

BNL-105101-2014-TECH

Booster Technical Note No. 54;BNL-105101-2014-IR

Calculation of Booster power requirements and power line flicker for 1.5 GeV proton operation

M. Meth

July 1986

Collider Accelerator Department Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No.DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

CALCULATION OF BOOSTER POWER REQUIREMENTS AND POWER LINE FLICKER FOR 1.5 GEV PROTON OPERATION

Booster Technical Note No. 54

> MARVIN METH JULY 17, 1986

ACCELERATOR DEVELOPMENT DEPARTMENT Brookhaven National Laboratory Upton, N.Y. 11973 CALCULATION OF BOOSTER POWER REQUIREMENTS AND POWER LINE FLICKER FOR 1.5 GEV PROTON OPERATION

> MARVIN METH July 17, 1986

The Booster power requirements and power line flicker has been previously calculated for the 1 GEV proton cycle.¹ Since then the maximum proton energy has been increased to 1.5 GEV, and the cycle period increased from 100 to 133 millisec. the design manual lists the peak magnet current as 2220A (previous value of 1672A). The maximum stored energy is increased by a factor of 1.763 and the power swing is increased by a factor of 1.32; increasing the flicker approximately by this factor.

The required magnet voltage has been calculated and is given in Figures 1 and 2 for the dipole and quadrupole strings. The total power at the AC bus bar is given in Figure 3. To calculate the reactive power, the dipole excitation is assumed to consist of 5 - 1000 volt supplies in series and sequentially switched. The quadrupole supply consits of 5 -175 volt supplies in series and sequentially switched.

^{1.} Booster Tech. Note #45, June 12, 1986.

The power line flicker has been calculated using the circuit analysis program ECAP and the electrical model of the lab site. For the flicker calculations the Booster is excited from a dedicated 20 MVA, 66 Kv/13.8 Kv power transformer with 7.5% leakage. The transformer is connected to the 69 Kv bus at the Fifth Avenue Substation using either:

- 1. The primary 69 Kv LILCO feeders 69 858 and 69 863, or
- 2. The alternate 69 Kv LILCO feeder 69 861.

The results of these calculations are given in Table 1.

Since the flicker is approaching a value of 0.5%, the effects of a reactive power compensator in reducing the flicker has been included in a second series of calculations. The reactive compensator consists of a 3 phase controllable power choke and a 3 phase capacitor bank. The inductance is controlled to give a total reactive power of zero. This equipment is manufactured by AEG Telefunken under the commercial names of Megasemi and Varoverter. The two differ in power levels. A schematic of the 69 Kv distribution system on site is given in Figure 4.

It is interesting to note that the reactive power compensating scheme is not effective in reducing the amplitude flicker in the 69 Kv line on site but is effective in reducing the flicker at the LILCO substation. The reason for this is that the r/x ratio for a transformer is much smaller than the r/x ratio for a feeder.









Page 6

DEDICATED TRANSFORMER CONNEDTED TO ALTERNATE FEEDER	Mvar Compensation	Maximum Phase Flicker	•52°	•52°	.52°	5.38°
		Maximum Amplitude Flicker	.148	8 ti l.	. 1 th g	82%
	No Compensation	Maximum Phase Flicker	.51°	.51°	.51 °	5.32°
		Maximum Amplitude Flicker	.27%	.27%	.27%	2.91%
DEDICATED TRANSFORMER CONNECTED TO PRIMARY FEEDER	Mvar Compensation	Maximum Phase Flicker	.51。	.62°	.66°	5.27°
		Maximum Amplitude Flicker	.14%	.38%	20tr •	. 89%
	No Compensation	Maximum Phase Flicker	.51°	.62°	.67°	5.21°
		Maximum Amplitude Flicker	.27%	.42%	.45%	2.78%
		Location	LILCO Substation	69 Kv Temple Pl.	69 Kv Fifth Ave.	13.8 Kv Booster

¥

Table 1

POWER LINE FLICKER FOR 1.5 GEV PROTON CYCLE