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# Calculation of Booster power requirements based on a constant RF bucket area

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## CALCULATION OF BOOSTER POWER REQUIREMENTS BASED ON A CONSTANT RF BUCKET AREA

Booster Technical Note No. 45

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## CALCULATION OF BOOSTER POWER REQUIREMENTS BASED ON A CONSTANT RF BUCKET AREA

#### Marvin Meth

During the summer of 1985, the author conducted a preliminary study of the feasibility of exciting the AGS Heavy Ion/ Proton Booster directly from the electric power distribution system<sup>1</sup>. In the interim a number of critical magnet parameters have been modified. In addition, the time variation of the magnetic field has been changed from a linear ramp as used in the original study to a function that maintains the RF accelerating bucket area constant. The magnetic field function required to maintain the bucket area constant was developed by J. G. Cottingham.<sup>2</sup>

Based on the new magnet parameters and the magnetic field function the power requirements have been recalculated and the power grid flicker evaluated at the LILCO substation and on the Lab site. The flicker calculations were performed using the modify routine of the circuit analysis program ECAP.

In general, for the proton cycle the stored energy in the magnet has been substantially reduced but the field function "peaks" the power at the end of the rectification phase. The net affect is that the peak power and power swing has not been significantly changed from that of the original study.

Table I lists the parameters used this study.

The power requirements for the proton cycle for a bucket area of 0.71 ev. sec. (period of 0.1 sec) and 1.0 ev. sec. (period of 0.133 sec) are given in Figures 1 and 2. To limit the reactive power flow for the proton cycle the power supply was constructed from six modular supplies series connected and sequentially switched on to develop the drive voltage.

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The power requirements for the Heavy Ion Cycle has not significantly changed from the original study and is repeated in Figure 3.

The results of the power grid flicker evaluation at LILCO, on the 69 Kv Bus on site, and the 13.8 Kv Bus Feeding the Booster is summarized in Table II. The flicker given is for the 0.71 ev. sec. bucket area, since this cycle requires the largest power swing for the proton cycles studied.

A summary of the magnet power requirements is included as Table III.

<sup>1.</sup> M. Meth, <u>Preliminary Study of AC Power Feeders for AGS Booster</u>, Accelerator Division Technical Note No. 220, October 1, 1985.

<sup>2.</sup> J.G. Cottingham, RF Bucket Area, Booster Technical Note No. 31, May 6, 1986.

 	DIPOLE	QUADRUPOLE	_
TOTAL INDUCTANCE	.1152H	.0168H	
TOTAL RESISTANCE	.0432Ω	.048 Ω	
PROTON CYCLE I - Injection I - Maximum	635A 1672A	635A 1672A	
HEAVY ION CYCLE I - Injection I - Maximum	0 5174A	0 5174A	

#### TABLE I

MAGNET PARAMETER

		MAXIMUM AMPLITUDE	MAXIMUM PHASE
LOCATION	CYCLE	FLICKER	FLICKER
LILCO SUB STATION	PROTON	0.17%	0.39°
	HEAVY ION	0.31%	0.31°
69 KV FIFTH AVE SUB STATION	PROTON	0.26%	0.58°
	HEAVY ION	0.48%	0.39°
BOOSTER 13.8 KV	PROTON	1.97%	3.96°
	HEAVY ION	2.88%	3.24°

## TABLE II

RESULTS OF FLICKER STUDY Based On 0.1 Sec. Period For Proton Cycle

	PROTON CYCLE (0.1 sec)	HEAVY ION CYCLE (1.0 sec)
STORED ENERGY	•185 MJ	1.56 MJ
PEAK POWER	8.9 MW	9.0 MW
PEAK POWER SWING	16.0 MW	13.4 MW
AVERAGE POWER	.070MW	.72 MW

### TABLE III

MAGNET POWER REQUIREMENTS





