	L	Mild, transient adverse effects > C	Minor injuries; hospitalization		Minor injuries; no hospitalization > C								
	N	Consequences less than those for Low	Consequences less those for Low Conse	s than	Consequences less than those for Low								
		Consequence Level	Level		Consequence Level								

Table 2.12 Electrical Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy	Hazard: Shock hazard, >50 V, Arc	L:	See Section I Chapter 04	L:
Exposure	flash	C:		C:
		R:		R:
High Voltage	Hazard: Shock hazard, >50 V, Arc	L:	See Section I Chapter 04	L:
Exposure	flash outside	C:		C:
		R:		R:
Low Voltage,	<u>N/A</u>	L:	See Section I Chapter 04	L:
High Current		C:		C:
Exposure.		R:		R:

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

Table 2.13 Thermal Energy – Onsite-1 Facility Worker

Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hazard: Exposure to Oxygen	L:	See Section I Chapter 04	L:
Deficiency Hazard (ODH) due to	C:		C:
uncontrolled release of cryogenic	R:		R:
	Hazard: Exposure to Oxygen Deficiency Hazard (ODH) due to	Hazard Description Risk (without controls) Hazard: Exposure to Oxygen Deficiency Hazard (ODH) due to uncontrolled release of cryogenic R:	Hazard Description Risk (without controls) Hazard: Exposure to Oxygen Deficiency Hazard (ODH) due to uncontrolled release of cryogenic R: Preventative (P)/ Mitigative (M) See Section I Chapter 04 C: 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							
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	nt) of major concern								
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (ev	ent) of concern		1	A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ev	vent) of minor concern	ses	Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	ienc	M	II	II	Ш	IV		
Control(s) Type	C	Offsite (MOI)	nsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	T	III	III	IV	IV		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible, C	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	111	111	1 V	1 V		
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that		N	IV	IV	IV	IV		
Acronyms		or symptoms which	immediately life-	is immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an th	reatening or permanently	threatening or								
		individual's ability to	disabling.	permanently disabling.								
		take protective										
		action.										
	M	$C \ge Mild$, transient	$C \ge$ Serious injury, no	$C \ge$ 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								
	N	Consequences less	Consequences less than	Consequences less than								
		than those for Low th	ose for Low Consequence	those for Low								
		Consequence Level	Level	Consequence Level								

Table 2.14 Thermal Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenic	Hazard: Exposure to Oxygen	L:	See Section I Chapter 04	L:
Liquids	Deficiency Hazard (ODH) due to	C:		C:
	uncontrolled release of cryogenic	R:		R:
	liquid or gas			

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						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	nt) of major concern							
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (ev	ent) of concern			A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ev	vent) of minor concern	ses	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	ienc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI) O	nsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	T	III	III	IV	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible, C	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	111	111	10	1 V	
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that		N	IV	IV	IV	IV	
Acronyms		or symptoms which	immediately life-	is immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an th	reatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective									
		action.									
	M	$C \ge Mild$, transient	$C \ge$ Serious injury, no	$C \ge$ 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							
	N	Consequences less	Consequences less than	Consequences less than							
		than those for Low th	ose for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 2.15 Thermal Energy – MOI 1 Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenic	Hazard: Exposure to Oxygen	L:	See Section I Chapter 04	L:
Liquids	Deficiency Hazard (ODH) due to	C:		C:
	uncontrolled release of cryogenic liquid or gas	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	Risk (R, Qualitative Ranking)				Risk Matrix					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	I = situation (event) of major concern				lihood					
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (ev	ent) of concern		ı	Α	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ex	vent) of minor concern	seou	Н	I	I	II	III			
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV			
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	_	YYY	***	77.7	***			
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV			
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	Ö	N	IV	IV	IV	IV			
Acronyms		or symptoms which	immediately life-	is immediately life-									
MOI = Maximally-exposed Offsite Individual			threatening or permanently	threatening or									
		individual's ability to	disabling.	permanently disabling.									
		take protective	8										
		action.											
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ 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									
	N	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 2.16 Kinetic Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power Tools	Hazard: Personnel injury due to	L:	See Section I Chapter 04	L:
1 OWEL TOOLS	improper use of power tools	C:		C:
		R:		R:
Pumps and		L:	See Section I Chapter 04	L:
Motors		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L >1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	ent) of major concern	Risk	Matri	A	lihood EU	BEU	
EU = Extremely Unlikely $(1.0\text{E}-04 > \text{L} > 1.0\text{E}-06)$ BEU = Beyond Extremely Unlikely $(1.0\text{E}-06 > \text{L})$		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$	1	vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I	I	II	III
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	С	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsı	L	III	III	IV	IV IV
		other serious effects, or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately lifethreatening or permanently disabling.	Cor	N	IV	IV	IV	IV
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
		Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C						
	N	Consequences less than those for Low Consequence Level	Consequences less than hose for Low Consequence Level	Consequences less than those for Low Consequence Level						

Table 2.17 Kinetic Energy – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitativ e Risk (with controls)
Power Tools		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:
Pumps and		L:	See Section I Chapter 04	L:
Motors		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								
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	I = situation (event) of major concern				Like	lihood				
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (ev	ent) of concern			A	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (e	vent) of minor concern	nces	Н	I	I	II	III			
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	$IV = situation (e^{-1})$	vent) of minimal concern	(a)	M	II	II	III	IV			
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	edno	_	TTT	777	17.7	77.7			
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	$C \ge Prompt$ worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV			
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV			
Acronyms		or symptoms which	immediately life-	is immediately life-			•		•				
MOI = Maximally-exposed Offsite Individual		, ı	threatening or permanently	threatening or									
		individual's ability to	disabling.	permanently disabling.									
		take protective	8	7 8									
		action.											
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ 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									

Table 2.18 Kinetic Energy – MOI 1 Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power Tools		L: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors		L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.															
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	Ranking)	Risk	Matri	ix							
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (eve	ent) of major concern										
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern	_		A	U	EU	BEU				
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	es	Н	I	I	II	III				
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV				
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	sedneuces	L	III	III	IV	IV				
 P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 	Н	C ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	or i	Prompt worker fatality acute injury that is immediately life-tening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately lifethreatening or permanently disabling.	Con	N	IV	IV	IV	IV				
	M L	C ≥ Mild, transient adverse effects. Mild, transient adverse effects > C	imm per hosp	≥ Serious injury, no nediate loss of life no manent disabilities; pitalization required. Minor injuries; no ospitalization > C	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no hospitalization > C										

Table 2.19 Potential Energy – Onsite-1 Facility Worker

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

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) L = Unlikelike (1.0E-02) L > 1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	ent) of major concern	Risk	Matri	A	lihood EU	BEU	
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$		vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I II	II III	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	С	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsı	L	III	III	IV	IV
		other serious effects, or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	S N IV IV			IV	IV	
	M L	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	hospitalization > C Consequences less than hose for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

Table 2.20 Potential Energy – Onsite-2 Co-located Worker

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

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) L = Unlikelike (1.0E-02) L > 1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	ent) of major concern	Risk	Matri	A	lihood EU	BEU	
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$		vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I II	II III	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	С	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsı	L	III	III	IV	IV
		other serious effects, or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	S N IV IV			IV	IV	
	M L	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	hospitalization > C Consequences less than hose for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

Table 2.21 Potential Energy – MOI 1 Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations		L:	See Section I Chapter 04	L:
		C: R:		C: R:
Compressed		L:	See Section I Chapter 04	L:
Gasses		C:		C:
		R:		R:
Vacuum/		L:	See Section I Chapter 04	L:
Pressure Vessels/		C:		C:
Piping		R:		R:
Vacuum Pumps		L:	See Section I Chapter 04	L:
vacuum rumps		C:		C:
		R:		R:
Material Handling		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) L = Unlikelike (1.0E-02) L > 1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	ent) of major concern	Risk	Matri	A	lihood EU	BEU	
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$		vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I II	II III	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	С	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsı	L	III	III	IV	IV
		other serious effects, or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	Cor	N	IV	IV	IV	IV
	M L	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	hospitalization > C Consequences less than hose for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

Table 2.22 Magnetic Fields – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	Hazard: Personnel with implanted medical devices	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event)	year Risk (R, Qualitative	Ranking)	Risk	Matri	X					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	I = situation (event) of major concern				Like	lihood			
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (ev	ent) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (e	vent) of minor concern	s	Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	$IV = situation (e^{-1})$	vent) of minimal concern	edneuces	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbə	· ·	777	***	77.7	77.7		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV		
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	Ö	N	IV	IV	IV	IV		
Acronyms		or symptoms which	immediately life-	is immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or permanently	threatening or								
		individual's ability to	disabling.	permanently disabling.								
		take protective	S									
		action.										
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ 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								
	N	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 2.23 Magnetic Fields – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	Hazard: Personnel with implanted medical devices	L: C: R:	See Section I Chapter 04	L: C: R:

Likelihood (L, of event)/year	C	onsequence (C, of event)/y	year Risk (R, Qualitative	Ranking)	Risk Matrix						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	I = situation (event) of major concern				Likelihood			
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (even	ent) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ex	vent) of minor concern	es	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	r	III	III	IV	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	111	111	1 V	1 V	
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that		N	IV	IV	IV	IV	
Acronyms		or symptoms which	immediately life-	is 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.									
	M	$C \ge Mild$, transient	$C \ge$ Serious injury, no	$C \ge Serious injury, no$							
		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							
	N	Consequences less	Consequences less than	Consequences less than							
			those for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 2.24 Magnetic Fields – MOI 1 Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	Hazard: Personnel with implanted	L:	See Section I Chapter 04	L:
	medical devices	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							
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	ent) of major concern				Likelihood				
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (ev	ent) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (e	vent) of minor concern	es	Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	$IV = situation (e^{-1})$	vent) of minimal concern	enc	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedneuces	_	***	***	***	***		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	Ш	III	IV	IV		
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	Ö	N	IV	IV	IV	IV		
Acronyms		or symptoms which	immediately life-	is immediately life-								
MOI = Maximally-exposed Offsite Individual		could impair an	threatening or permanently	threatening or								
		individual's ability to	disabling.	permanently disabling.								
		take protective	8									
		action.										
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ 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								
	N	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 2.25 Other hazards – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Silica		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:
Ergonomics		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-	l, "E	Example Qualitative Cons	equence Matrix", DOE-HD	DBK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L > 1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	7 1	ent) of major concern	Risk	Matri	A A	Like U	lihood EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		L = Low $N = Negligible$	III = situation (e	vent) of minor concern vent) of minimal concern	ences	H M	I	II	II III	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	Н	C ≥ Irreversible, other serious effects, or symptoms which	Onsite-2 (co-located worker) C ≥ Prompt worker fatality or acute injury that is immediately life- threatening or permanently disabling.	Onsite-1 (facility worker) C ≥ Prompt worker fatality or acute injury that is immediately life- threatening or permanently disabling.	Consequences	L N	III IV	III IV	IV IV	IV IV
	M	action. C ≥ Mild, transient adverse effects. Mild, transient	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	hospitalization > C Consequences less than hose for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

Table 2.26 Other hazards – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Silica		L:	See Section I Chapter 04	L:
		C:		C:
		R:	•	R:
Ergonomics		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) L = Unlikelihood (D = 02) L > 1.0E 04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	ent) of major concern	Risk	Matri	A	Like U	lihood EU	BEU
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \text{Moderate}$ $\mathbf{L} = \text{Low}$ $\mathbf{N} = \text{Negligible}$		vent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I II	I	II III	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	C H	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsı	L	III	III	IV	IV
	11	other serious effects, or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life-threatening or permanently disabling.	Cor	N	IV	IV	IV	IV
	M L	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	hospitalization > C Consequences less than hose for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

Table 2.27 Other hazards – MOI 1 Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Silica		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:
Ergonomics		L:	See Section I Chapter 04	L:
		C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High	I = situation (eve	ent) of major concern	Risk	Matri	ix A	Like U	lihood EU	BEU
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		 M = Moderate L = Low N = Negligible 	,	ent) of concern vent) of minor concern vent) of minimal concern	ences	H M	I	I	II	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual	C H	Offsite (MOI)	Onsite-2 (co-located worker) $C \ge \text{Prompt worker fatality}$	Onsite-1 (facility worker) C ≥ Prompt worker	Conseque	L	III	III	IV	IV
		other serious effects, or symptoms which could impair an individual's ability to take protective action.	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life- threatening or permanently disabling.		N	IV	IV	IV	IV
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C						
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level						

Table 2.28 Access & Egress – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress		L:	See Section I Chapter 04	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	C	onsequence (C, of event)	/year Risk (R, Qualitative	Ranking)	Risk Matrix						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	ent) of major concern			Likelihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (ev	ent) of concern			A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (e	vent) of minor concern	es	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	$IV = situation (e^{-1})$	vent) of minimal concern	enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	_	TTT	777	17.7	17.7	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	0	N	IV	IV	IV	IV	
Acronyms		or symptoms which	immediately life-	is 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.									
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ 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							
	N	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 2.29 Access & Egress – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress		L:	See Section I Chapter 04	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	C	onsequence (C, of event)/y	vear Risk (R, Qualitative	Ranking)	Risk Matrix						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (even	uation (event) of major concern							
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (eve	ent) of concern		ı	A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ev	vent) of minor concern	sə	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely $(1.0E-06 > L)$		N = Negligible	IV = situation (ev	vent) of minimal concern	enc	M	П	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sednences	-	***	***	***	***	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	С	N	IV	IV	IV	IV	
Acronyms		or symptoms which	immediately life-	is immediately life-							
MOI = Maximally-exposed Offsite Individual			threatening or permanently	threatening or							
		individual's ability to	disabling.	permanently disabling.							
		take protective	S								
		action.									
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ 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							
	N	Consequences less	Consequences less than	Consequences less than							
		than those for Low t	those for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 2.30 Access & Egress – MOI 1 Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Life Safety Egress		L:	See Section I Chapter 04	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	year Risk (R, Qualitative	Risk (R, Qualitative Ranking) Risk Matrix								
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	I = situation (eve	n (event) of major concern				lihood		
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (ev	ent) of concern			A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ex	vent) of minor concern	es	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (ev	vent) of minimal concern	ences	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedu		***			
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	C	N	IV	IV	IV	IV
Acronyms		or symptoms which	immediately life-	is immediately life-						
MOI = Maximally-exposed Offsite Individual		* *	threatening or permanently	threatening or						
		individual's ability to	disabling.	permanently disabling.						
		take protective	S	, , ,						
		action.								
	M	C ≥ Mild, transient	C ≥ Serious injury, no	$C \ge Serious injury, no$						
		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						
	N	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 2.31 Environmental

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