Table 2. Summary of Baseline and Residual Risks APS-TD Non-accelerator Facilities

2,1 Radiological – Onsite-1 Facility Worker R: I R: IV 2.2 Radiological – Onsite-2 Co-located Worker R: I R: IV 2.3 Radiological – MOI Offsite R: IV R: IV 2.4 Toxic Materials – Onsite 1 Facility Worker R: I R: III, IV 2.5 Toxic Materials – Onsite 2 Co-located Worker R: II R: III, IV 2.6 Toxic Materials – MOI Offsite R: III R: III R: IV 2.6 Toxic Materials – MOI Offsite R: III R: IV 2.7 Flammable & Combustible Materials – Onsite-1 Facility Worker R: I R: IV 2.8 Flammable & Combustible Materials – MOI Offsite R: III R: IV 2.9 Flammable & Combustible Materials – MOI Offsite R: III R: IV 2.10 Electrical Energy – Onsite-2 Facility Worker R: * R: * 2.11 Electrical Energy – Onsite-2 Co-located Worker R: * R: * 2.12 Electrical Energy – Onsite-1 Facility Worker R: I R: IV 2.14 Thermal Energy – MOI Offsite R: * R: * 2.15 Thermal Energy – Onsite-1 Facility Worker <td< th=""><th></th><th>Risk Tables Description</th><th>Baseline Risk</th><th>Residual Risk</th></td<>		Risk Tables Description	Baseline Risk	Residual Risk
2.3Radiological – MOI OffsiteR: IVR: IV2.4Toxic Materials – Onsite 1 Facility WorkerR: IR: III, IV2.5Toxic Materials – Onsite 2 Co-located WorkerR: IR: III, IV2.6Toxic Materials – MOI OffsiteR: IIIR: IVI2.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: IR: IV2.8Flammable & Combustible Materials – MOI OffsiteR: IIR: IV2.9Flammable & Combustible Materials – MOI OffsiteR: IIIR: IV2.10Electrical Energy – Onsite-1 Facility WorkerR: *R: *2.11Electrical Energy – Onsite-2 Co-located WorkerR: *R: *2.12Electrical Energy – MOI OffsiteR: IR: IV2.13Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.14Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.15Thermal Energy – Onsite-1 Facility WorkerR: *R: *2.16Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy – Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-1 Facility WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: IR: III, IV2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-1 Facility Wo	2,1	Radiological – Onsite-1 Facility Worker	R: I	R: IV
2.3Radiological – MOI OffsiteR: IVR: IV2.4Toxic Materials – Onsite 1 Facility WorkerR: IR: III, IV2.5Toxic Materials – Onsite 2 Co-located WorkerR: IR: III, IV2.6Toxic Materials – MOI OffsiteR: IIIR: IVI2.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: IR: IV2.8Flammable & Combustible Materials – MOI OffsiteR: IIR: IV2.9Flammable & Combustible Materials – MOI OffsiteR: IIIR: IV2.10Electrical Energy – Onsite-1 Facility WorkerR: *R: *2.11Electrical Energy – Onsite-2 Co-located WorkerR: *R: *2.12Electrical Energy – MOI OffsiteR: IR: IV2.13Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.14Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.15Thermal Energy – Onsite-1 Facility WorkerR: *R: *2.16Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy – Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-1 Facility WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: IR: III, IV2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-1 Facility Wo	2.2	Radiological – Onsite-2 Co-located Worker	R: I	R: IV
2.5Toxic Materials – Onsite 2 Co-located WorkerR: IR: III, IV2.6Toxic Materials – MOI OffsiteR: IIIR: IV2.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: IR: IV2.8Flammable & Combustible Materials – MOI OffsiteR: IR: IV2.9Flammable & Combustible Materials – MOI OffsiteR: IIIR: IV2.10Electrical Energy – Onsite-1 Facility WorkerR: *R: *2.11Electrical Energy – Onsite-2 Co-located WorkerR: *R: *2.12Electrical Energy – MOI OffsiteR: IR: IV2.13Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.14Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.15Thermal Energy – MOI OffsiteR: IIIR: IV2.16Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy – Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy – Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-1 Facility WorkerR: *R: *2.21Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-1 Faci	2.3		R: IV	R: IV
2.6Toxic Materials – MOI OffsiteR: IIIR: IV2.7Flammable & Combustible Materials – Onsite-1 Facility WorkerR: IR: IV2.8Flammable & Combustible Materials – Onsite-2 Co-located workerR: IR: IV2.9Flammable & Combustible Materials – MOI OffsiteR: IIIR: IV2.10Electrical Energy – Onsite-1 Facility WorkerR: *R: *2.11Electrical Energy – Onsite-2 Co-located WorkerR: *R: *2.12Electrical Energy – MOI OffsiteR: IR: IV2.13Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.14Thermal Energy – Onsite-2 Co-located WorkerR: IIIR: IV2.15Thermal Energy – MOI OffsiteR: IIIR: IV2.16Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy – Onsite-2 Co-located WorkerR: *R: *2.19Potential Energy – MOI OffsiteR: *R: *2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: *R: *2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.27Other Hazards – Onsite	2.4	Toxic Materials – Onsite 1 Facility Worker	R: I	R: III, IV
2.7 Flammable & Combustible Materials – Onsite-1 Facility Worker R: I R: IV 2.8 Flammable & Combustible Materials – Onsite-2 Co-located worker R: I R: IV 2.9 Flammable & Combustible Materials – MOI Offsite R: III R: IV 2.10 Electrical Energy – Onsite-1 Facility Worker R: * R: * R: * 2.11 Electrical Energy – Onsite-2 Co-located Worker R: * R: * 2.12 Electrical Energy – MOI Offsite R: I R: IV 2.13 Thermal Energy – Onsite-1 Facility Worker R: I R: IV 2.14 Thermal Energy – Onsite-2 Co-located Worker R: I R: IV 2.15 Thermal Energy – MOI Offsite R: III R: IV 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 – Onsite-2 Co-located Worker R: * R: * 2.19 Potential Energy – MOI Offsite R: * R: * 2.20 Potential Energy – Onsite-2 Co-located Worker R: * R: * 2.21 Potential Energy – Onsite-2 Co-located Worker R: * R: * 2.22 Magnetic Fields – Onsite-1 Facility Worker R: I R: III, IV 2.23 Magnetic Fields – Onsite-2 Co-located Worker R: I R: III, IV 2.24 Magnetic Fields – MOI Offsite R: I R: III, IV 2.25 Other Hazards – Onsite-1 Facility Worker R: I R: III, IV 2.26 Other Hazards – Onsite-2 Co-located Worker R: I R: III, IV 2.27 Other Hazards – Onsite-1 Facility Worker R: I R: III, IV 2.28 Access & Egress – Onsite-1 Facility Worker R: R: R: *	2.5	Toxic Materials – Onsite 2 Co-located Worker	R: I	R: III, IV
2.8Flammable & Combustible Materials – Onsite-2 Co-located workerR: IR: IV2.9Flammable & Combustible Materials – MOI OffsiteR: IIIR: IV2.10Electrical Energy – Onsite-1 Facility WorkerR: *R: *2.11Electrical Energy – Onsite-2 Co-located WorkerR: *R: *2.12Electrical Energy – MOI OffsiteR: *R: *2.13Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.14Thermal Energy – Onsite-2 Co-located WorkerR: IIIR: IV2.15Thermal Energy – MOI OffsiteR: IIIIR: IV2.16Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy – Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy – Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: IR: III, IV2.23Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.27Other Hazards – Onsite-1 Facility WorkerR: N/AR: N/A	2.6	Toxic Materials – MOI Offsite	R: III	R: IV
2.9Flammable & Combustible Materials – MOI OffsiteR: IIIR: IV2.10Electrical Energy – Onsite-1 Facility WorkerR: *R: *2.11Electrical Energy – Onsite-2 Co-located WorkerR: *R: *2.12Electrical Energy – MOI OffsiteR: *R: *2.13Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.14Thermal Energy – Onsite-2 Co-located WorkerR: IIIR: IVI2.15Thermal Energy – MOI OffsiteR: IIIR: IV2.16Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy – Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy – Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: *R: *2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III, IV2.27Other Hazards – MOI OffsiteR: N/AR: N/A	2.7	Flammable & Combustible Materials – Onsite-1 Facility Worker	R: I	R: IV
2.10Electrical Energy - Onsite-1 Facility WorkerR:*R:*2.11Electrical Energy - Onsite-2 Co-located WorkerR:*R:*2.12Electrical Energy - MOI OffsiteR: IR: I2.13Thermal Energy - Onsite-1 Facility WorkerR: IR: IV2.14Thermal Energy - Onsite-2 Co-located WorkerR: IIR: IV2.15Thermal Energy - MOI OffsiteR: IIIR: V2.16Kinetic Energy - Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy - Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy - MOI OffsiteR: *R: *2.19Potential Energy - Onsite-1 Facility WorkerR: *R: *2.20Potential Energy - Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy - MOI OffsiteR: *R: *2.22Magnetic Fields - Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields - Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields - MOI OffsiteR: IR: III, IV2.25Other Hazards - Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards - Onsite-2 Co-located WorkerR: IR: III, IV2.27Other Hazards - MOI OffsiteR: *R: *2.28Access & Egress - Onsite-1 Facility WorkerR: N/AR: N/A	2.8	Flammable & Combustible Materials – Onsite-2 Co-located worker	R: I	R: IV
2.11Electrical Energy – Onsite-2 Co-located WorkerR: *R: *2.12Electrical Energy – MOI OffsiteR: *R: *2.13Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.14Thermal Energy – Onsite-2 Co-located WorkerR: IIR: IV2.15Thermal Energy – MOI OffsiteR: IIIR: IV2.16Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy – Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy – Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: *R: *2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III, IV2.27Other Hazards – Onsite-1 Facility WorkerR: N/AR: N/A	2.9	Flammable & Combustible Materials – MOI Offsite	R: III	R: IV
2.12Electrical Energy - MOI OffsiteR: *R: *2.13Thermal Energy - Onsite-1 Facility WorkerR: IR: IV2.14Thermal Energy - Onsite-2 Co-located WorkerR: IIR: IV2.15Thermal Energy - MOI OffsiteR: IIIR: IV2.16Kinetic Energy - Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy - Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy - MOI OffsiteR: *R: *2.19Potential Energy - Onsite-1 Facility WorkerR: *R: *2.20Potential Energy - Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy - MOI OffsiteR: *R: *2.22Magnetic Fields - Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields - Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields - MOI OffsiteR: IR: III, IV2.25Other Hazards - Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards - Onsite-2 Co-located WorkerR: IR: III, IV2.27Other Hazards - MOI OffsiteR: *R: *2.28Access & Egress - Onsite-1 Facility WorkerR: N/AR: N/A	2.10	Electrical Energy – Onsite-1 Facility Worker	R: *	R: *
2.13Thermal Energy – Onsite-1 Facility WorkerR: IR: IV2.14Thermal Energy – Onsite-2 Co-located WorkerR: IR: IV2.15Thermal Energy – MOI OffsiteR: IIIR: IV2.16Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy – Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy – Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: *R: IR: III, IV2.23Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – MOI OffsiteR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III, IV2.27Other Hazards – MOI OffsiteR: *R: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.11	Electrical Energy – Onsite-2 Co-located Worker	R: *	R: *
2.14Thermal Energy - Onsite-2 Co-located WorkerR: IR: IV2.15Thermal Energy - MOI OffsiteR: IIIR: IV2.16Kinetic Energy - Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy - Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy - MOI OffsiteR: *R: *2.19Potential Energy - Onsite-1 Facility WorkerR: *R: *2.20Potential Energy - Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy - MOI OffsiteR: *R: I2.22Magnetic Fields - Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields - Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields - MOI OffsiteR: IR: III, IV2.25Other Hazards - Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards - Onsite-2 Co-located WorkerR: IR: III, IV2.26Other Hazards - MOI OffsiteR: XR: X2.27Other Hazards - MOI OffsiteR: *R: N/A2.28Access & Egress - Onsite-1 Facility WorkerR: N/AR: N/A	2.12	Electrical Energy – MOI Offsite	R: *	R: *
2.15Thermal Energy – MOI OffsiteR: IIIR: IV2.16Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy – Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy – Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: *R: I2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III, IV2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.13	Thermal Energy – Onsite-1 Facility Worker	R: I	R: IV
2.16Kinetic Energy – Onsite-1 Facility WorkerR: *R: *2.17Kinetic Energy – Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy – Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: *R: *2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.14	Thermal Energy – Onsite-2 Co-located Worker	R: I	R: IV
2.17Kinetic Energy – Onsite-2 Co-located WorkerR: *R: *2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy- Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: *R: *2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.15	Thermal Energy – MOI Offsite	R: III	R: IV
2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy- Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: *R: *2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.16	Kinetic Energy – Onsite-1 Facility Worker		R: *
2.18Kinetic Energy – MOI OffsiteR: *R: *2.19Potential Energy – Onsite-1 Facility WorkerR: *R: *2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: *R: *2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.17	Kinetic Energy – Onsite-2 Co-located Worker	R: *	R: *
2.20Potential Energy – Onsite-2 Co-located WorkerR: *R: *2.21Potential Energy – MOI OffsiteR: *R: *2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.18		R: *	R: *
2.21Potential Energy – MOI OffsiteR: *R: *2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.19	Potential Energy- Onsite-1 Facility Worker	R: *	
2.22Magnetic Fields – Onsite-1 Facility WorkerR: IR: III, IV2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.20	Potential Energy – Onsite-2 Co-located Worker	R: *	R: *
2.23Magnetic Fields – Onsite-2 Co-located WorkerR: IR: III, IV2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.21	Potential Energy – MOI Offsite	R: *	R: *
2.24Magnetic Fields – MOI OffsiteR: IR: III, IV2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.22	Magnetic Fields – Onsite-1 Facility Worker	R: I	R: III, IV
2.25Other Hazards – Onsite-1 Facility WorkerR: IR: III, IV2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.23	Magnetic Fields – Onsite-2 Co-located Worker	R: I	R: III, IV
2.26Other Hazards – Onsite-2 Co-located WorkerR: IR: III2.27Other Hazards – MOI OffsiteR: *R: *2.28Access & Egress – Onsite-1 Facility WorkerR: N/AR: N/A	2.24	Magnetic Fields – MOI Offsite	R: I	R: III, IV
2.27 Other Hazards – MOI Offsite R: * R: * 2.28 Access & Egress – Onsite-1 Facility Worker R: N/A R: N/A	2.25	Other Hazards – Onsite-1 Facility Worker	R: I	R: III, IV
2.28 Access & Egress – Onsite-1 Facility Worker R: N/A R: N/A	2.26	Other Hazards – Onsite-2 Co-located Worker	R: I	R: III
	2.27	Other Hazards – MOI Offsite	R: *	R: *
	2.28	Access & Egress – Onsite-1 Facility Worker	R: N/A	R: N/A
2.29 Access & Egress – Onsite-2 Co-located Worker R: N/A R: N/A	2.29	Access & Egress – Onsite-2 Co-located Worker	R: N/A	R: N/A
2.30 Access & Egress – MOI Offsite R: N/A R: N/A	2.30	Access & Egress – MOI Offsite	R: N/A	R: N/A
2.31 Environmental Hazards R: * R: *	2.31	Environmental Hazards	R: *	R: *

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

NOTE:

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

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

Table~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: Devices which have been	L: A	P: All staff are required to take GERT training	L: BEU
activation	used in an accelerator (i.e. "seen	C: H	P: All staff working on radioactive materials are required to be Radiation	C: M
	beam") can become Class 1, or	R: I	Worker trained	R: IV
	higher, and these devices are worked		P: All impacted materials are surveyed and tagged with appropriate class	
	on within APS-TD facilities. The		P: "Invasive" work on a radioactive device is often performed in a separate	
	residual activated material poses a		building (IB2A)	
	health and safety hazard.		P: Class 2, or higher, devices require ALD approval before being moved	
			into APS-TD facilities	
			M: Materials are surveyed upon arrival at the "next facility", and if	
			something is identified as radioactive that wasn't previously known, we can	
			trace its history and perform any necessary cleanup	
Radioactive	Hazard: Devices which have been	L: A	P: All staff are required to take GERT training	L: BEU
waste	used in an accelerator (i.e. "seen	C: H	P: All staff working on radioactive materials are required to be Radiation	C: M
	beam") can become Class 1, or	R: I	Worker trained	R: IV
	higher, and these devices are worked		P: All impacted materials are surveyed and tagged with appropriate class	
	on within APS-TD facilities. Work to		P: "Invasive" work on a radioactive device is often performed in a separate	
	repair such devices generates		building (IB2A)	
	radioactive waste, which poses a		P: Class 2, or higher, devices require ALD approval before being moved	
	health and safety hazard.		into APS-TD facilities	
			P: All staff managing radioactive waste are identified and trained as Waste	
			Generators	
			M: before it leaves the site all waste is surveyed and anything that is found	
			to be radioactive but was placed into the incorrect waste stream is traced	
			back to its source and remediation is performed	

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	Hazard: Devices which have been	L: A	P: All staff are required to take GERT training	L: BEU
	used in an accelerator (i.e. "seen	C: H	P: All staff working on radioactive materials are required to be Radiation	C: M
	beam") can become Class 1, or	R: I	Worker trained	R: IV
	higher, and these devices are worked		P: All impacted materials are surveyed and tagged with appropriate class	
	on within APS-TD facilities. The		P: "Invasive" work on a radioactive device is often performed in a separate	
	residual activated material can spread		building (IB2A)	
	and cause contamination, which poses		P: Class 2, or higher, devices require ALD approval before being moved	
	a health and safety hazard.		into APS-TD facilities	
			M: Materials are surveyed upon arrival at the "next facility", and if	
			something is identified as radioactive that wasn't previously known, we can trace its history and perform any necessary cleanup	
Radiation	Hazard: APS-TD operates several	L: A	P: all staff operating RGDs are required to be formally trained on their safe	L: BEU
Generating	RGDs (e.g. SEM, XRF alloy analyzer).	C: L	operation	C: N
Devices (RDGs)		R: III	P: All staff operating RGDs are required to be Radiation Workers	R: IV
			P: All RGDs have RWPs	
			P: All RGDs in operation in APS-TD are commercial products with built-in	
			shielding	
			M: Rad Workers wear dosimetry when operating the RGD	
Non-ionizing	Hazard: Three pieces of equipment in	L:	See Section I Chapter 04	L:
Radiation -	APS-TD generate lasers: laser cutter	C:		C:
Lasers	in IB3A (class 4), laser tracker operated by QC (class 2), SQMS laser in ICB (class 3B)	R:		R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Non-ionizing	Hazard: RF Sources (SRF plasma	RF sources:	RF Sources:	RF Sources:
Radiation – RF	processing, SQMS quantum labs)	L: EU	P: Both RF sources use very low power RF, and so neither pose any RF	L: BEU
and UV		C: L	risk	C: L
	Two pieces of equipment in APS-TD generate UV: a source in the cleanrooms to detect organics, and a source in the ultra-pure water system in IB4	R: III UV sources: L: EU C: L R: III	P: Both RF sources went through the ORC process prior to being operated UV sources: M: the UV source in the cleanroom is very low power (like a flashlight), and requires no special PPE or procedures M: the UV source in the UPW system is enclosed and cannot expose individuals when it is operating, and it is only serviced by an outside company	R: IV UV sources: L: EU C: N R: IV

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Co	nsequence (C, of event)/	year	Risk (R, Qualitative R	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even	t) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = \text{situation (even}$	nt) of concern	l		Α	U	EU	BEU	
$\mathbf{EU} = \text{Extremely Unlikely } (1.0\text{E}-04 > \text{L} > 1.0\text{E}-06)$		L = Low		III = situation (eve	ent) of minor concern	S	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern		enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsi	te-2 (co-located worker)	Onsite-1 (facility worker)	nbə	-	***	***	***	TT 7	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	ous	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	$00 \text{ rem} > \mathbf{C} \ge 25 \text{ rem}$	100 rem > C ≥ 25 rem		N	IV	IV	IV	IV	
Acronyms MOI - Movimelly, avenued Officia Individual	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							

 $Table\ 2.2\ Radiological-Onsite-2\ Co\text{-located}\ Worker$

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Residual activation	Hazard: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. The residual activated material poses a health and safety hazard.	L: A C: H R: I	P: All staff are required to take GERT training P: All buildings are identified at their entrances regarding the radioactive status P: Specific areas where work on radioactive materials is being performed are usually identified and chained off P: All impacted materials are surveyed and tagged with appropriate class P: "Invasive" work on a radioactive device is often performed in a separate building (IB2A) P: Class 2, or higher, devices require ALD approval before being moved into APS-TD facilities M: Materials are surveyed upon arrival at the "next facility", and if something is identified as radioactive that wasn't previously known, we can trace its history and perform any necessary cleanup	L: BEU C: M R: IV
Radioactive waste	Hazard: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. Work to repair such devices generates radioactive waste, which poses a health and safety hazard.	L: A C: H R: I	P: All staff are required to take GERT training P: All buildings are identified at their entrances regarding the radioactive status; all radioactive waste is identified/tagged as such P: All impacted materials are surveyed and tagged with appropriate class; "invasive" work on a radioactive device is often performed in a separate building (IB2A) P: Class 2, or higher, devices require ALD approval before being moved into APS-TD facilities P: All staff managing radioactive waste are identified and trained as Waste Generators M: before it leaves the site all waste is surveyed and anything that is found to be radioactive but was placed into the incorrect waste stream is traced back to its source and remediation is performed	L: BEU C: M R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	Hazard: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. The residual activated material can spread and cause contamination, which poses a health and safety hazard.	L: A C: H R: I	P: All staff are required to take GERT training P: All buildings are identified at their entrances regarding the radioactive status P: All impacted materials are surveyed and tagged with appropriate class P: "Invasive" work on a radioactive device is often performed in a separate building (IB2A) P: Class 2, or higher, devices require ALD approval before being moved into APS-TD facilities M: Materials are surveyed upon arrival at the "next facility", and if something is identified as radioactive that wasn't previously known, we can trace its history and perform any necessary cleanup	L: BEU C: M R: IV
Radiation Generating Devices (RDGs)	Hazard: APS-TD operates several RGDs (e.g. SEM, XRF alloy analyzer).	L: U C: M R: I	P: all staff operating RGDs are required to be formally trained on their safe operation P: All staff operating RGDs are required to be Radiation Workers P: All RGDs have RWPs P: All RGDs in operation in APS-TD are commercial products with built-in shielding P: All trained operators inform those around to maintain proper distance when the RGD is being operated	L: BEU C: M R: IV
Non-ionizing Radiation - Lasers	Hazard: Three pieces of equipment in APS-TD generate lasers: laser cutter in IB3A (class 4), laser tracker operated by QC (class 2), SQMS laser in ICB (class 3B)	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)
Non-ionizing	Hazard: RF Sources (SRF plasma	RF sources:	RF Sources:	RF Sources:
Radiation – RF	processing, SQMS quantum labs)	L: EU	P: Both RF sources use very low power RF, and so neither pose any RF	L: BEU
and UV		C: L	risk	C: L
	Two pieces of equipment in APS-TD generate UV: a source in the cleanrooms to detect organics, and a source in the ultra-pure water system in IB4	R: III UV sources: L: EU C: L R: III	P: Both RF sources went through the ORC process prior to being operated UV sources: M: the UV source in the cleanroom is very low power (like a flashlight), and requires no special PPE or procedures M: the UV source in the UPW system is enclosed and cannot expose individuals when it is operating, and it is only serviced by an outside company	R: IV UV sources: L: EU C: N R: IV

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Co	nsequence (C, of event)/	year	Risk (R, Qualitative R	Ranking)	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even	t) of major concern				Like	lihood		
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = \text{situation (even}$	nt) of concern	l		Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (eve	ent) of minor concern	S	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (event) of minimal concern		enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsit	te-2 (co-located worker)	Onsite-1 (facility worker)	nbə	-	***	***	***	TT 7	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ 25.0 rem		C ≥ 100 rem	C ≥ 100 rem	ous	L	III	III	IV	IV	
M = Mitigative (reduces event consequences)	M	$25.0 \text{ rem} > \mathbf{C} \ge 5 \text{ rem}$	10	00 rem > C ≥ 25 rem	100 rem > C ≥ 25 rem		N	IV	IV	IV	IV	
Acronyms MOI - Movimelly, avenued Officia Individual	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 activation	Hazard: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. The residual activated material poses a health and safety hazard.	L: EU C: L R: IV	The public cannot access areas where there is residual activation, and so no further analysis is necessary.	L: EU C: L R: IV
Radioactive waste	Hazard: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. Work to repair such devices generates radioactive waste, which poses a health and safety hazard.	L: EU C: L R: IV	The public cannot access areas where there is radioactive waste, and so no further analysis is necessary.	L: EU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Contamination	Hazard: Devices which have been used in an accelerator (i.e. "seen beam") can become Class 1, or higher, and these devices are worked on within APS-TD facilities. The residual activated material can spread and cause contamination, which poses a health and safety hazard.	L: EU C: L R: IV	P: Impacted materials are not taken offsite P: Individuals who are working in areas where there may be contamination are surveyed upon exiting the work area to ensure there is no contamination on them M: Any contamination found on an individual or their clothing is removed and cannot be taken offsite	L: BEU C: N R: IV
Radiation Generating Devices (RDGs)	Hazard: APS-TD operates several RGDs (e.g. SEM, XRF alloy analyzer).	L: EU C: L R: IV	P: All buildings are secured, and members of the public cannot access the area where the SEM is P: All RGDs in operation in APS-TD are commercial products with built-in shielding M: trained operators inform those around to maintain proper distance when the RGD (in this case the alloy analyzer in the extremely unlikely event it's being used outside in a public area) is being operated	L: BEU C: N R: IV
Non-ionizing Radiation - Lasers	Hazard: Three pieces of equipment in APS-TD generate lasers: laser cutter in IB3A (class 4), laser tracker operated by QC (class 2), SQMS laser in ICB (class 3B)	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)
Non-ionizing	Hazard: RF Sources (SRF plasma	L:	See Section I Chapter 04	L:
Radiation – RF	processing, SQMS quantum labs)	C:		C:
and UV		R:		R:
	Two pieces of equipment in APS-TD			
	generate UV: a source in the			
	cleanrooms to detect organics, and a			
	source in the ultra-pure water system			
	in IB4			

Radiological Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	Cor	nsequence (C, of event)/	year	Risk (R, Qualitative R	Ranking)	Risk	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	ences	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	C	Offsite (MOI)	Onsi	te-2 (co-located worker)	Onsite-1 (facility worker)	edn		***	***	***	TX 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 rem > C ≥ 25 rem	100 rem > C ≥ 25 rem		N	IV	IV	IV	IV	
Acronyms MOI = Maximally-exposed Offsite Individual	L	5 rem > C		25 rem > C	25 rem > C							
rem = Roentgen equivalent man	N	0.5 rem > C		5 rem > C	5 rem > C							

Table 2.4 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. The only lead shielding in use in APSTD is on the very rare occasion when we use lead-lined blankets to shield a Class 2, or higher, magnet while it is being repaired. Lead-based solder is used to make electrical connections. Lead Paint (old magnets)	L: U C: M R: II	P: FESHM 4200 controls the use of lead-based materials; when needed, lead-lined blankets used for shielding are fully enclosed and so there is no personnel exposure. P: Lead handling training P: Lead-based soldering is done in well-ventilated areas. M: Lead-based solder continues to be used less frequently M: XRF alloy analyzer is used to confirm presence of lead in paint in old magnets, which is followed up by official sampling by IH M: PPE for the grit blast booth operator prevents any chance of inhalation in the event there is any lead present	L: EU C: L R: IV
Beryllium	Hazard: Potential exposure to beryllium dust during manual handling of un-encased, or machining dusts from fabrication shop activities.	L: U C: M R: I	P: FESHM 4190 controls the use of Beryllium and its alloys P: All staff who handle Beryllium are required to be formally trained P: No machining or welding of Beryllium or its alloys is allowed M: All Beryllium alloy components used in APS-TD are "articles", and so present no risk for airborne contamination and are outside the DOE program requirements	L: BEU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hydrofluoric	Hazard: HF is used in both the IB4	L: A	P: all operations involving HF are tightly controlled with written	L: U
Acid	Cavity Processing Lab (CPL) and in	C: H	procedures, formal training and qualifications (including on emergency	C: L
	the MDTL	R: I	response), and must be pre-authorized	I: III
			M: the amount of HF is limited to ~ one 30-gallon drum of electrolyte	
			being received and sent for waste each month for CPL, and only liters for	
			MDTL	
			M: safety showers and eyewash stations are in each facility	
			M: All staff using HF must wear PPE; safety showers and eyewash stations	
			are in each facility	
Nanoparticle	Hazard: Airborne exposure	L:	See Section I Chapter 04	L:
Exposures		C:		C:
		R:		R:

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	Risk Matrix						
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Likelihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{II} = \text{situation (ev}$	ent) of concern			A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (e	vent) of minor concern	es	Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		\mathbf{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)	nbə	ī	Ш	III	IV	IV		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	ons	L	Ш	111	1 V	1 V		
$\mathbf{M} = \mathbf{M}$ itigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P.A	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$		N	IV	IV	IV	IV		
Acronyms IDLH = Immediately Dangerous to Life and Health	L	PAC-1 > C		PAC-2 > C	PEL or TLV _c > C								
MOI = Maximally-exposed Offsite Individual PAC = Protective Action Criteria PEL = Permissible Exposure Limit TLV _c = Threshold Limit Value (ceiling)	N	Consequences less than those for Low Consequence Level		nsequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level								

Table 2.5 Toxic Materials – Onsite 2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Lead	Hazard: Potential exposure to lead dust during manual handling of unencased lead bricks, lead shot, and lead sheets. The only lead shielding in use in APSTD is on the very rare occasion when we use lead-lined blankets to shield a Class 2, or higher, magnet while it is being repaired. Lead-based solder is used to make electrical connections. Lead Paint (old magnets)	L: U C: H R: I	P: FESHM 4200 controls the use of lead-based materials; when needed, lead-lined blankets used for shielding are fully enclosed and so there is no personnel exposure. P: Lead-based soldering is done in well-ventilated areas. M: Lead-based solder continues to be used less frequently M: XRF alloy analyzer is used to confirm presence of lead in paint in old magnets, which is followed up by official sampling by IH	L: EU C: M R: III
Beryllium	Hazard: Potential exposure to beryllium dust during manual handling of un-encased, or machining dusts from fabrication shop activities.	L: U C: L R: I	P: FESHM 4190 controls the use of Beryllium and its alloys P: All staff who handle Beryllium are required to be formally trained P: No machining or welding of Beryllium or its alloys is allowed M: All Beryllium alloy components used in APS-TD are "articles", and so present no risk for airborne contamination and are outside the DOE program requirements	L: BEU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Hydrofluoric	Hazard: HF is used in both the IB4	L: U	P: all operations involving HF are tightly controlled with written	L: BEU
Acid	Cavity Processing Lab (CPL) and in	C: M	procedures, formal training and qualifications (including on emergency	C: L
	the MDTL	R: I	response), and must be pre-authorized	I: IV
			P: No co-located workers are allowed in areas when HF is in use	
			M: the amount of HF is limited to ~ one 30-gallon drum of electrolyte	
			being received and sent for waste each month for CPL, and only liters for	
			MDTL	
			M: safety showers and eyewash stations are in each facility	
Nanoparticle	Hazard: Airborne exposure	L:	See Section I Chapter 04	L:
Exposures		C:	•	C:
		R:		R:

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	Matr	x					
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Likelihood				
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern		1	Α	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (e	vent) of minor concern	es	Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	ences	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite	e-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	т	Ш	III	IV	IV		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	, Ons	L	111	111	1 V	1 V		
M = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P/	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$		N	IV	IV	IV	IV		
Acronyms IDLH = Immediately Dangerous to Life and Health	L	PAC-1 > C		PAC-2 > C	PEL or $TLV_c > C$								
MOI = Maximally-exposed Offsite Individual PAC = Protective Action Criteria PEL = Permissible Exposure Limit TLV _c = Threshold Limit Value (ceiling)	N	Consequences less than those for Low Consequence Level		nsequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level								

Table 2.6 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, lead shot, and lead sheets. The only lead shielding in use in APSTD is on the very rare occasion when we use lead-lined blankets to shield a Class 2, or higher, magnet while it is being repaired. Lead-based solder is used to make electrical connections. Lead Paint (old magnets)	L: C: R:	See Section I Chapter 04	L: C: R:
Beryllium	Hazard: Potential exposure to beryllium dust during manual handling of un-encased, or machining dusts from fabrication shop activities.	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)
Hydrofluoric Acid	Hazard: HF is used in both the IB4 Cavity Processing Lab (CPL) and in the MDTL	L: U C: L R: III	P: all buildings are secured, and guests are only allowed with an escort; all operations involving HF are tightly controlled with written procedures, formal training and qualifications (including on emergency response), and must be pre-authorized P: no members of the public are allowed in areas where HF is used M: the amount of HF is limited to ~ one 30-gallon drum of electrolyte being received and sent for waste each month for CPL, and only liters for MDTL M: Safety showers and eyewash stations are in each facility	L: BEU C: N I: IV
Nanoparticle Exposures	Hazard: Airborne exposure	L: C: R:	See Section I Chapter 04	L: C: R:

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						
$\mathbf{A} = \text{Anticipated } (L > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Likelihood			
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern		1	Α	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \text{Low}$		III = situation (e ^x	vent) of minor concern	S	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ex	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)	edn	,	III	III	IV	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ PAC-2		C ≥ PAC-3	C ≥ IDLH	ons	L	Ш	Ш	1 V	1 V	
M = Mitigative (reduces event consequences)	M	$PAC-2 > C \ge PAC-1$	P/	$AC-3 > C \ge PAC-2$	$IDLH > C \ge PEL \text{ or } TLV_c$	0	N	IV	IV	IV	IV	
Acronyms IDLH = Immediately Dangerous to Life and Health	L	PAC-1 > C		PAC-2 > C	PEL or $TLV_c > C$							
MOI = Maximally-exposed Offsite Individual PAC = Protective Action Criteria PEL = Permissible Exposure Limit TLV _c = Threshold Limit Value (ceiling)	N	Consequences less than those for Low Consequence Level		nsequences less than for Low Consequence Level	Consequences less than those for Low Consequence Level							

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible	Hazard: Combustible materials can	L: A	P: regular housekeeping	L: EU
materials (cables,	ignite under certain circumstances	C: H	P: area inspections	C: N
Boxes, Paper,		R: I	M: smoke detectors	R: IV
wood cribbing,			M: fire suppression systems	
etc.)			M: onsite Fire Department;	
			M: employee evacuation training/drills	
			M: all staff know to call x3131 in an emergency	
Flammable	Hazard: Fire under certain	L: A	P: flammable materials are stored in flame-proof cabinets when not in use	L: EU
Materials	circumstances	C: H	P: area inspections	C: N
(Flammable gas,		R: I	P: Hot Work program administered by the Fire Department	R: IV
cleaning			M: smoke detectors	
materials, etc.)			M: fire suppression systems	
			M: onsite Fire Department	
			M employee evacuation training/drills	
			M: all staff know to call x3131 in an emergency	

Other Hazard Consequences, derived from Figure C-	1, "F	Example Qualitative Cons	sequence Matrix", DOE-HI	DBK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High		Risk (R, Qualitative Ranking) I = situation (event) of major concern		Matri	ix	Like	lihood	
U = Unlikely (1.0E-02> L >1.0E-04) EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		$\mathbf{M} = \mathbf{Moderate}$ $\mathbf{L} = \mathbf{Low}$	II = situation (ex	, ,		Н	A	U	EU II	BEU III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	IV = situation (e	vent) of minimal concern	ences	M	II	II	III	IV
Control(s) Type P = Preventive (reduce event occurrence likelihood)	C H		Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbedn	L	III	III	IV	IV
M = Mitigative (reduces event consequences)	11	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	Consequences less than those for Low Consequence Level	Consequences less than those for Low Consequence Level						

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Combustible	Hazard: Combustible materials can	L: A	P: regular housekeeping	L: EU
materials (cables,	ignite under certain circumstances	C: H	P: area inspections	C: N
Boxes, Paper,		R: I	M: smoke detectors	R: IV
wood cribbing,			M: fire suppression systems	
etc.)			M: onsite Fire Department;	
			M: employee evacuation training/drills	
			M: all staff know to call x3131 in an emergency	
Flammable	Hazard: Fire under certain	L: A	P: flammable materials are stored in flame-proof cabinets when not in use	L: EU
Materials	circumstances	C: H	P: area inspections	C: N
(Flammable gas,		R: I	P: Hot Work program administered by the Fire Department	R: IV
cleaning			M: smoke detectors	
materials, etc.)			M: fire suppression systems	
			M: onsite Fire Department	
			M employee evacuation training/drills	
			M: all staff know to call x3131 in an emergency	

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) ent) of major concern	Risk Matri		x	Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	II = situation (ev	, ,		ı	A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06)		$\mathbf{L} = \text{Low}$	`	vent) of minor concern	sea	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L) Control(s) Type	С	N = Negligible Offsite (MOI)	IV = situation (ev Onsite-2 (co-located worker)	vent) of minimal concern Onsite-1 (facility worker)	uənt	M	II	II	III	IV
P = Preventive (reduce event occurrence likelihood)	Н	,	$C \ge \text{Prompt worker fatality}$	$C \ge Prompt worker$	Consequences	L	III	III	IV	IV
M = Mitigative (reduces event consequences)	11	other serious effects,	or acute injury that is	fatality or acute injury that	ప	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	Minor injuries; no	Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low	hospitalization > C Consequences less than hose for Low Consequence	hospitalization > C Consequences less than 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: Combustible materials can	L: U	P: all buildings are secured and locked	L: BEU
materials (cables,	ignite under certain circumstances	C: L	P: all guests must be escorted	C: N
Boxes, Paper,		R: III	P: regular housekeeping	R: IV
wood cribbing,			P: area inspections	
etc.)			M: smoke detectors	
			M: fire suppression systems	
			M: onsite Fire Department	
Flammable	Hazard: Fire under certain	L: U	P: all buildings are secured and locked	L: BEU
Materials	circumstances	C: L	P: all guests must be escorted	C: N
(Flammable gas,		R: III	P: flammable materials are stored in flame-proof cabinets when not in use	R: IV
cleaning			P: area inspections	
materials, etc.)			P: Hot Work program administered by the Fire Department	
			P: EPHS demonstrates no risk of offsite releases to the public	
			M: smoke detectors	
			M: fire suppression systems	
			M: onsite Fire Department	

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 Matrix					
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	Ş	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		\mathbf{N} = Negligible	`	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	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						

 ${\bf Table~2.10~Electrical~Energy-Onsite-1~Facility~Worker}$

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy	Hazard: unexpected shock from	L:	See Section I Chapter 04 (non-interlocked enclosures)	L:
Exposure	capacitors/transformers/devices from	C:		C:
	infrastructure, testing equipment, and energized magnets.	R:		R:
High Voltage	Hazard: arc flash, electrocution, or	L:	See Section I Chapter 04 (non-interlocked enclosures)	L:
Exposure	burns from infrastructure, testing	C:	-	C:
	equipment, and energized magnets	R:		R:
Low Voltage,	Hazard: arc flash, electrocution, or	L:	See Section I Chapter 04 (non-interlocked enclosures)	L:
High Current	burns from infrastructure, testing	C:		C:
Exposure.	equipment, and energized magnets	R:		R:

Other Hazard Consequences, derived from Figure C-1	l, "E	xample Qualitative Cons	sequence Matrix", DOE-HD	BK-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	ent) 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)		L = Low	III = situation (e	vent) of minor concern	saou	Н	I	I	II	III
BEU = 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-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	_	TTT	777	13.7	13.7
P = Preventive (reduce event occurrence likelihood)	H	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		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	those for Low Consequence	those for Low						
		Consequence Level	Level	Consequence Level						

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy	Hazard: unexpected shock from	L:	See Section I Chapter 04 (non-interlocked enclosures)	L:
Exposure	capacitors/transformers/devices from	C:		C:
	infrastructure, testing equipment,	R:		R:
	and energized magnets.			
High Voltage	Hazard: arc flash, electrocution, or	L:	See Section I Chapter 04 (non-interlocked enclosures)	L:
Exposure	burns from infrastructure, testing	C:		C:
	equipment, and energized magnets	R:		R:
Low Voltage,	Hazard: arc flash, electrocution, or	L:	See Section I Chapter 04 (non-interlocked enclosures)	L:
High Current	burns from infrastructure, testing	C:		C:
Exposure.	equipment, and energized magnets	R:		R:

Other Hazard Consequences, derived from Figure C-1	, " F	xample Qualitative Cons	sequence Matrix", DOE-HD	BK-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	ent) 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)		L = Low	III = situation (e	vent) of minor concern	saou	Н	I	I	II	III
BEU = 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-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	_	TTT	777	13.7	13.7
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	၁	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	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 $> \mathbf{C}$						
	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 2.12 Electrical Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Stored Energy	Hazard: unexpected shock from	L:	See Section I Chapter 04	L:
Exposure	capacitors/transformers/devices from	C:		C:
	infrastructure, testing equipment,	R:		R:
	and energized magnets.			
High Voltage	Hazard: arc flash, electrocution, or	L:	See Section I Chapter 04	L:
Exposure	burns from infrastructure, testing	C:		C:
	equipment, and energized magnets	R:		R:
Low Voltage,	Hazard: arc flash, electrocution, or	L:	See Section I Chapter 04	L:
High Current	burns from infrastructure, testing	C:		C:
Exposure.	equipment, and energized magnets	R:		R:

Other Hazard Consequences, derived from Figure C-	1, "E	Example Qualitative Cons	equence Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/y H = High		Ranking) ent) of major concern	Risk	Matri	x	Like	lihood	
U = Unlikely (1.0E-02> L > 1.0E-04)		$\mathbf{M} = \mathbf{M}$ Moderate	$\mathbf{H} = \text{situation (even}$, ,		1	A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		$\mathbf{L} = \mathbf{Low}$		vent) of minor concern	nces	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L) Control(s) Type	C	N = Negligible Offsite (MOI)	Onsite-2 (co-located worker)	vent) of minimal concern Onsite-1 (facility worker)	sedner	M	II	II	III	IV
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	$C \ge Prompt worker fatality$	C ≥ Prompt worker	Conse	L	III	III	IV	IV
M = Mitigative (reduces event consequences)		other serious effects,	or acute injury that is	fatality or acute injury that		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	Minor injuries; no	Minor injuries; no						
	N	adverse effects > C Consequences less	hospitalization > C Consequences less than	hospitalization > C Consequences less than						
		than those for Low Consequence Level	those for Low Consequence Level	those for Low 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)
Bakeout	Hazard: in the context of APS-TD, bakeouts may be done on individual magnets (e.g. Lambertsons), using heaters, power supplies, and insulating materials. This presents electrical and heat-related hazards. It is not performed very often (perhaps once every few years).	L: U C: M R: II	P: bakeouts are performed using approved procedures through WPC/ORC; equipment approved by electrical safety; equipment has overcurrent protection M: the area where the bakeout is occurring is roped off, with signage stating not to enter	L: BEU C: L R: IV
Hot Work	Hazard: Welding, brazing, torch cutting, and grinding can produce thermal burns or fire from sparks or slag. Welding also produces UV radiation, and also risk of exposure to Hexavalent Chromium when welding stainless steels. Fuels used in brazing and torch cutting can be explosive.	L: A C: M R: I	P: Hot Work Permits are required for all welding, brazing, torch cutting, and grinding activities (FESHM 6020.2) P: only qualified welders perform welding; P: PPE is required for all hot work activities; P: proper ventilation is required and verified when welding stainless, and this includes environmental monitoring M: flash-back arrestors are required for oxyacetylene tanks; M: onsite emergency services	L: EU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenics	Hazard: Liquid Nitrogen and Liquid	L: A	P: Pressure, piping, and vacuum systems require Engineering Notes per	L: BEU
	Helium in cryogenic vessels/dewars	C: H	various FESHM chapters;	C: L
	and systems	R: I	P: all in-house systems are fabricated using BPVC Section IX qualified	R: IV
			welding procedures and welders;	
			P: all dewars are commercially-made;	
			P: all new or modified cryogenic systems require an ORC to be operated;	
			P: personnel handling cryogens have formal training;	
			P: personnel must be medically qualified to enter ODH spaces	
			M: all systems have relief valves;	
		M: all ODH areas have Oxygen monitors/alarms;		
			M: onsite emergency services	

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) 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	A U E				
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)	$\mathbf{L} = \mathbf{Low}$ $\mathbf{N} = \mathbf{Negligible}$,	III = situation (event) of minor concern IV = situation (event) of minimal concern		Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)			· · · · · · · · · · · · · · · · · · ·			M	II	II	III	IV		
Control(s) Type	H M	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)		C ≥ Irreversible, other serious effects,	$C \ge Prompt worker fatality$	$C \ge Prompt worker$	Con	N	IV	IV	IV	IV		
Acronyms MOI = Maximally-exposed Offsite Individual		or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life- threatening or permanently disabling.			1					
		$C \ge Mild$, 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.								
		Mild, transient	Minor injuries; no	Minor injuries; no								
		adverse effects > C	hospitalization > C	hospitalization > C								
			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)
Bakeouts	Hazard: in the context of APS-TD, bakeouts may be done on individual magnets (e.g. Lambertsons), using heaters, power supplies, and insulating materials. This presents electrical and heat-related hazards. It is not performed very often (perhaps once every few years).	L: U C: M R: II	P: bakeouts are performed using approved procedures through WPC/ORC P: equipment approved by electrical safety P: equipment has overcurrent protection M: the area where the bakeout is occurring is roped off, with signage stating not to enter	L: BEU C: L R: IV
Hot Work	Hazard: Welding, brazing, torch cutting, and grinding can produce thermal burns or fire from sparks or slag. Welding also produces UV radiation, and also risk of exposure to Hexavalent Chromium when welding stainless steels. Fuels used in brazing and torch cutting can be explosive.	L: A C: M R: I	P: Hot Work Permits are required for all welding, brazing, torch cutting, and grinding activities (FESHM 6020.2) P: only qualified welders perform welding P: PPE is required for all hot work activities P: proper ventilation is required and verified when welding stainless, and this includes environmental monitoring P: welding screens are used to protect personnel outside the welding area M: flash-back arrestors are required for oxyacetylene tanks M: onsite emergency services	L: BEU C: L R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenic	Hazard: Liquid Nitrogen and Liquid	L: A	P: Pressure, piping, and vacuum systems require Engineering Notes per	L: BEU
Liquids	Helium in cryogenic vessels/dewars	C: H	various FESHM chapters	C: L
	and systems	R: I	P: all in-house systems are fabricated using BPVC Section IX qualified welding procedures and welders P: all dewars are commercially-made P: all new or modified cryogenic systems require an ORC to be operated P: personnel handling cryogens have formal training M: all systems have relief valves M: all ODH areas have Oxygen monitors/alarms M: onsite emergency services	R: IV

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L > 1.0E-04)		onsequence (C, of event)/y H = High		Risk (R, Qualitative Ranking) I = situation (event) of major concern II = situation (event) of concern		Matri	ix	k Likelihood			
		$\mathbf{M} = \mathbf{Moderate}$	II = situation (ev				A	U	EU II	BEU III	
EU = Extremely Unlikely (1.0E-04 > L >1.0E-06) BEU = Beyond Extremely Unlikely (1.0E-06> L)		$\mathbf{L} = \text{Low}$ $\mathbf{N} = \text{Negligible}$		III = situation (event) of minor concern IV = situation (event) of minimal concern		H M	II	II	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 ≥ Irreversible, other serious effects,	C ≥ Prompt worker fatality or acute injury that is	$C \ge Prompt worker$ fatality or acute injury that	Con	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.		•	ļ				
	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	Consequences less than those for Low Consequence Level	Consequences less than those for Low 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)
Bakeouts	Hazard: in the context of APS-TD, bakeouts may be done on individual magnets (e.g. Lambertsons), using heaters, power supplies, and insulating materials. This presents electrical and heat-related hazards. It is not performed very often (perhaps once every few years).	L: U C: L R: III	P: all buildings are secured, and all guests are required to be escorted P: bakeouts are performed using approved procedures through WPC/ORC P: equipment approved by electrical safety P: equipment has overcurrent protection M: the area where the bakeout is occurring is roped off, with signage stating not to enter	L: BEU C: N R: IV
Hot Work	Hazard: Welding, brazing, torch cutting, and grinding can produce thermal burns or fire from sparks or slag. Welding also produces UV radiation, and also risk of exposure to Hexavalent Chromium when welding stainless steels. Fuels used in brazing and torch cutting can be explosive.	L: U C: L R: III	P: all buildings are secured, and all guests are required to be escorted P: Hot Work Permits are required for all welding, brazing, torch cutting, and grinding activities (FESHM 6020.2) P: only qualified welders perform welding P: proper ventilation is required and verified when welding stainless, and this includes environmental monitoring P: welding screens are used to protect personnel outside the welding area M: flash-back arrestors are required for oxyacetylene tanks M: onsite emergency services	L: BEU C: N R: IV

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Cryogenics	Hazard: Liquid Nitrogen and Liquid	L: U	P: all buildings are secured, and all guests are required to be escorted	L: BEU
	Helium in cryogenic vessels/dewars	C: L	P: pressure, piping, and vacuum systems require Engineering Notes per	C: N
	and systems	R: III	various FESHM chapters	R: IV
			P: all in-house systems are fabricated using BPVC Section IX qualified	
			welding procedures and welders	
			P: all dewars are commercially-made	
			P: all new or modified cryogenic systems require an ORC to be operated	
			P: personnel handling cryogens have formal training	
			M: all systems have relief valves	
			M: all ODH areas have Oxygen monitors/alarms	
			M: onsite emergency services	

Other Hazard Consequences, derived from Figure C-1	l, "E	xample Qualitative Cons	sequence Matrix", DOE-HD	DBK-1163-2020.						
Likelihood (L, of event)/year	C	onsequence (C, of event)/	year Risk (R, Qualitative	Ranking)	Risk	Matri	ix			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (eve	ent) of major concern				Like	lihood	
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	vent) of concern		1	A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (e	vent) of minor concern	nces	Н	I	I	II	III
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	$IV = situation (e^{-1})$	vent) of minimal concern	enc	M	II	II	III	IV
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	_	111	777	13.7	13.7
P = Preventive (reduce event occurrence likelihood)	H	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		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 2.16 Kinetic Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power tools	Hazard: Various hand tools used in assembly of magnets, cavities, and cryoassemblies. Various machine tools (mills, lathes) used in Tech and Machine Shops. All have potential to injure people if not being used properly.	L: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors	Hazard: Various pumps and motors used in the assembly of magnets, cavities, and cryoassemblies.	L: C: R:	See Section I Chapter 04	L: C: R:
Motion Tables	Hazard: Motion tables used in the assembly of coils for magnets can create pinch points and crushing hazards.	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 Matrix					
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	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 = Preventive (reduce event occurrence likelihood)	С	0 ()	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbesu	L	III	III	IV	IV
M = Mitigative (reduces event occurrence fixelinood) M = Mitigative (reduces event consequences)	H	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	$C \ge Mild$, 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	adverse effects > C	hospitalization > C Consequences less than	hospitalization > C Consequences less than						
	1		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)
Power tools	Hazard: Various hand tools used in assembly of magnets, cavities, and cryoassemblies. Various machine tools (mills, lathes) used in Tech and Machine Shops. All have potential to injure people if not being used properly.	L: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors	Hazard: Various pumps and motors used in the assembly of magnets, cavities, and cryoassemblies.	L: C: R:	See Section I Chapter 04	L: C: R:
Motion Tables	Hazard: Motion tables used in the assembly of coils for magnets can create pinch points and crushing hazards.	L: C: R:	See Section I Chapter 04	L: C: R:

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

Table 2.18 Kinetic Energy – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Power tools	Hazard: Various hand tools used in assembly of magnets, cavities, and cryoassemblies. Various machine tools (mills, lathes) used in Tech and Machine Shops. All have potential to injure people if not being used properly.	L: C: R:	See Section I Chapter 04	L: C: R:
Pumps and Motors	Hazard: Various pumps and motors used in the assembly of magnets, cavities, and cryoassemblies.	L: C: R:	See Section I Chapter 04	L: C: R:
Motion Tables	Hazard: Motion tables used in the assembly of coils for magnets can create pinch points and crushing hazards.	L: C: R:	See Section I Chapter 04	L: C: R:

Other Hazard Consequences, derived from Figure C-1	1, "F	Example Qualitative Con	sequer	nce Matrix", DOE-HD	BK-1163-2020.										
Likelihood (L, of event)/year	C	Consequence (C, of event)/year Risk (R, Qualitative Rank			Ranking)	Ranking) Risk Matri				ix					
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern			Likelihood							
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		II = situation (ev	ent) of concern	_	1	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	ces	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)	sedn	ī	III	III	IV	IV				
P = Preventive (reduce event occurrence likelihood) M = Mitigative (reduces event consequences) Acronyms MOI = Maximally-exposed Offsite Individual		C ≥ Irreversible, other serious effects, or symptoms which could impair an individual's ability to take protective action.	or i	Prompt worker fatality acute injury that is immediately life-tening or permanently disabling.	C ≥ Prompt worker fatality or acute injury that is immediately lifethreatening or permanently disabling.	Cons	N	IV	IV	IV	IV				
	M L	C ≥ Mild, transient adverse effects. Mild, transient adverse effects > C	imm per hosp	≥ Serious injury, no nediate loss of life no rmanent disabilities; pitalization required. Minor injuries; no ospitalization > C	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no hospitalization > C										

Table 2.19 Potential Energy – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations	Hazard: Most APS-TD buildings have overhead cranes, either rail or jib.	L: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses	Hazard: Compressed gases are used throughout APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum/ Pressure Vessels	Hazard: Vacuum/pressure vessels are used throughout APS-TD, and are fabricated by APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	Hazard: Vacuum pumps are used throughout APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.	L: C: R:	See Section I Chapter 04	L: C: R:

Material Handling	Hazard: Materials are moved almost	L:	See Section I Chapter 04	L:
	constantly throughout APS-TD, using	C:	•	C:
	vehicles, forklift trucks, pallet jacks,	R:		R:
	and by hand. Hazards include injury			
	from falling objects, crushing hands			
	or feet, driving accidents, physical			
	strain.			

Other Hazard Consequences, derived from Figure C-	l, "E	xample Qualitative Cons	sequenc	ce Matrix", DOE-HD	BK-1163-2020.						
Likelihood (L, of event)/year A = Anticipated (L > 1.0E-02)	C	onsequence (C, of event)/ H = High M = Moderate	/year	*	nt) of major concern	Risk	Matri	X 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)		$\mathbf{L} = \mathbf{M}$ $\mathbf{L} = \mathbf{L}$ $\mathbf{N} = \mathbf{N}$ $\mathbf{N} = \mathbf{N}$		II = situation (event) of concern III = situation (event) of minor concern IV = situation (event) of minimal concern		nces	H M	I II	I	II	III IV
Control(s) Type P = Preventive (reduce event occurrence likelihood)	C H			2 (co-located worker) rompt worker fatality	Onsite-1 (facility worker) C ≥ Prompt worker	Consequences	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.	Ö	N	IV	IV	IV	IV
	M L	C ≥ Mild, transient adverse effects. Mild, transient	imme pern hospi M	Serious injury, no ediate loss of life no manent disabilities; italization required. Iinor injuries; no	C ≥ Serious injury, no immediate loss of life no permanent disabilities; hospitalization required. Minor injuries; no						
	N	adverse effects > C Consequences less than those for Low Consequence Level	Cons	espitalization > C sequences less than for Low Consequence Level	hospitalization > C Consequences less than those for Low Consequence Level						

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations	Hazard: Most APS-TD buildings have overhead cranes, either rail or jib.	L: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses	Hazard: Compressed gases are used throughout APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum/ Pressure Vessels	Hazard: Vacuum/pressure vessels are used throughout APS-TD, and are fabricated by APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	Hazard: Vacuum pumps are used throughout APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.	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)
Material Handling	Hazard: Materials are moved almost	L:	See Section I Chapter 04	L:
	constantly throughout APS-TD, using	C:		C:
	vehicles, forklift trucks, pallet jacks,	R:		R:
	and by hand. Hazards include injury			
	from falling objects, crushing hands			
	or feet, driving accidents, physical			
	strain.			

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	Risk Matrix						
$\mathbf{A} = \text{Anticipated (L} > 1.0\text{E}-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (eve	nt) of major concern				Like	lihood			
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		$\mathbf{H} = \text{situation (even}$	ent) of concern		1	A	U	EU	BEU		
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low		III = situation (ev	vent) of minor concern	es	Н	I	I	II	III		
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV		
Control(s) Type	C	Offsite (MOI)	Onsite	-2 (co-located worker)	Onsite-1 (facility worker)	sednences		TIT		13.7	IV		
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	$C \ge P$	Prompt worker fatality	C ≥ Prompt worker	Cons	L	III	III	IV	IV		
$\mathbf{M} = \mathbf{Mitigative}$ (reduces event consequences)		other serious effects,		acute injury that is	fatality or acute injury that) i	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		-									
		action.											
	M	C ≥ 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	linor injuries; no	Minor injuries; no								
		adverse effects > C	ho	ospitalization > C	hospitalization $> \mathbf{C}$								
	N	Consequences less		sequences less than	Consequences less than								
		than those for Low	those f	for Low Consequence	those for Low								
		Consequence Level		Level	Consequence Level								

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

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Crane Operations	Hazard: N/A	L: C: R:	See Section I Chapter 04	L: C: R:
Compressed Gasses	Hazard: Compressed gases are used throughout APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum/ Pressure Vessels	Hazard: Vacuum/pressure vessels are used throughout APS-TD, and are fabricated by APS-TD, and present a hazard from the possibility of the stored energy being released in an uncontrolled fashion resulting in injury.	L: C: R:	See Section I Chapter 04	L: C: R:
Vacuum Pumps	Hazard: N/A	L: C: R:	See Section I Chapter 04	L: C: R:
Material Handling	Hazard: N/A	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	Ranking)	Risk	Matri	Matrix							
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)		$\mathbf{L} = \text{Low}$,	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 P = Proventive (reduce event accommon a likelih acd)	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,	$C \ge Prompt worker fatality$	$C \ge Prompt worker$	Cor	N	IV	IV	IV	IV			
Acronyms MOI = Maximally-exposed Offsite Individual		or symptoms which	or acute injury that is immediately life-threatening or permanently disabling.	fatality or acute injury that is immediately life- threatening or permanently disabling.									
	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									
	NT	adverse effects > C	hospitalization > C	hospitalization > C									
	11		Consequences less than those for Low Consequence	Consequences less than those for Low									
		Consequence Level	Level	Consequence Level									

Table 2.22 Magnetic Fields – Onsite-1 Facility Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	Hazard: Exposure to fringe fields beyond allowable limits (worker with ferromagnetic or electronic medical device(s)) Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic	L: A C: H R: I	P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, helping to prevent workers from accessing the hazard. P: Electromagnets are de-energized prior to worker entry using LOTO procedure. M: Employees self-identify (to their supervisor and Medical) as having an implanted medical device, and are provided information regarding how to protect themselves from fringe fields.	L: EU C: M R: III
	medical device(s)) Exposure to flying metallic objects causing potential injury. Ferromagnetic bricks used in the assembly of permanent magnets can pose a pinching or crushing	L: A C: L R: III	 P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, to prevent workers from accessing the hazard. P: Electromagnets are de-energized prior to worker entry using LOTO procedure. 	L: EU C: L R: IV
	hazard.	L: A C: M R: II	P: WPC P: SOP P: OJT P: Use of nonmagnetic tooling when necessary M: PPE	L: BEU C: L R: IV

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event)/	year Risk (R, Qualitative	Ranking)	Risk	Matri	X				
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	$\mathbf{I} = \text{situation (even}$	ent) of major concern				Like	lihood		
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 2.23 Magnetic Fields – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	Hazard: Exposure to fringe fields beyond allowable limits (worker with ferromagnetic or electronic medical device(s)) Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic medical device(s)) Exposure to flying metallic objects causing potential injury. Ferromagnetic bricks used in the	L: A C: H R: I L: A C: L R: III	 P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, to prevent workers from accessing the hazard. P: Electromagnets are de-energized prior to worker entry using LOTO procedure. M: Employees self-identify (to their supervisor and Medical) as having an implanted medical device, and are provided information regarding how to protect themselves from fringe fields. P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, to prevent workers from accessing the hazard. P: Magnets are de-energized prior to worker entry using LOTO procedure. 	L: EU C: M R: III L: EU C: L R: IV
	assembly of permanent magnets can pose a pinching or crushing hazard.	L: U C: M R: II	P: Use of nonmagnetic tooling when necessary P: Co-located workers are not handling permanent magnets, and so have no risk of being pinched/crushed.	L: EU C: M R: III

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		<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 2.24 Magnetic Fields – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Fringe Fields	Hazard: Exposure to fringe fields beyond allowable limits (worker with ferromagnetic or electronic medical device(s)) Exposure to fringe fields beyond allowable limits (worker without ferromagnetic or electronic	L: U C: H R: I	P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, to prevent workers from accessing the hazard. P: Electromagnets are de-energized prior to worker entry using LOTO procedure.	L: BEU C: H R: III
	medical device(s)) Exposure to flying metallic objects causing potential injury. Ferromagnetic bricks used in the assembly of permanent magnets can pose a pinching or crushing	L: U C: L R: III	P: Industrial hygiene conducts field surveys to establish safe field boundaries for workers. P: Visual barriers are provided to identify extent of fringe fields, to prevent workers from accessing the hazard. P: Magnets are de-energized prior to worker entry using LOTO procedure.	L: BEU C: L R: IV
	hazard.	L: U C: M R: II	P: Use of nonmagnetic tooling when necessary P: MOI individuals are not handling permanent magnets, and so have no risk of being pinched/crushed.	L: BEU C: M R: IV

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event)/	year Risk (R, Qualitative	Ranking)	Risk	Matri	ix				
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (eve	ent) 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	A	U	EU	BEU	
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (e	vent) of minor concern	saou	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible	$IV = situation (e^{-1})$	vent) of minimal concern	enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	_	111	777	13.7	13.7	
P = Preventive (reduce event occurrence likelihood)	H	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	၁	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	G								
		action.									
	M	C ≥ Mild, transient	C ≥ Serious injury, no	C ≥ Serious injury, no							
		adverse effects.	immediate loss of life no	immediate loss of life no							
			permanent disabilities;	permanent disabilities;							
			hospitalization required.	hospitalization required.							
	L	Mild, transient	Minor injuries; no	Minor injuries; no							
		adverse effects > C	hospitalization > C	hospitalization $> C$							
	N	Consequences less	Consequences less than	Consequences less than							
		than those for Low	those for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

 $Table\ 2.25\ Other\ hazards-Onsite-1\ Facility\ Worker$

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined	Hazard: Toxic atmosphere	L:	See Section I Chapter 04	L:
Spaces	Limited egress	C:		C:
	Poor quality walking surface	R:		R:
Noise	Hazard: facility infrastructure (e.g.	L:	See Section I Chapter 04	L:
	motors, pumps, HVAC), and various	C:		C:
	machinery (e.g. water jet machines,	R:		R:
	grinding operations) can generate			
	loud noises which pose a hazard for			
	hearing damage.			
Silica	Hazard: Airborne exposure above		Concrete:	
	OEL via concrete (or similar	L: A	P: Silica Awareness Training, Respiratory Protection Training	L: EU
	material) machining, moving dirt or	C: H	P: Work Planning (HA, SOP)	C: N
	gravel	R: I	M: Engineering Controls (HEPA, wet method) M: PPE (respirator, PAPR)	R: IV
	In APS-TD Fumed Silica is used in			
	very small quantities, on very rare	L: U	Fumed Silca:	L: U
	occasions, as part of making a small	C: M	M: N95 masks are worn when mixing in fumed silica	C: L
	batch of epoxy for magnet repairs.	R: II		R: III
	Note: the water jet machines in the			
	Machine Shop use garnet, and the			
	grit blast booth in IB2 uses			
	Aluminum Oxide (i.e. neither use			
	Silica).			

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Ergonomics	Hazard: with all the material moving, assembly and testing work,	L: C:	See Section I Chapter 04	L: C:
	and computer-based work in APS-	R:		R:
	TD, ergonomics (or lack thereof) poses a risk for injury from repetitive motion, improper alignment, reaching/straining, etc.			
Working at	Hazard: Falls, dropped	L:	See Section I Chapter 04	L:
Heights	tools/material	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			
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$	I = situation (eve	ent) of major concern				Likelihoo		
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$	$\mathbf{II} = \text{situation (ev}$	ent) of concern		1	A	U	EU	BEU
EU = Extremely Unlikely (1.0E-04 > L > 1.0E-06)		L = Low	III = situation (e	vent) of minor concern	saou	Н	I	I	II	III
BEU = 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-2 (co-located worker)	Onsite-1 (facility worker)	nbəs	_	111	777	13.7	13.7
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	၁	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	G							
		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 2.26 Other hazards – Onsite-2 Co-located Worker

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined	Hazard: Toxic atmosphere	L:	See Section I Chapter 04	L:
Spaces		C:		C:
	Accidental entry	R:		R:
Noise	Hazard: facility infrastructure (e.g.	L:	See Section I Chapter 04	L:
	motors, pumps, HVAC), and various	C:		C:
	machinery (e.g. water jet machines,	R:		R:
	grinding operations) can generate			
	loud noises which pose a hazard for hearing damage.			
Silica	Hazard: Airborne exposure above		Concrete:	
Sincu	OEL via concrete (or similar	L: A	P: Work Planning (HA, SOP)	L: EU
	material) machining, moving dirt or	C: H	P: Work oversite (Work planner, ESH)	C: M
	gravel	R: I	M: Engineering Controls (HEPA, wet method)	R: III
	In APS-TD Fumed Silica is used in	L: U	Fumed Silica:	L: U
	very small quantities, on very rare	C: M	M: Co-located workers are not near enough the mixing to be exposed	C: L
	occasions, as part of making a small	R: II		R: III
	batch of epoxy for magnet repairs.			
	Note: the water jet machines in the			
	Machine Shop use garnet, and the			
	grit blast booth in IB2 uses			
	Aluminum Oxide (i.e. neither use			
	Silica).	T		+
Ergonomics	Hazard: N/A	L:	See Section I Chapter 04	L:
		C: R:		C:
		K.		R:

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Working at Heights	Hazard: Struck by dropped tools/material	L: C:	See Section I Chapter 04	L: C:
	10000	R:		R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.												
Likelihood (L, of event)/year	C	onsequence (C, of event)/y	year Ris	isk (R, Qualitative	Ranking)	Risk	Matri	ix				
$\mathbf{A} = \text{Anticipated } (L > 1.0E-02)$		$\mathbf{H} = \mathbf{High}$		I = situation (even	nt) of major concern			Likeliho				
U = Unlikely (1.0E-02 > L > 1.0E-04)		$\mathbf{M} = \mathbf{Moderate}$		\mathbf{II} = situation (even	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	sə	Н	I	I	II	III	
BEU = Beyond Extremely Unlikely (1.0E-06> L)		N = Negligible		IV = situation (ev	vent) of minimal concern	enc	M	II	II	III	IV	
Control(s) Type	C	Offsite (MOI)	Onsite-2 (co	co-located worker)	Onsite-1 (facility worker)	Consequences	т	ш	777	13.7	IV	
P = Preventive (reduce event occurrence likelihood)	Н	C ≥ Irreversible,	C ≥ Promi	npt worker fatality	C ≥ Prompt worker	ons	L	III	III	IV	1 V	
M = Mitigative (reduces event consequences)		other serious effects,	_	te injury that is	fatality or acute injury that	$^{\circ}$	N	IV	IV	IV	IV	
Acronyms		or symptoms which		nediately life-	is immediately life-							
MOI = Maximally-exposed Offsite Individual		could impair an	threatening	ng or permanently	threatening or							
		individual's ability to	di	disabling.	permanently disabling.							
		take protective		-								
		action.										
	M	C ≥ Mild, transient	C ≥ Ser	rious injury, no	C ≥ Serious injury, no							
		adverse effects.	immediat	ate loss of life no	immediate loss of life no							
			permane	nent disabilities;	permanent disabilities;							
			hospitali	ization required.	hospitalization required.							
	L	Mild, transient		or injuries; no	Minor injuries; no							
		adverse effects > C	hospita	talization > C	hospitalization $> C$							
	N	Consequences less	Consequ	uences less than	Consequences less than							
		than those for Low	those for L	Low Consequence	those for Low							
		Consequence Level		Level	Consequence Level							

Table 2.27 Other hazards – MOI Offsite

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Confined	Hazard: N/A (all confined spaces	L:	N/A	L:
Spaces	in APS-TD are inside secured	C:		C:
	buildings)	R:		R:
Noise	Hazard: facility infrastructure (e.g.	L:	See Section I Chapter 04	L:
	motors, pumps, HVAC), and various	C:		C:
	machinery (e.g. water jet machines,	R:		R:
	grinding operations) can generate			
	loud noises which pose a hazard for			
	hearing damage.			
Silica	Hazard:	L:	See Section I Chapter 04	L:
	Airborne exposure above OEL via	C:		C:
	concrete (or similar material)	R:		R:
	machining, moving dirt or gravel			
Ergonomics	Hazard: N/A	L:	See Section I Chapter 04	L:
		C:	•	C:
		R:		R:
Working at	Hazard: Struck by dropped	L:	See Section I Chapter 04	L:
Heights	tools/material	C:		C:
		R:		R:

Other Hazard Consequences, derived from Figure C-1, "Example Qualitative Consequence Matrix", DOE-HDBK-1163-2020.											
Likelihood (L, of event)/year	C	onsequence (C, of event)/y		<u>o</u> .	Risk	Matri					
A = Anticipated (L > 1.0E-02) U = Unlikely (1.0E-02> L >1.0E-04)	$\mathbf{H} = \text{High}$ $\mathbf{I} = \text{situation (event) of major concern}$ $\mathbf{M} = \text{Moderate}$ $\mathbf{II} = \text{situation (event) of concern}$					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 = Preventive (reduce event occurrence likelihood)	С	0 2 - 10 - 10 - 10 - 10 - 10 - 10 - 1	Onsite-2 (co-located worker)	Onsite-1 (facility worker)	nbesu	L	III	III	IV	IV	
M = Mitigative (reduces event occurrence fixelinood)	H	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							
	NI	adverse effects > C	hospitalization > C Consequences less than	hospitalization > C Consequences less than							
	1		hose for Low Consequence	those for Low							
		Consequence Level	Level	Consequence Level							

Table 2.31 Environmental

Hazard	Hazard Description	Baseline Qualitative Risk (without controls)	Preventative (P)/ Mitigative (M)	Residual Qualitative Risk (with controls)
Airborne	Hazard: Airborne release of radionuclides beyond permitted limits.	L: C: R:	Radionuclide release: N/A	L: C: R:
	Airborne release of chemicals beyond permitted limits (Consequences based on Onsite Worker qualitative consequence matrix)	L: C: R:	Chemical release: See Section I Chapter 04	L: C: R:
Water	Hazard: Discharge of radionuclides into onsite surface waters beyond permitted limits.	L: C: R:	Radionuclide release: N/A	L: C: R:
	Discharge of chemicals into onsite surface waters beyond permitted limits. (Consequence based on Onsite worker qualitative consequence matrix)	L: C: R:	Chemical release: 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: Radioactive soil in beam loss areas beyond allowable concentrations of radionuclides above Fermilab limits.	L: C: R:	Radionuclide release: N/A	L: C: R:
	Discharge of chemicals into onsite soils beyond permitted limits.	L: C: R:	Chemical release: See Section I Chapter 04	L: C: R: