ACCELERATOR DIVISION ADMINISTRATIVE PROCEDURE

ADAP-11-0003

APPROVED ACCELERATOR BEAM INTENSITY OPERATING LIMITS

RESPONSIBLE DEPARTMENT: ESH&Q RPS

PREPARED BY _____ DATE 8/10/18
Radiation Physics Science Department Head

REVIEWED BY _____ DATE 8/10/18
Radiation Physics Engineering Department Head

REVIEWED BY _____ DATE 8/10/18
AD Operations Department Head

APPROVED BY _____ DATE 8/10/2018
Accelerator Division Head

REVISION NO. 7 REVISION ISSUE DATE 8/9/2018

Table of Contents

1.0 PURPOSE AND SCOPE 1

2.0 BEAM INTENSITY OPERATING LIMITS 2

3.0 DISTRIBUTION 2

4.0 REFERENCES 3

1.0 PURPOSE AND SCOPE

In accordance with the DOE Accelerator Safety Order, DOE O 420.2C, and as flowed down through the Fermilab Director's Policies, the Fermilab Environment Safety and Health Manual (FESHM) including the Fermilab Radiological Control Manual (FRCM), this procedure defines the approved accelerator beam intensity operating limits derived from the various radiological shielding assessments or other safety documents such as the Fermilab Safety Assessment Document.

The table in Section 2.0 specifies the beam power limitations for each operational section of the Fermilab accelerator complex. The shielding assessments conducted for each beamline or experimental area with respect to the FRCM limits found that continuous operation at an intensity defined in the Operating Intensity Limits along with the stated beam energy is safe and defines the normal Beam Permit operating limits.

The Basis listed in the table identifies what limits the beam intensity for each area. The term "Overburden" is used in the table when the Operating Intensity is limited by the shielding surrounding the beamline enclosure. The term "Absorber" is used when the intensity is limited by the thermal and/or mechanical properties of a specified beam absorber. These intensity limits are specified in particles per hour since the concern here is prompt radiation exposures from beam operations.

The term "Groundwater" or "Surface Water" is used when the intensity is limited by the number of particles that, due to activation of unprotected soil surrounding the enclosures, result in radioactivity in the ground or surface water. Ground and surface water limits are cumulative effects and are expressed in particles per year.

2.0 BEAM INTENSITY OPERATING LIMITS

Area	Operating Intensity Limit	Beam Energy	Basis
Linac to NTF	6.70 E17 protons/hour	66 MeV	Overburden [i, ii]
Linac	3.54 E17 protons/hour	400 MeV	Overburden [i]
Linac Absorber #1	6.40 E20 protons/year	400 MeV	Groundwater [iii]
Linac Absorber #2	6.40 E20 protons/year	400 MeV	Groundwater [iii]
FAST Beam to Low Energy Absorber	1.96 E17 electrons/hour	55 MeV	Absorber [iv]
FAST Beam to High Energy Absorber	3.37 E18 electrons/hour	300 MeV	Overburden [v]
FAST Injection into IOTA Ring	3.60 E13 electrons/hour**	150 MeV	Overburden [v, vi]
IOTA Ring Circulating Beam	2.00 E10 electrons	150 MeV	Overburden [vi]
FAST Low Energy Absorber	1.16 E21 electrons/year	55 MeV	Surface Water [v]
FAST High Energy Absorber	3.40 E21 electrons/year	300 MeV	Surface Water [v]

** The shielding assessment for FAST/IOTA was performed using a higher Operating Limit (3.37 E18 electrons/hour) as the worst potential accident scenario. However, the Safety Assessment Document (SAD) chapter for FAST/IOTA sets the Operating Limit at 3.6 E13 electrons/hour due to physical constraints of the machine. The lower of these two Operating Limits will be used.

3.0 DISTRIBUTION

An electronic controlled copy of this procedure is maintained on the AD ESH website at: http://ad-esh.fnal.gov/ad_adap.html.

An uncontrolled copy is provided to the Fermilab Site Office.

4.0 REFERENCES

[i] **Memo, "Completion of the Linac Shielding Assessment and Verification of Operation at Full Intensity,"** from G. Dugan to D. Cossairt, page 2, June 28, 1991. **Radiation Shielding Assessment of the Linac High Energy Enclosure Following the 1993 Upgrade Installation and Low Intensity Commissioning**, Charles Schmidt and Thomas Kroc, September 21, 1993.

[ii] **Neutron Therapy Facility 1992 Shielding Assessment**, Arlene J. Lennox, April 10, 1992.

[iii] **Linac Momentum Beam Dump Vacuum**, L. Allen, J. Fulgham, F.G. Garcia, M. Gerardi, B. Higgins, K. Vaziri, G. Lauten, A. Lee, D. Newhart, B. Ogert, I. Rakhno, R. Reilly, D. Reitzner, November 2011.

[iv] **Shielding Assessment for the Advanced Superconducting Test Accelerator (ASTA) Injector**, M. Church, I. Rakhno, E. Harms, December 12, 2014.

[v] **Shielding Assessment for IOTA/FAST Electron Injector at 300 MeV**, D. Broemmelsiek, I. Rakhno, 23 August 2017.

[vi] **Safety Assessment Document, Revision 16, Section IV, Chapter IV-3 "Fermilab Accelerator Science & Technology (IOTA/FAST) Electron Injector,"** E. Harms, J. Anderson Jr., D. Edstrom Jr., D. Broemmelsiek, April 23, 2018.