Table 2. Summary of Baseline and Residual Risks – Radiation Analysis Facility (RAF)

	Risk Tables Description	Baseline Risk	Residual Risk
2.1	Radiological – Onsite-1 Facility Worker	R: III	R: IV
2.2	Radiological – Onsite-2 Co-located Worker	R: III	R: IV
2.3	Radiological – MOI Offsite	R: IV	R: IV
2.4	Toxic Materials – Onsite 1 Facility Worker	R: *	R: *
2.5	Toxic Materials – Onsite 2 Co-located Worker	R: *	R: *
2.6	Toxic Materials – MOI Offsite	R: *	R: *
2.7	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: *	R: *
2.8	Flammable & Combustible Materials – Onsite-2 Co-located worker	R: *	R: *
2.9	Flammable & Combustible Materials – MOI Offsite	R: *	R: *
2.10	Electrical Energy – Onsite-1 Facility Worker	R: *	R: *
2.11	Electrical Energy – Onsite-2 Co-located Worker	R: *	R: *
2.12	Electrical Energy – MOI Offsite	R: *	R: *
2.13	Thermal Energy – Onsite-1 Facility Worker	R: *	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	Other Hazards – Onsite-1 Facility Worker	R: *	R: *
2.23	Other Hazards – Onsite-2 Co-located Worker	R: *	R: *
2.24	Other Hazards – MOI Offsite	R: *	R: *
2.25	Environmental Hazards	R: *	R: *

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

NOTE:

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

Table~2.1~Radiological-Onsite-1~Facility~Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Residual	Hazard: Presence of activated	L: A	P: SOPs provides the process for workers to follow to avoid exposure to	L: EU
activation	samples for analysis.	C: L	residual radiation in samples.	C: N
		R: III	P: Only trained workers allowed to perform sample analysis at RAF (over) M: RWPs provide work controls to mitigate exposure of workers to residual activation.	R: IV
			M: postings inform workers of potential hazard to mitigate exposure to residual activation.	
			M: dosimetry (down) provides an ongoing method to measure exposure	
			buildup allowing workers the opportunity to mitigate their exposure.	
Radioactive	Hazard: Presence of analysis	L: A	P: SOPs provides the process for workers to follow to generate radioactive	L:EU
waste	materials and containers that are	C: N	wastes while avoid exposure to it,	C: N
	designated as radioactive waste after	R: IV	P: Only trained workers allowed to perform sample analysis at RAF (over)	R: IV
	preparation or analysis.		M: RWPs provide work controls to mitigate exposure of workers to radioactive waste.	
			M: postings inform workers of potential hazard to mitigate exposure to	
			radioactive waste.	
			M: dosimetry (down) provides an ongoing method to measure exposure	
			buildup allowing workers the opportunity to mitigate their exposure.	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	Hazard: Contamination from spills or inadvertent transfer of material from analytical samples.	L: A C: N R: IV	P: SOPs provide the process for workers to follow during analytical work to prevent contamination transfer to themselves, P: Only trained workers allowed to perform sample analysis at RAF (over) M: RWPs provide work controls to mitigate exposure of workers to contamination. M:PPE mitigates to movement of contamination between objects and workers. M: postings inform workers of potential hazard to mitigate exposure to radioactive waste. M: dosimetry (down) provides an ongoing method to measure exposure buildup allowing workers the opportunity to mitigate their exposure.	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
Radioactive Sources	Hazard: Presence of check sources for detector calibration.	L: A C: L R: III	P: SOPs provides the process for workers to follow to avoid direct exposure to radioactive sources, P: Only trained workers allowed to perform sample analysis at RAF (over) M: RWPs provide the work controls to mitigate radiation exposure by limiting time, distance and shielding. M: postings inform workers of potential hazard so they can actively mitigate exposure to radioactive sources. M: dosimetry (down) provides an ongoing method to measure exposure buildup allowing workers the opportunity to mitigate their exposure.	L: EU C: N R: IV

Radiological Hazard Consequences, derived from Figu		<u> </u>											
Likelihood (L, of event)/year	Co	nsequence (C, of event)/y	year	Risk (R, Qualitative Ranking)			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			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		ence	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nba				***			
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	ons	L	III	III	IV	IV		
$\mathbf{M} = $ Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	100	$0 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	$100 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	Co	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 2.2 Radiological – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Residual	Hazard: Presence of activated	L: A	P: SOPs provide the process for co-located workers to follow to avoid	L: EU
activation	samples for analysis.	C: N	samples with residual activation.,	C: N
		R: III	 P: Only trained workers allowed to perform sample analysis at RAF (over) M: RWPs provide work controls with prohibit co-located workers from working with samples containing residual activation. M: postings inform co-located workers of potential hazard so they can actively mitigate exposure to residual activation. M: dosimetry (down) provides an ongoing method to measure exposure buildup allowing co-located workers the opportunity to mitigate their exposure. 	R: IV
Radioactive	Hazard: Presence of analysis	L: U	P: SOPs provides the process for co-located workers to follow to avoid	L:BEU
waste	materials and containers that are	C: N	radioactive wastes staging areas in the facility,	C: N
	designated as radioactive waste after preparation or analysis.	R: IV	 P: Only trained workers allowed to perform sample analysis at RAF (over) M: RWPs provide work controls to mitigate exposure of co-located workers to radioactive waste. M: postings inform co-located workers of potential hazard so they can actively mitigate exposure to radioactive waste. M: dosimetry (down) provides an ongoing method to measure exposure buildup allowing co-located workers the opportunity to mitigate their exposure. 	R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	Hazard: Contamination from spills or	L: U	P: SOPs,	L:BEU
	inadvertent transfer of material from	C: N	P: Only trained workers allowed to perform sample analysis at RAF (over)	C: N
	analytical samples.	R: IV	M: RWPs provide work controls to mitigate exposure of workers to contamination.	R: IV
			M: posting postings inform co-located workers of potential hazard so they can actively mitigate exposure to contamination.	
			M: dosimetry (down) provides an ongoing method to measure exposure buildup allowing co-located workers the opportunity to mitigate their exposure.	
⁷ Be	Hazard: Potential radiation exposure	L: A	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't	L: A
	to 7Be (uptake/committed dose).	C: N	hazardous in this pattern of use by facility.	C: N
	,	R: IV		R: IV
Radioactive	Hazard: Presence of check sources for	L: A	P: SOPs provide the process for co-located workers to follow to avoid	L: EU
Sources	detector calibration.	C: L	radioactive sources in the workplace,	C: N
		R: III	P: Only trained workers allowed to perform sample analysis at RAF (over)	R: IV
			M: RWPs provide work controls to mitigate exposure of co-located workers to contamination.	
			M: postings inform co-located workers of potential hazard so they can	
			actively mitigate exposure to radioactive sources.	
			M: dosimetry (down) provides an ongoing method to measure exposure	
			buildup allowing co-located workers the opportunity to mitigate their	
			exposure.	

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	Co	nsequence (C, of event)/y	year	Risk (R, Qualitative R	, Qualitative Ranking)			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)		$\mathbf{M} = \mathbf{Moderate}$		\mathbf{II} = situation (even	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		ence	M	II	II	III	IV			
Control(s) Type	C	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	nba	-							
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	ons	L	III	III	IV	IV			
$\mathbf{M} = \mathbf{Mitigative}$ (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	$00 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	$100 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	Co	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 2.3 Radiological – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Residual	Hazard: Presence of activated	L: EU	P: RAF is a locked facility, preventing access by members of the public.	L: BEU
activation	samples for analysis.	C: N		C: N
		R: IV		R: IV
Radioactive	Hazard: Presence of analysis	L: EU	P: RAF is a locked facility, preventing access by members of the public.	L:BEU
waste	materials and containers that are	C: N		C: N
	designated as radioactive waste after	R: IV		R: IV
	preparation or analysis.			
Contamination	Hazard: Contamination from spills or	L: EU	P: RAF is a locked facility, preventing access by members of the public.	L:BEU
	inadvertent transfer of material from	C: N		C: N
	analytical samples.	R: IV		R: IV
⁷ Be	Hazard: Potential radiation exposure	L: EU	Not Applicable. No prevention or mitigation is required. ⁷ Be isn't	L: BEU
	to 7Be (uptake/committed dose).	C: N	hazardous in this pattern of use by facility.	C: N
		R: IV		R: IV
Radioactive	Hazard: Presence of activated	L: UE	P: RAF is a locked facility, preventing access by members of the public.	L: BEU
Sources	samples for analysis.	C: L		C: L
		R: IV		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)/y	ear	Risk (R, Qualitative R	anking)	Risk Matrix							
$\mathbf{A} = \text{Anticipated } (L > 1.0\text{E}-02)$		$\mathbf{H} = \text{High}$		I = situation (even)	nation (event) 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)		$\mathbf{L} = \text{Low}$		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		iences	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	nbə	_	777	777	77.7	***		
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	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	$00 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	$100 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	Ċ	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: C: R:	See Section I Chapter 04	L: C: R:
Liquid Scintillator Oil	Hazard: Potential exposure to liquid scintillator oil during sample preparation or analysis.	L: A C:L R: III	P: SOPs require samples to be prepared in a fume hood. P: Only trained workers allowed to perform sample analysis at RAF M: SOPs require gloves when preparing LSC samples.	L: EU C: N R: IV

Chemical Hazard Consequences, derived from Figure	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 Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even)	nt) of major concern				Like	ihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (evo	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	sa	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	,	Ш	111	IV	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	suo	L	111	III	1 V	1 V	
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$	M	PAC-2 > C ≥ PAC-1	P.A	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$	С	N	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		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 2.5 Toxic Materials – Onsite 2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	Hazard: Potential exposure to lead dust during manual handling of unencased lead bricks, lead shot, and lead sheets.	L: C: R:I	See Section I Chapter 04.	L: C: R:
Liquid Scintillator Oil	Hazard: N/A	L: U C: L R: III	P: SOPs require samples to be prepared in a fume hood. P: Only trained workers allowed to perform sample analysis at RAF M: SOPs require gloves when preparing LSC samples.	L: BEU C: N R: IV

Chemical Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event))/year	Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = \text{situation (ev}$	ent) of concern		-	A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		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	ence	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbəsı	_	TTT	TTT	IV	13.7	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	ons	L	III	III	IV	IV	
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$	M	PAC-2 > C ≥ PAC-1	P	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$		N	IV	IV	IV	IV	
Acronyms	T.	$PAC-1 > \mathbf{C}$	- 1	$\frac{\text{PAC-2} > \mathbf{C}}{\text{PAC-2} > \mathbf{C}}$	PEL or $TLV_c > C$							
IDLH = Immediately Dangerous to Life and Health	N	Consequences less	Cor	nsequences less than	Consequences less than							
MOI = Maximally-exposed Offsite Individual	11	*		•	those for Low							
PAC = Protective Action Criteria		than those for Low	tnose	for Low Consequence								
PEL = Permissible Exposure Limit		Consequence Level		Level	Consequence Level							
TLV_c = Threshold Limit Value (ceiling)												

Table 2.6 Toxic Materials – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	Hazard: Potential exposure to lead dust during manual handling of unencased lead bricks.	L: C: R:	See Section I Chapter 04	L: C: R:
Liquid Scintillator Oil	Hazard: Potential exposure.	L: EU C: L R: IV	P: Public screening at the Fermilab site boundary. P: RAF is a locked facility which does not allow unaccompanied public access.	L: BEU C: L R: IV

Chemical Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.																
Likelihood (L, of event)/year	Consequence (C, of event)/year Risk (R, Qualitative Ranking)									Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like							
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 ^x	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	ences	M	II	II	III	IV					
Control(s) Type	C	Offsite (MOI) Onsite-2		e-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	ī	III	III	IV	IV					
P = Preventive (reduce event occurrence likelihood)	H	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	ons	L	Ш	111	1 V	1 V					
M = Mitigative (reduces event consequences)	M	PAC-2 > C ≥ PAC-1	P/	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$		N	IV	IV	IV	IV					
Acronyms	T.	PAC-1 > C		PAC-2 > C	PEL or TLV $_c > C$											
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		Consequence Level	tilosc	Level	Consequence Level											
PEL = Permissible Exposure Limit		Consequence Level		TEACI	Consequence Lever											
TLV_c = Threshold Limit Value (ceiling)																

 ${\bf Table~2.7~Flammable~and~Combustible~Materials-Onsite~-1~Facility~Worker}$

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible	Hazard: Smoke inhalation and or	L:	See Section I Chapter 04	L:
materials	burns from a fire involving	C:		C:
(cables, Boxes,	combustible materials.	R:		R:
Paper, wood				
cribbing, etc.)				
Flammable	Hazard: Smoke inhalation and or	L:	See Section I Chapter 04	L:
Materials	burns from a fire caused by	C:		C:
(Flammable gas,	flammable materials resulting in	R:		R:
cleaning	smoke inhalation or burns.			
materials, etc.)				

Other Hazard Consequences, derived from Figure C-	l, "E	xample Qualitative Cons	equence Matrix", DOE-HD	PBK-1163-2020.									
Likelihood (L, of event)/year	C	onsequence (C, of event)/		0.	Risk	Matri							
A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L >1.0E-04)		$\mathbf{H} = \text{High}$ $\mathbf{M} = \text{Moderate}$	I = situation (eve II = situation (ev	ent) of major concern		A		Like U	lihood EU	BEU			
EU = Extremely Unlikely (1.0E-04)		$\mathbf{L} = \text{Low}$,	vent) of minor concern	nces	Н	I	I	II	III			
BEU = Beyond Extremely Unlikely (1.0E-06> L)		\mathbf{N} = Negligible	`	IV = situation (event) of minimal concern			II	II	III	IV			
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	т	Ш	III	IV	IV			
P = Preventive (reduce event occurrence likelihood)	Н	$C \ge Irreversible$,	$C \ge Prompt worker fatality$	C ≥ Prompt worker	Cons								
M = Mitigative (reduces event consequences) Acronyms		other serious effects,	or acute injury that is	fatality or acute injury that	لللل	N	IV	IV	IV	IV			
MOI = Maximally-exposed Offsite Individual		or symptoms which could impair an	immediately life- threatening or permanently	is immediately life- threatening or									
		individual's ability to	disabling.	permanently disabling.									
		take protective	C										
		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	those for Low Consequence	those for Low									
		Consequence Level	Level	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	Hazard: Smoke inhalation and or	L: C:	See Section I Chapter 04	L: C:
materials	burns from a fire involving			
(cables, Boxes,	combustible materials.	R:		R:
Paper, wood				
cribbing, etc.)				
Flammable	Hazard: Smoke inhalation and or	L:	See Section I Chapter 04	L:
Materials	burns from a fire caused by	C:		C:
(Flammable gas,	flammable materials resulting in	R:		R:
cleaning	smoke inhalation or burns.			
materials, etc.)				

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020. Likelihood (L, of event)/year Risk (R, Qualitative Ranking) Risk Matrix										
Likelihood (L, of event)/year	C	onsequence (C, of event)/	Risk	Matri	X					
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	$\mathbf{I} = \text{situation (even}$	ent) of major concern						
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	vent) 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	sa	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (e	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		***	***	***	***
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Suo	L	III	III	IV	IV
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	or acute injury that is	fatality or acute injury that	ت	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	e e e e e e e e e e e e e e e e e e e							
		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	1					
		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 2.9 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: Smoke inhalation and or	L: C:	See Section I Chapter 04	L: C:
materials	burns from a fire involving			
(cables, Boxes,	combustible materials.	R:		R:
Paper, wood				
cribbing, etc.)				
Flammable	Hazard: Smoke inhalation and or	L:	See Section I Chapter 04	L:
Materials	burns from a fire caused by	C:		C:
(Flammable gas,	flammable materials resulting in	R:		R:
cleaning	smoke inhalation or burns.			
materials, etc.)				

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Cons	equence Matrix", DOE-HD	PBK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/y		<u>.</u>	Risk	Matri	ix			
A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L >1.0E-04)		$\mathbf{H} = \text{High}$ $\mathbf{M} = \text{Moderate}$,	I = situation (event) of major concern II = situation (event) of concern			A	Like U	lihood EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	,	vent) of minor concern	nces	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \text{Negligible}$	· · · · · · · · · · · · · · · · · · ·	vent) of minimal concern	- E	M	II	II	III	IV
Control(s) Type P = Proventive (reduce event economerce likelih and)	C	0 2 - 10 - 10 - 10 - 10 - 10 - 10 - 1	Onsite-2 (co-located worker)	Onsite-1 (facility worker) C ≥ Prompt worker	nbəsı	L	III	III	IV	IV
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		Cor	N	IV	IV	IV	IV
 M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 		or symptoms which	immediately life- threatening or permanently disabling.	fatality or acute injury that is immediately life- threatening or permanently disabling.						
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	L	Mild, transient	Minor injuries; no	Minor injuries; no						
	N	adverse effects > C Consequences less	hospitalization > C Consequences less than	hospitalization > C Consequences less than						
	IN		those 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)
High Voltage	Hazard: Shock hazard from bias	L:	See Section I Chapter 04	L:
Exposure	greater than 50V.	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	Matri	X	x					
$\mathbf{A} = \text{Anticipated } (L > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (event) of major concern					Like	lihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = situation (evolution (evolution for evolution $	ent) of concern	_	ı	Α	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	saou	Н	I	I	II	III			
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	<u>a</u>	M	II	II	III	IV			
Control(s) Type	C	Offsite (MOI)	Onsite-	·2 (co-located worker)	Onsite-1 (facility worker)	edno	_				***			
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C > P1	rompt worker fatality	C ≥ Prompt worker	us	L	III	III	IV	IV			
M = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that	Co	N	IV	IV	IV	IV			
Acronyms		or symptoms which		mmediately life-	is immediately life-									
MOI = Maximally-exposed Offsite Individual		could impair an		ening or permanently	threatening or									
		individual's ability to		disabling.	permanently disabling.									
		take protective		Ü										
		action.												
	M	C ≥ Mild, transient	C ≥	Serious injury, no	C ≥ Serious injury, no									
		adverse effects.	imme	ediate loss of life no	immediate loss of life no									
			perr	nanent disabilities;	permanent disabilities;									
			hosp	italization required.	hospitalization required.									
	L	Mild, transient	M	Iinor injuries; no	Minor injuries; no									
		adverse effects > C	ho	ospitalization > C	hospitalization $> \mathbf{C}$									
	N	Consequences less	Con	sequences less than	Consequences less than									
		than those for Low	those f	for Low Consequence	those for Low									
		Consequence Level		Level	Consequence Level									

 Table 2.11 Electrical Energy Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
High Voltage	Hazard: Shock hazard from bias	L:	See Section I Chapter 04	L:
Exposure	greater than 50V.	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	Matri	x					
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like	lihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = \text{situation (ev}$	ent) of concern		ı	A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (evaluation	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)	edne	_						
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C > Pr	rompt worker fatality	C ≥ Prompt worker		L	III	III	IV	IV		
M = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that	رة ا	N	IV	IV	IV	IV		
Acronyms		or symptoms which		mmediately life-	is immediately life-				•				
MOI = Maximally-exposed Offsite Individual		could impair an		ening or permanently	threatening or								
		individual's ability to		disabling.	permanently disabling.								
		take protective		Ü									
		action.											
	M	C ≥ Mild, transient	C≥	Serious injury, no	C ≥ 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	M	linor injuries; no	Minor injuries; no								
		adverse effects > C	ho	ospitalization > C	hospitalization > C								
	N	Consequences less	Cons	sequences less than	Consequences less than								
		than those for Low	those f	For Low Consequence	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)
High Voltage Exposure	Hazard: Shock hazard from bias greater than 50V.	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				
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even)	nt) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (evolution)	ent) of concern		ı	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	nces	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)	edne		***	***	T 7	***	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C > P	Prompt worker fatality	C ≥ Prompt worker	Suo	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that	Ď	N	IV	IV	IV	IV	
Acronyms		or symptoms which		mmediately life-	is 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								
		action.										
	M	C ≥ Mild, transient	C ≥	≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	imm	nediate loss of life no	immediate loss of life no							
			per	manent disabilities;	permanent disabilities;							
			hosp	pitalization required.	hospitalization required.							
	L	Mild, transient	N	Minor injuries; no	Minor injuries; no							
		adverse effects > C	h	ospitalization > C	hospitalization $> \mathbf{C}$							
	N	Consequences less	Con	sequences less than	Consequences less than							
		than those for Low	those	for Low Consequence	those for Low							
		Consequence Level		Level	Consequence Level							

Table 2.13 Thermal Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenic Liquids	Hazard: Burns to face or extremities during liquid nitrogen transfer from Tank #53 to 5 l or 600 ml vessels.	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.									
Likelihood (L, of event)/year	C	onsequence (C, of event)/y		<u>o</u> .	Risk	Matri	ix	x Likelihood					
A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L >1.0E-04)		$\mathbf{H} = \text{High}$ $\mathbf{M} = \text{Moderate}$	I = situation (eve II = situation (eve	ent) of major concern ent) of concern			A	Like U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$	III = situation (ex	vent) of minor concern	uces	Н	I	I	II	III			
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	·	vent) of minimal concern	- E	M	II	II	III	IV			
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəsı	L	III	III	IV	IV			
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	Con	N	IV	IV	IV	IV			
 M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual 		or symptoms which	immediately life- threatening or permanently disabling.	is immediately life- threatening or permanently disabling.									
	M	$C \ge Mild$, 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	Minor injuries; no	Minor injuries; no									
	N.T	adverse effects > C	hospitalization > C	hospitalization > C									
	IN		Consequences less than those for Low Consequence	Consequences less than 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 Liquids	Hazard: Burns to face or extremities during liquid nitrogen transfer from Tank #53 to 5 l or 600 ml vessels.	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Cons	equence Matrix", DOE-HD	PBK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/y		<u>.</u>	Risk	Matri	ix			
A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L >1.0E-04)		$\mathbf{H} = \text{High}$ $\mathbf{M} = \text{Moderate}$	I = situation (eve II = situation (ev	ent) of major concern			A	Like U	lihood EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	,	vent) of minor concern	nces	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{N} = \text{Negligible}$	· · · · · · · · · · · · · · · · · · ·	vent) of minimal concern	- E	M	II	II	III	IV
Control(s) Type P = Proventive (reduce event economerce likelih and)	C	0 2 - 10 - 10 - 10 - 10 - 10 - 10 - 1	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəsı	L	III	III	IV	IV
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	$C \ge Prompt worker$ fatality or acute injury that	Cor	N	IV	IV	IV	IV
Acronyms MOI = Maximally-exposed Offsite Individual		or symptoms which	immediately life- threatening or permanently disabling.	is immediately life- threatening or permanently disabling.						
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	L	Mild, transient	Minor injuries; no	Minor injuries; no						
	N	adverse effects > C	hospitalization > C Consequences less than	hospitalization > C Consequences less than						
	1	Consequences less than those for Low	those for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

Table 2.15 Thermal Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenic Liquids	Hazard: Burns to face or extremities during liquid nitrogen transfer from Tank #53 to 5 l or 600 ml vessels.	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Conse	quence 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		Ranking) nt) of major concern	Risk	Matri	ix	Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	`	ation (event) of concern		11	A	U	EU	BEU
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 minor concern vent) of minimal concern	Consequences	H M	I	II	III	III IV
Control(s) Type	С		Onsite-2 (co-located worker)	Onsite-1 (facility worker)	edne	L	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences)	Н		C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	N	IV	IV	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- hreatening or permanently disabling.	fatality or acute injury that is immediately life- threatening or permanently disabling.						
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C						
	N	Consequences less	Consequences less than hose for Low Consequence Level	Consequences less than those for Low Consequence Level						

 $Table~{\bf 2.16~Kinetic~Energy-Onsite-1~Facility~Worker}$

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Mobile Shielding	Hazard: Injury from mishandling of lead shielding bricks during movement or transfer.	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	ear Risk (R, Qualitative	Ranking)	Risk	Matri	X			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	$\mathbf{I} = \text{situation (eve}$	nt) of major concern				Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	ent) of concern		1	Α	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (ex	vent) of minor concern	nces	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)	edner	_	***	***		TX 7
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV
$\mathbf{M} = \text{Mitigative (reduces event consequences)}$		other serious effects,	or acute injury that is	fatality or acute injury that) i	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 $> \mathbf{C}$						
	N	Consequences less	Consequences less than	Consequences less than						
		than those for Low	hose for Low Consequence	those for Low						
		Consequence Level	Level	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 Qualitative Risk (with controls)
Mobile Shielding	Hazard: Injury from mishandling of lead shielding bricks during movement or transfer.	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	Co	onsequence (C, of event)/	year	Risk (R, Qualitative	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern							
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{H} = \text{situation (even}$	ent) of concern	_	1	A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (ex	vent) of minor concern	sea	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)	nbə	_		***	TX 7	TY 7	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ P	rompt worker fatality	C ≥ Prompt worker	suo	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that	$^{\circ}$	N	IV	IV	IV	IV	
Acronyms		or symptoms which		mmediately life-	is 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.										
	M	$C \ge Mild$, transient	C ≥	Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	imm	ediate loss of life no	immediate loss of life no							
			peri	manent disabilities;	permanent disabilities;							
			hosp	italization required.	hospitalization required.							
	L	Mild, transient	N	Inor injuries; no	Minor injuries; no							
		adverse effects $> \mathbf{C}$	ho	ospitalization > C	hospitalization > C							

Table 2.18 Kinetic Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Mobile Shielding	Hazard: Injury from mishandling of lead shielding bricks during movement or transfer.	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1						Dial	k Matr	<u> </u>						
Likelihood (L, of event)/year	C	onsequence (C, of event)	/year	Risk (R, Qualitative	8/	Kisi	k Matr	IX .						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \text{High}$		I = situation (eve	nt) of major concern					lihood				
U = Unlikely (1.0E-02> L>1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = \text{situation (ev}$	ent) of concern		1	Α	U	EU	BEU			
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (evaluation	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)	Consequences	L	Ш	III	IV	IV			
P = Preventive (reduce event occurrence likelihood)	H	$C \ge Irreversible$,	$\mathbf{C} \ge \mathbf{P}$	Prompt worker fatality	C ≥ Prompt worker	Cons								
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	i	mmediately life-	is 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		C	, ,									
		action.												
	M	C ≥ Mild, transient	C ≥	≥ Serious injury, no	C ≥ Serious injury, no									
		adverse effects.	imm	nediate loss of life no	immediate loss of life no									
			per	manent disabilities;	permanent disabilities;									
			hosp	oitalization required.	hospitalization required.									
	L	Mild, transient	N	Minor injuries; no	Minor injuries; no									
		adverse effects > C	h	ospitalization > C	hospitalization $> C$									

Table 2.19 Potential Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Compressed Gasses	Hazard: Injury from unexpected failure of P-10 (Ar/CH4) gas cylinder regulation during routine handling.	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	Hazard: Injury from unexpected failure of vacuum pumps during liquid transfers between containers.	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/y		<u>o</u> .	Risk	Matri	ix			
A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L >1.0E-04)		$\mathbf{H} = \text{High}$ $\mathbf{M} = \text{Moderate}$	I = situation (eve II = situation (eve	ent) of major concern			A	Like U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$	III = situation (ex	vent) of minor concern	nces	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	·	vent) of minimal concern	- E	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəsı	L	III	III	IV	IV
P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences)	H		$C \ge Prompt worker fatality$	C ≥ Prompt worker	Con	N	IV	IV	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.						
	M	$C \ge Mild$, 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	Minor injuries; no	Minor injuries; no						
	N.T	adverse effects > C	hospitalization > C	hospitalization > C						
	IN	Consequences less than those for Low	Consequences less than those for Low Consequence	Consequences less than those for Low						
		Consequence Level	Level	Consequence Level						

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Compressed Gasses	Hazard: Injury from unexpected failure of P-10 (Ar/CH4) gas cylinder regulation during routine handling.	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	Hazard: Injury from unexpected failure of vacuum pumps during liquid transfers between containers.	L: C: R:	See Section I Chapter 04	L: C: R:

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

 $Table\ 2.21\ Potential\ Energy-MOI\ Offsite$

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Compressed Gasses	Hazard: Injury from unexpected failure of P-10 (Ar/CH4) gas cylinder regulation during routine handling.	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	Hazard: Injury from unexpected failure of vacuum pumps during liquid transfers between containers.	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 A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/ye H = High		Ranking) nt) of major concern	Risk	Matri	x	Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$,	II = situation (event) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$,	vent) of minor concern	ces	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely $(1.0E-06>L)$	-	N = Negligible		vent) of minimal concern	nen	M	II	II	III	IV	
Control(s) Type P = Preventive (reduce event occurrence likelihood)	C		site-2 (co-located worker)	Onsite-1 (facility worker)	Consequences	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)	H	$C \ge$ Irreversible, other serious effects,	C ≥ Prompt worker fatality or acute injury that is	C ≥ Prompt worker fatality or acute injury that	Col	N	IV	IV	IV	IV	
M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual		or symptoms which could impair an individual's ability to take protective action.	immediately life- reatening or permanently disabling.	is immediately life- threatening or permanently disabling.		ı					
	M		C ≥ Serious injury, no mmediate loss of life no permanent disabilities; nospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
	N	-	hospitalization > C Consequences less than ose for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level							

 $Table\ 2.22\ Other\ hazards-Onsite-1\ Facility\ Worker$

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Ergonomics	Hazard: Injury from sitting/standing for extended periods at benchtops or workstations.	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Cons	equence Matrix", DOE-HD	DBK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High		Ranking) ent) of major concern	Risk	Matri	ix	Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \text{Moderate}$ $\mathbf{II} = \text{situation (event) of major concern}$				A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \text{Low}$ $\mathbf{N} = \text{Negligible}$		vent) of minor concern vent) of minimal concern	nces	Н	I	I	II	III
Control(s) Type	C		Onsite-2 (co-located worker)	Onsite-1 (facility worker)	edne	M	II	II	III	IV
P = Preventive (reduce event occurrence likelihood)	H	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Conse	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.	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	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level						

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Ergonomics	Hazard: Injury from sitting/standing for extended periods at benchtops or workstations.	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)/y		Risk (R, Qualitative Ranking) I = situation (event) of major concern II = situation (event) of concern III = situation (event) of minor concern		Risk Matrix					
A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L >1.0E-04)		$\mathbf{H} = \text{High}$ $\mathbf{M} = \text{Moderate}$	`				A	Likelihood U EU		BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	,			Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	·	IV = situation (event) of minimal concern		M	II	II	III	IV	
Control(s) Type P = Preventive (reduce event occurrence likelihood)	Н	0 ()	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbesu	L	III	III	IV	IV	
M = Mitigative (reduces event occurrence fixenhood)		C ≥ Irreversible, other serious effects,	$C \ge Prompt$ worker fatality or acute injury that is	$C \ge Prompt worker$ fatality or acute injury that	Cor	N	IV	IV	IV	IV	
Acronyms MOI = Maximally-exposed Offsite Individual		or symptoms which	immediately life- threatening or permanently disabling.	is immediately life- threatening or permanently disabling.							
	M	$C \ge Mild$, 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	Minor injuries; no	Minor injuries; no							
		adverse effects > C Consequences less	hospitalization > C Consequences less than	hospitalization > C Consequences less than							
		_	those for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 2.24 Other hazards – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Ergonomics	Hazard: Injury from sitting/standing for extended periods at benchtops or workstations.	L: BEU C: N R: IV	NA.	L: BEU C: N R: IV

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event)/y		Risk (R, Qualitative Ranking) I = situation (event) of major concern II = situation (event) of concern		Risk Matrix					
A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L >1.0E-04)		$\mathbf{H} = \text{High}$ $\mathbf{M} = \text{Moderate}$,			ŀ		Like U	BEU		
EU = Extremely Unlikely (1.0E-04)	$\mathbf{L} = \text{Moderate}$,	III = situation (event) of concern IV = situation (event) of minimal concern		Н	A I	I	EU II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	,			M	II	II	III	IV	
Control(s) Type	C H	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	sedn	ī	III	III	IV	IV	
P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences)			C ≥ Prompt worker fatality	C ≥ Prompt worker	Con		IV	IV	IV	IV	
M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual		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	17	1 1	1 1	14	
	M	$C \ge Mild$, 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	Minor injuries; no	Minor injuries; no							
		adverse effects > C Consequences less	hospitalization > C Consequences less than	hospitalization > C Consequences less than							
		_	those for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 2.25 Environmental

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Airborne	 Hazard: Airborne release of radionuclides beyond permitted limits. Discharge of chemicals into onsite surface waters beyond permitted limits. 	L: C: R:	See Section I Chapter 04	L: C: R:
Water	 Hazard: Discharge of radionuclides into onsite surface waters beyond permitted limits. Discharge of chemicals into onsite surface waters beyond permitted limits. 	L: C: R:	See Section I Chapter 04	L: C: R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Soil	 Hazard: Discharge of radionuclides 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: