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	<del>R: *</del>	R: *
2.14	Thermal Energy – Onsite-2 Co-located Worker	<del>R: *</del>	R: *
2.15	Thermal Energy – MOI Offsite	R: *	<del>R:</del>
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: *

<sup>\*</sup> 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	<ul> <li>P: Only trained workers allowed to perform sample analysis at RAF (over)</li> <li>M: RWPs provide work controls to mitigate exposure of workers to residual activation.</li> <li>M: postings inform workers of potential hazard to mitigate exposure to residual activation.</li> <li>M: dosimetry (down) provides an ongoing method to measure exposure buildup allowing workers the opportunity to mitigate their exposure.</li> </ul>	R: IV
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 preparation or analysis.	R: IV	<ul> <li>P: Only trained workers allowed to perform sample analysis at RAF (over)</li> <li>M: RWPs provide work controls to mitigate exposure of workers to radioactive waste.</li> <li>M: postings inform workers of potential hazard to mitigate exposure to radioactive waste.</li> <li>M: dosimetry (down) provides an ongoing method to measure exposure buildup allowing workers the opportunity to mitigate their exposure.</li> </ul>	R: IV

Hazard Hazard Description Qual (with		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	L: A C: N	P: SOPs provide the process for workers to follow during analytical work to prevent contamination transfer to themselves,	L:EU C: N
	analytical samples.	R: IV	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	R: IV
<sup>7</sup> Be	Hazard: Potential radiation exposure to 7Be (uptake/committed dose).	L: A C: N R: IV	buildup allowing workers the opportunity to mitigate their exposure.  Not Applicable. No prevention or mitigation is required. <sup>7</sup> 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

Likelihood (L, of event)/year	Co	nsequence (C, of event)/y	year Risk	(R, Qualitative R	anking)	Risk Matrix						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	1	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)		$\mathbf{L} = \mathbf{Low}$		III = situation (eve	ent) of minor concern	es	Н	I	I	II	III	
<b>BEU</b> = 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-2 (co	o-located worker)	Onsite-1 (facility worker)	nbə						
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem	<b>C</b> ≥	≥ 100 rem	C ≥ 100 rem	ons	L	III	III	IV	IV	
<b>M</b> = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	100 rem	1 > C ≥ 25 rem	100 rem > C ≥ 25 rem	0	N	IV	IV	IV	IV	
Acronyms	L	5 rem > <b>C</b>	25	rem > C	25 rem > C							
MOI = Maximally-exposed Offsite Individual rem = Roentgen equivalent man	N	0.5 rem > <b>C</b>	5 r	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	R: IV
			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.	
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.	R: IV
			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.	

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
			<ul> <li>M: posting postings inform co-located workers of potential hazard so they can actively mitigate exposure to contamination.</li> <li>M: dosimetry (down) provides an ongoing method to measure exposure buildup allowing co-located workers the opportunity to mitigate their exposure.</li> </ul>	
<sup>7</sup> Be	Hazard: Potential radiation exposure	L: A	Not Applicable. No prevention or mitigation is required. <sup>7</sup> 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.	

Likelihood (L, of event)/year	Co	nsequence (C, of event)/y	year	Risk (R, Qualitative R	lanking)	Risk Matrix						
A = 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)	$\mathbf{M} = \mathbf{Moderate}$			$\mathbf{II} = \text{situation (even}$	nt) of concern			Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (eve	ent) of minor concern	es	Н	I	I	II	III	
<b>BEU</b> = 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)	edn						
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		<b>C</b> ≥ 100 rem	C ≥ 100 rem	ons	L	III	III	IV	IV	
<b>M</b> = 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 > <b>C</b>		25 rem > <b>C</b>	25 rem > <b>C</b>							
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
<sup>7</sup> Be	Hazard: Potential radiation exposure	L: EU	Not Applicable. No prevention or mitigation is required. <sup>7</sup> 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

Likelihood (L, of event)/year	Consequence (C, of event)/yea			nalitative Ranking)			Risk Matrix						
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \text{High}$			t) of major concern				Like	lihood			
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$			nt) of concern		•	A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)	$\mathbf{L} = \mathbf{Low}$		III = situati	ion (eve	ent) of minor concern	es	Н	I	I	II	III		
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)	N = Negligible		IV = situati	IV = situation (event) of minimal concern		enc	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located wor	rker)	Onsite-1 (facility worker)	nba							
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem	C ≥ 100 rem		C ≥ 100 rem	ons	L	III	III	IV	IV		
<b>M</b> = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	$100 \text{ rem} > \mathbf{C} \ge 25 \text{ re}$	em	$100 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	C	N	IV	IV	IV	IV		
Acronyms	L	5 rem > C	$\frac{25 \text{ rem} > \mathbf{C}}{25 \text{ rem}} > \mathbf{C}$		25 rem > C								
<b>MOI</b> = Maximally-exposed Offsite Individual <b>rem</b> = 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

C-1	, "Example Qualitative	Conseq	quence Matrix", DOE-	HDBK-1163-2020.						
C	onsequence (C, of event)	)/year	Risk (R, Qualitative Ranking)			k Matri	X			
	$\mathbf{H} = \mathbf{High}$	$\mathbf{H} = \mathbf{High}$		I = situation (event) of major concern				Like	lihood	
	$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			A	U	EU	BEU
	L = Low		III = situation (e	vent) of minor concern	es	Н	I	I	II	III
	N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV
C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbə		TTT	TTT	TX /	17.7
Н	C > PAC-2			C > IDLH	ons	L	111	111	10	IV
М	_				C	N	IV	IV	IV	IV
T		1 7								
N	Consequences less than those for Low Consequence Level		nsequences less than	Consequences less than those for Low Consequence Level						
	C	Consequence (C, of event) $H = High$ $M = Moderate$ $L = Low$ $N = Negligible$ $C                                    $	Consequence (C, of event)/year $H = High$ $M = Moderate$ $L = Low$ $N = Negligible$ C Offsite (MOI) Onsite $H  C \ge PAC-2$ $M  PAC-2 > C \ge PAC-1$ $L  PAC-1 > C$ N Consequences less Contain those for Low those		$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$

**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	Risk Matrix										
A = 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)		$\mathbf{M} = \mathbf{Moderate}$		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		
<b>BEU</b> = 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)	Offsite (MOI) Onsite-2		Onsite-1 (facility worker)	ean	٠ 🖵	TTT	TTT	IV	IV		
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	Suo		III	III	1 V	1 V		
<b>M</b> = Mitigative (reduces event consequences)	М	$PAC-2 > C \ge PAC-1$	P.	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$		N	IV	IV	IV	IV		
Acronyms	Τ.	$PAC-1 > \mathbf{C}$	- 11	$\frac{\text{PAC-2} > \mathbf{C}}{\text{PAC-2} > \mathbf{C}}$	PEL or $TLV_c > C$								
<b>IDLH</b> = Immediately Dangerous to Life and Health	NI		C										
MOI = Maximally-exposed Offsite Individual	11	Consequences less		nsequences less than	Consequences less than								
<b>PAC</b> = Protective Action Criteria				for Low Consequence	those for Low								
<b>PEL</b> = Permissible Exposure Limit		Consequence Level		Level	Consequence Level								
TLV <sub>c</sub> = 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	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				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	sea	Н	I	I	II	III		
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ex	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	T	III	m	IV	IV		
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	ons	L	1111	III	1 V	1 V		
<b>M</b> = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P/	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$	0	N	IV	IV	IV	IV		
Acronyms	L	PAC-1 > <b>C</b>		PAC-2 > <b>C</b>	PEL or $TLV_c > C$								
IDLH = Immediately Dangerous to Life and Health MOI = Maximally-exposed Offsite Individual PAC = Protective Action Criteria PEL = Permissible Exposure Limit TLV <sub>c</sub> = 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 2.7 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-	1, "F	Example Qualitative Conse	quence Matrix", DOE-HD	BK-1163-2020.								
Likelihood (L, of event)/year  A = Anticipated (L > 1.0E-02)  L = Unlikelikelike(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	Δ	Likelihood				
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) PEU = Payand Extremely Unlikely (1.0E.06> L)		L = Low	III = situation (e	II = situation (event) of concern III = situation (event) of minor concern		Н	I	I	II	BEU		
BEU = Beyond Extremely Unlikely (1.0E-06> L)  Control(s) Type P = Preventive (reduce event occurrence likelihood)	C	/	Onsite-2 (co-located worker)	vent) of minimal concern Onsite-1 (facility worker)	Consequences	M L	III	III	III IV	IV IV		
<b>M</b> = Mitigative (reduces event consequences)	Н	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 could impair an individual's ability to take protective action.	immediately life- hreatening or permanently disabling.	is immediately life- threatening or permanently disabling.								
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.								
	L	Mild, transient adverse effects $> \mathbb{C}$	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C								
I	N Consequences less Cor		Consequences less than hose 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	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-	1, "F	Example Qualitative Conse	equence Matrix", DOE-HD	BK-1163-2020.								
Likelihood (L, of event)/year  A = Anticipated (L > 1.0E-02)  L = U-1/2-1-(1.0E-02) L > 1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	nt) of major concern	Risk	Matri	A	Likelihood				
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)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$	III = situation (ex	II = situation (event) of concern  III = situation (event) of minor concern			I	I	II	BEU		
Control(s) Type  P = Preventive (reduce event occurrence likelihood)	C H	Offsite (MOI)	Onsite-2 (co-located worker)	, , ,			III	III	III	IV IV		
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,	C ≥ Prompt worker fatality or acute injury that is	C ≥ Prompt worker 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.	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 $> \mathbf{C}$	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C								
Ī		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 2.9 Flammable and Combustible Materials – MOI Offsite

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

Other Hazard Consequences, derived from Figure C-1	l, "F	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.								
Likelihood (L, of event)/year	Risk	Matri	ix									
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 (even	ent) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	<b>III</b> = situation (ex	vent) of minor concern	es	Н	I	I	II	III		
<b>BEU</b> = 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)	nbəs	_	TTT	TTT	17.7	17.7		
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	$C \ge Irreversible$ , $C \ge Pro$	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	Ш	III	IV	IV		
<b>M</b> = 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 2.10 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	ix							
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		<b>I</b> = situation (event) of major concern											
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (event) of concern			T	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				
<b>BEU</b> = 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)	nba	_	***	***	77.7	***				
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C > P	rompt worker fatality	C ≥ Prompt worker	Suo	L	III	III	IV	IV				
<b>M</b> = 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-										
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		ening or permanently	threatening or										
		individual's ability to		disabling.	permanently disabling.										
		take protective		8	, , , , , , , , , , , , , , , , , , ,										
		action.													
	M	C ≥ Mild, transient	<b>C</b> ≥	≥ Serious injury, no	C ≥ Serious injury, no										
		adverse effects.		ediate 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	ho	ospitalization > C	hospitalization > 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 2.11 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:
1		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	ix					
A = 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)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern			Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	sea	Н	I	I	II	III		
<b>BEU</b> = 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)	nba	_						
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C > Pr	compt worker fatality	C ≥ Prompt worker	Suc	L	III	III	IV	IV		
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,		icute injury that is	fatality or acute injury that	Co	N	IV	IV	IV	IV		
Acronyms		or symptoms which		nmediately life-	is immediately life-								
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		ening or permanently	threatening or								
		individual's ability to		disabling.	permanently disabling.								
		take protective		C									
		action.											
	M	C ≥ Mild, transient	<b>C</b> ≥	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	spitalization > C	hospitalization > C								
	N	Consequences less	Cons	sequences less than	Consequences less than								
		than those for Low	those for	or 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					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$		I = situation (ever	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			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	seou	Н	I	I	II	III		
<b>BEU</b> = 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							
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C > P	rompt worker fatality	C ≥ Prompt worker	Suo	L	III	III	IV	IV		
<b>M</b> = Mitigative (reduces event consequences)	_	other serious effects,		acute injury that is	fatality or acute injury that	ŭ	N	IV	IV	IV	IV		
Acronyms		or symptoms which		mmediately life-	is immediately life-								
<b>MOI</b> = Maximally-exposed Offsite Individual		could impair an		ening or permanently	threatening or								
		individual's ability to		disabling.	permanently disabling.								
		take protective		8									
		action.											
	M	$C \ge Mild$ , transient	C≥	≥ Serious injury, no	C ≥ Serious injury, no								
		adverse effects.		ediate 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								
	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 Conse	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year  A = Anticipated (L > 1.0E-02)  L = U-1/2-1-(1.0E-02) L > 1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	nt) 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)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$		vent) of concern vent) of minor concern vent) of minimal concern	ences	Н	I	I	II	III
Control(s) Type  P = Preventive (reduce event occurrence likelihood)	C H	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəsu	M L	III	III	III	IV IV
M = Mitigative (reduces event consequences) Acronyms		other serious effects,	C ≥ Prompt worker fatality or acute injury that is	C ≥ Prompt worker fatality or acute injury that	Cor	N	IV	IV	IV	IV
MOI = Maximally-exposed Offsite Individual		or symptoms which could impair an individual's ability to take protective action.	immediately life- threatening or permanently disabling.	is immediately life- threatening or permanently disabling.						
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	L	Mild, transient adverse effects $> \mathbf{C}$	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 2.14 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	l, "F	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	year Risk (R, Qualitative	Ranking)	Risk	Matri	X			
A = 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)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (even	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	s	Н	I	I	II	III
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	<b>IV</b> = 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)	nbəs	· ·	TTT	TTT	17.7	17.7
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV
<b>M</b> = 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			threatening 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.	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 2.15 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	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year  A = Anticipated (L > 1.0E-02)  L = U-1/2-1-(1.0E-02) L > 1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	nt) 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)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$		vent) of concern vent) of minor concern vent) of minimal concern	ences	Н	I	I	II	III
Control(s) Type  P = Preventive (reduce event occurrence likelihood)	C H	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəsu	M L	III	III	III	IV IV
M = Mitigative (reduces event consequences) Acronyms		other serious effects,	C ≥ Prompt worker fatality or acute injury that is	C ≥ Prompt worker fatality or acute injury that	Cor	N	IV	IV	IV	IV
MOI = Maximally-exposed Offsite Individual		or symptoms which could impair an individual's ability to take protective action.	immediately life- threatening or permanently disabling.	is immediately life- threatening or permanently disabling.						
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.						
	L	Mild, transient adverse effects $> \mathbf{C}$	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 2.16 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:

Likelihood (L, of event)/year	C	onsequence (C, of event)/y	year Risk (R, Qualitative	Ranking)	Risk	Matri	ix				
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \text{High}$	• •	ent) of major concern			Likelihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{H} = \text{situation (ev}$	ent) of concern		1	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	
<b>BEU</b> = 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	_	***	***	***	***	
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV	
<b>M</b> = 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-				•	•		
<b>MOI</b> = Maximally-exposed Offsite Individual			threatening 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.	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 2.17 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						
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	l .	1	A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		$III = situation (e^{-1})$	vent) of minor concern	ses	Н	I	I	II	III	
<b>BEU</b> = 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)	edn	_	777	TTT	17.7	TX /	
	Н	C ≥ Irreversible,	<b>C</b> ≥ P	rompt worker fatality	C ≥ Prompt worker	ons	L	III	III	IV	IV	
<b>M</b> = 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		mmediately life-	is immediately life-							
<b>MOI</b> = 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 ≥ Mild, transient	<b>C</b> ≥	≥ 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	oitalization required.	hospitalization required.							
	L	Mild, transient	N	Minor injuries; no	Minor injuries; no							
		adverse effects > 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:

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			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	
<b>BEU</b> = 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)	sednences	T	III	III	IV	IV	
<ul> <li>P = Preventive (reduce event occurrence likelihood)</li> <li>M = Mitigative (reduces event consequences)</li> </ul>	Н	C ≥ Irreversible, other serious effects,		Prompt worker fatality acute injury that is	C ≥ Prompt worker fatality or acute injury that	Cons	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- tening or permanently disabling.	is immediately life- threatening or permanently disabling.							
	M	C ≥ Mild, transient adverse effects.	imm per	≥ Serious injury, no nediate loss of life no manent disabilities; pitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.							
	L	Mild, transient adverse effects > C		Minor injuries; no ospitalization > C	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)
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	l, "F	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	Risk	Matri	X					
A = Anticipated (L > 1.0E-02)		$\mathbf{H} = \mathbf{High}$	<b>I</b> = situation (eve	nt) of major concern				lihood		
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (even	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
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	<b>IV</b> = 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)	nbəs	_	***	***	***	***
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	_	L	III	III	IV	IV
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	Co	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	those for Low Consequence	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	l, "F	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.								
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	Risk	Matri	ix							
A = Anticipated (L > 1.0E-02)		$\hat{\mathbf{H}} = \mathbf{High}$		nt) 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	s	Н	I	I	II	III		
<b>BEU</b> = 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)	nbəs	-	***	***	***	***		
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Prompt worker fatality	C ≥ Prompt worker	_	L	III	III	IV	IV		
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that	Co	N	IV	IV	IV	IV		
Acronyms		or symptoms which	immediately life-	is immediately life-								
<b>MOI</b> = 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 2.21 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, "F	Example Qualitative Cons	equence Matrix", DOE-HD	DBK-1163-2020.							
Likelihood (L, of event)/year  A = Anticipated (L > 1.0E-02)  L = U-1/2-1-(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	ix A	Likelihood			
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)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$	•	event) of concern event) of minor concern event) of minimal concern	ences	Н	I	I	II	BEU	
Control(s) Type  P = Preventive (reduce event occurrence likelihood)	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəsı	M L	III	III	IV	IV IV	
<b>M</b> = Mitigative (reduces event consequences)		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 could impair an individual's ability to take protective action.	immediately life- threatening or permanently disabling.	is immediately life- threatening or permanently disabling.							
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.							
	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C							
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level							

Table 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)  L = U-1/2-1-(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	ix A	Likelihood			
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)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$	•	event) of concern event) of minor concern event) of minimal concern	ences	Н	I	I	II	BEU	
Control(s) Type  P = Preventive (reduce event occurrence likelihood)	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəsı	M L	III	III	IV	IV IV	
<b>M</b> = Mitigative (reduces event consequences)		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 could impair an individual's ability to take protective action.	immediately life- threatening or permanently disabling.	is immediately life- threatening or permanently disabling.							
	M	C ≥ Mild, transient adverse effects.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required.							
	L	Mild, transient adverse effects > C	Minor injuries; no hospitalization > C	Minor injuries; no hospitalization > C							
	N	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level							

Table 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, "F	Example Qualitative Cons	equence Matrix", DOE-HD	DBK-1163-2020.							
Likelihood (L, of event)/year  A = Anticipated (L > 1.0E-02)  L = U-1/2-1-(1.0E-02) L > 1.0E-04)	C	onsequence (C, of event)/y H = High M = Moderate	I = situation (eve	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			ix A	Likelihood			
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)		$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$	III = situation (e				I	I	II	III	
Control(s) Type  P = Preventive (reduce event occurrence likelihood)	С	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	usedneuces	M L	III	III	IV	IV IV	
M = Mitigative (reduces event consequences) Acronyms	11	other serious effects,	C ≥ Prompt worker fatality or acute injury that is	C ≥ Prompt worker fatality or acute injury that is immediately life-	Cor	N	IV	IV	IV	IV	
MOI = Maximally-exposed Offsite Individual		or symptoms which could impair an individual's ability to take protective action.	could impair an andividual's ability to take protective take protective 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							
		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 2.24 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   Consequence (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				Likelihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (event) of concern				A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		III = situation (event) of minor concern		sə	Н	I	I	II	III	
<b>BEU</b> = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern			M	П	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)		Onsite-1 (facility worker)	edn	-	***	TTT	77.7	TX /	
<b>P</b> = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C > Prompt	worker fatality	C ≥ Prompt worker fatality or acute injury that	Consequences	L	III	III	IV	IV	
<b>M</b> = Mitigative (reduces event consequences)		other serious effects,	_	injury that is			N	IV	IV	IV	IV	
Acronyms		or symptoms which	immediately life-		is immediately life-				•	•		
MOI = Maximally-exposed Offsite Individual		could impair an threatening or perma		-	threatening or							
	M	individual's ability to	_	abling.	permanently disabling.							
		take protective		C								
		action.										
		C ≥ Mild, transient	C ≥ Serio	ous injury, no	C ≥ Serious injury, no							
		adverse effects.	immediate	loss of life no	immediate loss of life no							
	L		permanen	nt disabilities;	permanent disabilities;							
			hospitaliza	ation required.	hospitalization required.							
		Mild, transient	Minor i	injuries; no	Minor injuries; no							
		adverse effects > C	hospital	lization > C	hospitalization > C							
	N	Consequences less	Conseque	nces less than	Consequences less than							
		than those for Low	those for Lo	w Consequence	those for Low							
		Consequence Level	L	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	<ul> <li>Hazard:</li> <li>Airborne release of radionuclides beyond permitted limits.</li> <li>Discharge of chemicals into onsite surface waters beyond permitted limits.</li> </ul>	L: C: R:	See Section I Chapter 04	L: C: <b>R:</b>
Water	<ul> <li>Hazard:         <ul> <li>Discharge of radionuclides into onsite surface waters beyond permitted limits.</li> <li>Discharge of chemicals into onsite surface waters beyond permitted limits.</li> </ul> </li> </ul>	L: C: R:	See Section I Chapter 04	L: C: <b>R:</b>

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Soil	<ul> <li>Hazard:</li> <li>Discharge of radionuclides beyond allowable concentrations of radionuclides beyond calculated Fermilab limits.</li> <li>Discharge of chemicals into onsite soils beyond permitted limits.</li> </ul>	L: C: R:	See Section I Chapter 04	L: C: <b>R:</b>