national accelerator laboratory

TM-296
2261

13.8 KV FEEDERS AND LOAD DISTRIBUTION IN THE NEUTRINO LABORATORY

T. E. Toohig

April 1971

The electrical power distribution from the Master Substation to the Neutrino Laboratory consists in two 13.0 kV feeders, Feeder 32 and Feeder 33, running the length of the area. Appropriate unit substations at various locations as detailed in Figure 1 convert the 13.0 kV to voltages required for equipment. These are DUSAF-supplied substations with the exception of the supply for the Chicago cyclotron in the Muon Laboratory Area and the 30-inch ANL bubble chamber. The feeders are rated for about 7 KVA each and loads are distributed accordingly.

Tables I and II illustrate operating loads for maximum running of various beam lines and facilities in the area. From the point of view of power, it is apparent that compromises in beam momentum and/or experimental equipment operating levels must be made to operate facilities simultaneously. In particular, the lumped loads for the cyclotron and bubble chambers are so large relative to the power consumption of the beams even under extreme operating conditions, that substantial compromises must be made in the operating levels of these to achieve simultaneous operation.

Operated by Universities Research Association Inc. Under Contract with the United States Atomic Energy Commission

SUBJECT: Neutrino Laboratory - magnet loads
Power requirements and distribution

NAME: T. E. Toohig

DATE: 4-20-71 | REVISION DATE:

TABLE I

Beam N-7 N-3 to 500 GeV/c + 30-inch b.c.

Transf.	Encl.	Power (MW)	Fdr
NL-1	S.B.11 G	.5 .5	32
NL-2	S.B.12 100	.3 .5	33
NL-3	101	.75	32
NL-5	103	.03	33
NL-6	S.B.13	.5	32 *
NL-7	105	.2	32 *
NL-8	108	.04	33
NL-8	112	.08	33
NL-9	114	.25	32
NL-13	"D"	1.	32 *
NAL	b.c.	6.3 (MVA)	33

Totals:
Feeder 32 3.7 MW (1.7 MW beam)
" 33 7.3 MW (0.66 " ")

Put "B" on fdr. 32

* can be switched to the other feeder.

Beam N-1 to 300 GeV/c + v.c. cyclotron

Transf.	Encl.	Power (MW)	Fdr.
NL-1	S.B. 11 G	.5 .5	32
NL-2	S.B. 12 100	.3 .4	33
NL-3	101	.6	32
NL-4	102	.4	32
NL-5	103	.5	32
NL-6	S.B.13 104	.5 .4	32 *
NAL	cyclotron	2.	32 *

Totals:
Feeder 32 5.4 MW (2.4 MW beam)
" 33 0.7 MW (0.7 " ")

Non-redundant loads†
Feeder 32 8. MW (4.1 MW beam)
" 33 8. MW (1.35 " ")

† may need a little more divergence plus conventional.

NATIONAL ACCELERATOR LABORATORY
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
			- 3 -

SUBJECT: Neutrino Laboratory - magnet loads
Power requirements and distribution

NAME: T. E. Toohig

DATE: 4-20-71

REVISION DATE:

TABLE II

Beam N-7, N-5 to 500 GeV/c + 15-foot b.c.

Transf	Encl.	Power (MW)	Fdr.
NL-1	S.B. 11	.5	32
	G	.5	
NL-2	S.B. 12	.5	32
	100	.5	
NL-3	101	.75	32
NL-6	S.B. 13	.5	32 *
NL-7	105	.75	32 *
	106	.2	
NL-8	109	1.	33
NL-9	113	.25	32
	115	.15	
NL-10	"B"	1.	33 *
NL-11	"B"	1.	33 *

Totals:
Feeder 32 3.6 MW (2.6 MW beam)
" 33 3.0 MW (1.0 " ")

* can be switched to the other feeder.

Beam N-0 + Lab "C" experiment

Transf.	Encl.	Power (MW)	Fdr.
NL-1	S.B. 11	.5	32
	G	.5	
NL-12	"C"	.5	32*

Totals
Feeder 32 1.5 MW
" 33 0 "

NATIONAL ACCELERATOR LABORATORY ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE
SUBJECT: Neutrino Laboratory 13.8 KV Feeders and Substations	NAME: T. E. Toohig			
	DATE: 4-20-71	REVISION DATE		

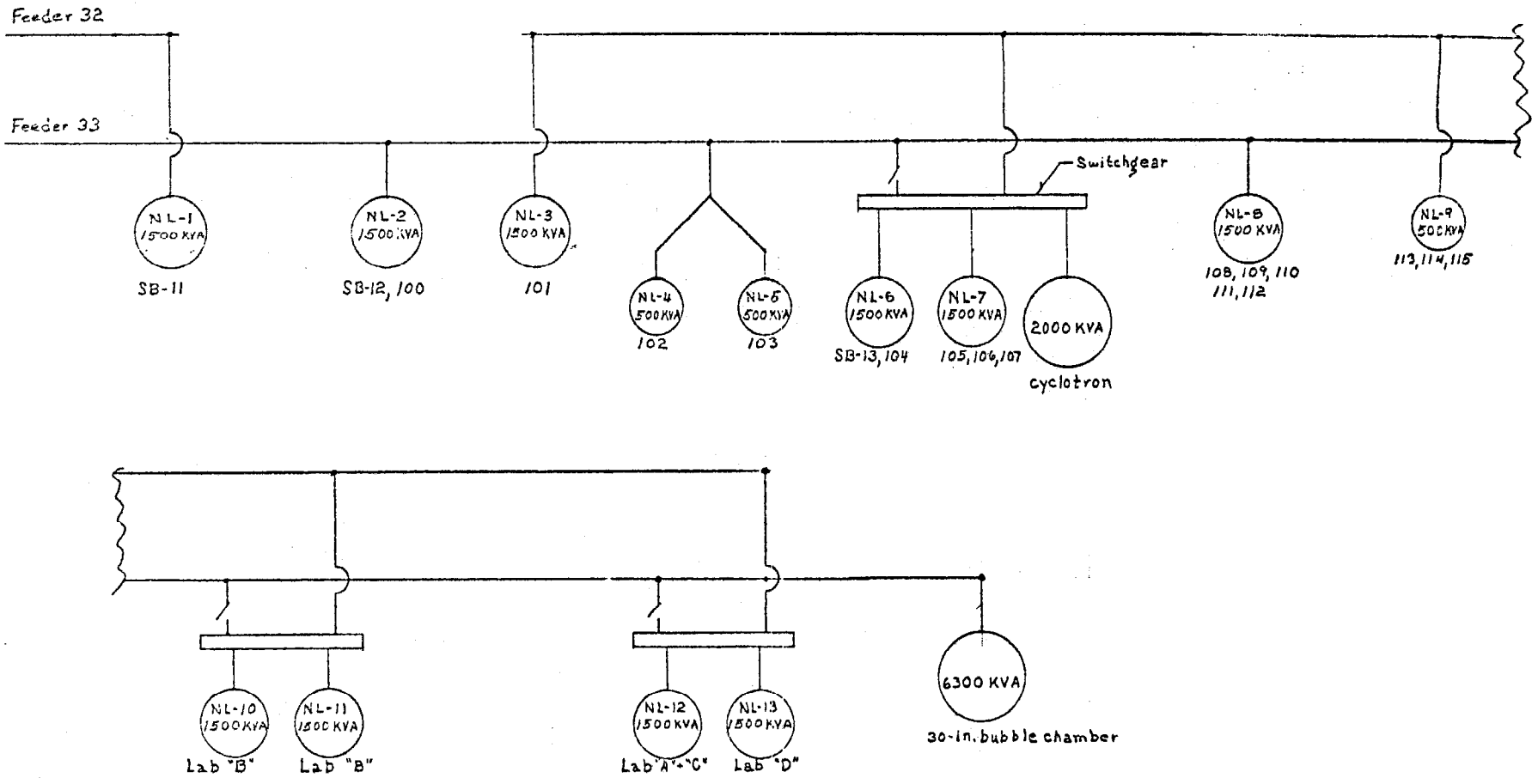


FIGURE 1

national accelerator laboratory

TM-296-A
2261

13.8 KV FEEDERS AND LOAD DISTRIBUTION IN THE NEUTRINO LABORATORY

T. E. Toohig

May 1971

The electrical power distribution from the Master Substation to the Neutrino Laboratory consists in two 13.8 kV feeders, Feeder 32 and Feeder 33, running the length of the area. Appropriate unit substations at various locations as detailed in Figure 1 convert the 13.8 kV to voltages required for equipment. These are DUSAF-supplied substations with the exception of the supply for the Chicago cyclotron in the Muon Laboratory Area and the 30-inch ANL bubble chamber. The feeders are rated for about 7 KVA each and loads are distributed accordingly.

Tables I and II illustrate operating loads for maximum running of various beam lines and facilities in the area. From the point of view of power, it is apparent that compromises in beam momentum and/or experimental equipment operating levels must be made to operate facilities simultaneously. In particular, the lumped loads for the cyclotron and bubble chambers are so large relative to the power consumption of the beams even under extreme operating conditions, that substantial compromises must be made in the operating levels of these to achieve simultaneous operation.

Operated by Universities Research Association Inc. Under Contract with the United States Atomic Energy Commission

NATIONAL ACCELERATOR LABORATORY
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE

SUBJECT: Neutrino Laboratory - magnet loads
Power requirements and distribution

NAME: T. E. Toohig
DATE: 4-20-71
REVISION DATE: 5-11-71

TABLE I

Beam N-7 N-3 to 500 GeV/c + 20-inch b.c.

Transf.	Encl.	Power (MW)	Fdr.
NL-1	S.B.11	.5	32
	G	.5	
NL-2	S.B.12	.3	32
	100	.5	
NL-3	101	.75	32
NL-5	103	.03	33
NL-6	S.B.13	.5	32 *
NL-7	105	.2	32 *
NL-8	108	.04	33
NL-8	112	.08	33
NL-9	114	.25	32
NL-13	"D"	1.	32 *
NAL	b.c.	6.3 (MVA)	33

Totals:
Feeder 32 4.5 MW (2.2 MW beam)
" 33 6.5 MW (0.15 " ")

Put "B" on fdr. 32

* can be switched to the other feeder.

Beam N-1 to 300 GeV/c + U.C. cyclotron

Transf.	Encl.	Power (MW)	Fdr.
NL-1	S.B. 11	.5	32
	G	.5	
NL-2	S.B. 12	.3	32
	100	.4	
NL-3	101	.6	32
NL-4	102	.4	33
NL-5	103	.5	33
NL-6	S.B.13	.5	32 *
	104	.4	
NAL	cyclotron	2.	32 *

Totals:
Feeder 32 5.2 MW (1.4 MW beam)
" 33 0.9 MW (0.9 " ")

Non-redundant loads†
Feeder 32 7.9 MW (3.6 MW beam)
" 33 7.4 MW (1.1 " ")

† may need a little more divergence plus conventional.

NATIONAL ACCELERATOR LABORATORY
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE

SUBJECT: Neutrino Laboratory - magnet loads
Power requirements and distribution

NAME: T. E. Toohig
DATE: 4-20-71
REVISION DATE:

TABLE II

Beam N-7, N-5 to 500 GeV/c + 15-foot b.c.

Transf	Encl.	Power (MW)	Fdr
NL-1	S.B. 11 G	.5 .5	32
NL-2	S.B. 12 100	.5 .5	32
NL-3	101	.75	32
NL-6	S.B. 13	.5	32 *
NL-7	105 106	.75 .2	32 *
NL-8	109	1.	33
NL-9	113 115	.25 .15	32
NL-10	"B"	1.	33 *
NL-11	"B"	1.	33 *

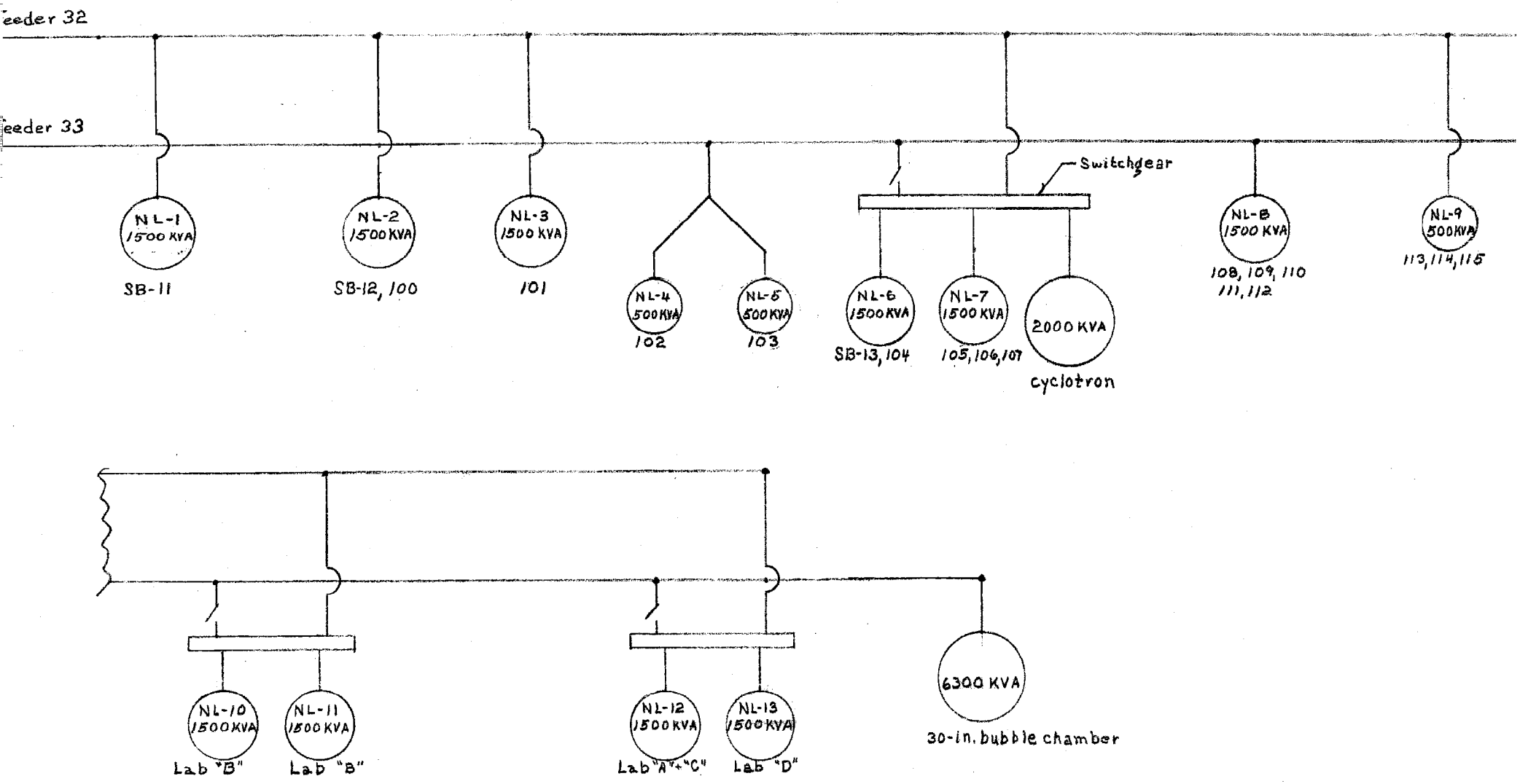
Totals:
Feeder 32 3.6 MW (2.6 MW beam)
" 33 3.0 MW (1.0 " ")

* can be switched to the other feeder.

Beam N-0 + Lab "C" experiment

Transf.	Encl.	Power (MW)	Fdr.
NL-1	S.B. 11 G	.5 .5	32
NL-12	"C"	.5	32 *

Totals
Feeder 32 1.5 MW
" 33 0 "



Neutrino Laboratory
13.8 KV Feeders and Substations

Rev. 1: NL-2 to feeder 32

FIGURE 1

national accelerator laboratory

TM-296-B
2261

13.8 kV FEEDERS AND LOAD DISTRIBUTION IN THE NEUTRINO AREA

T. E. Toohig

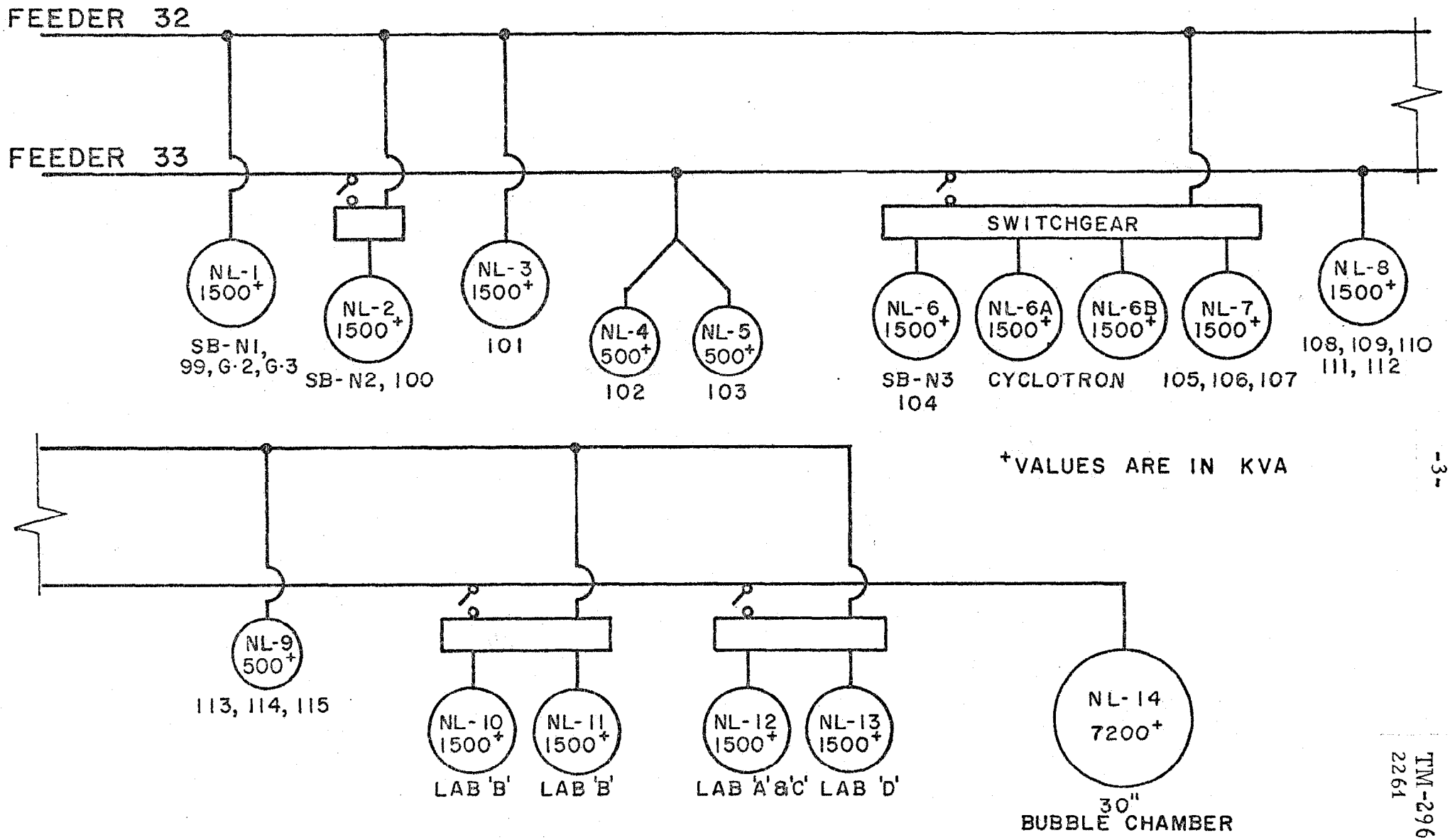
March 1973

The electrical power distribution from the Master Substation to the Neutrino Area consists in two 13.8 kV feeders, Feeder 32 and Feeder 33, running the length of the area. Appropriate unit substations at various locations as detailed in Fig. 1 convert the 13.8 kV to voltages required for equipment. These are DUSAF supplied substations with the exception of the supply for the 30-inch hydrogen bubble chamber. The feeders are rated for 7.0 MVA each as installed in the power ducts and loads are balanced between the feeders accordingly.

The attached graphs, NL-1 to NL-14, illustrate operating loads on the various substations under different conditions of beam settings and facility operation. The shading on the graphs indicates the approximate increment of power available from the substation if fans were to be added. An efficiency of 0.75 was used for the power supplies, and a power factor of 0.8 was used over-all in calculating the graphs. These numbers are derived from early operating experience and will probably have to be refined with time.

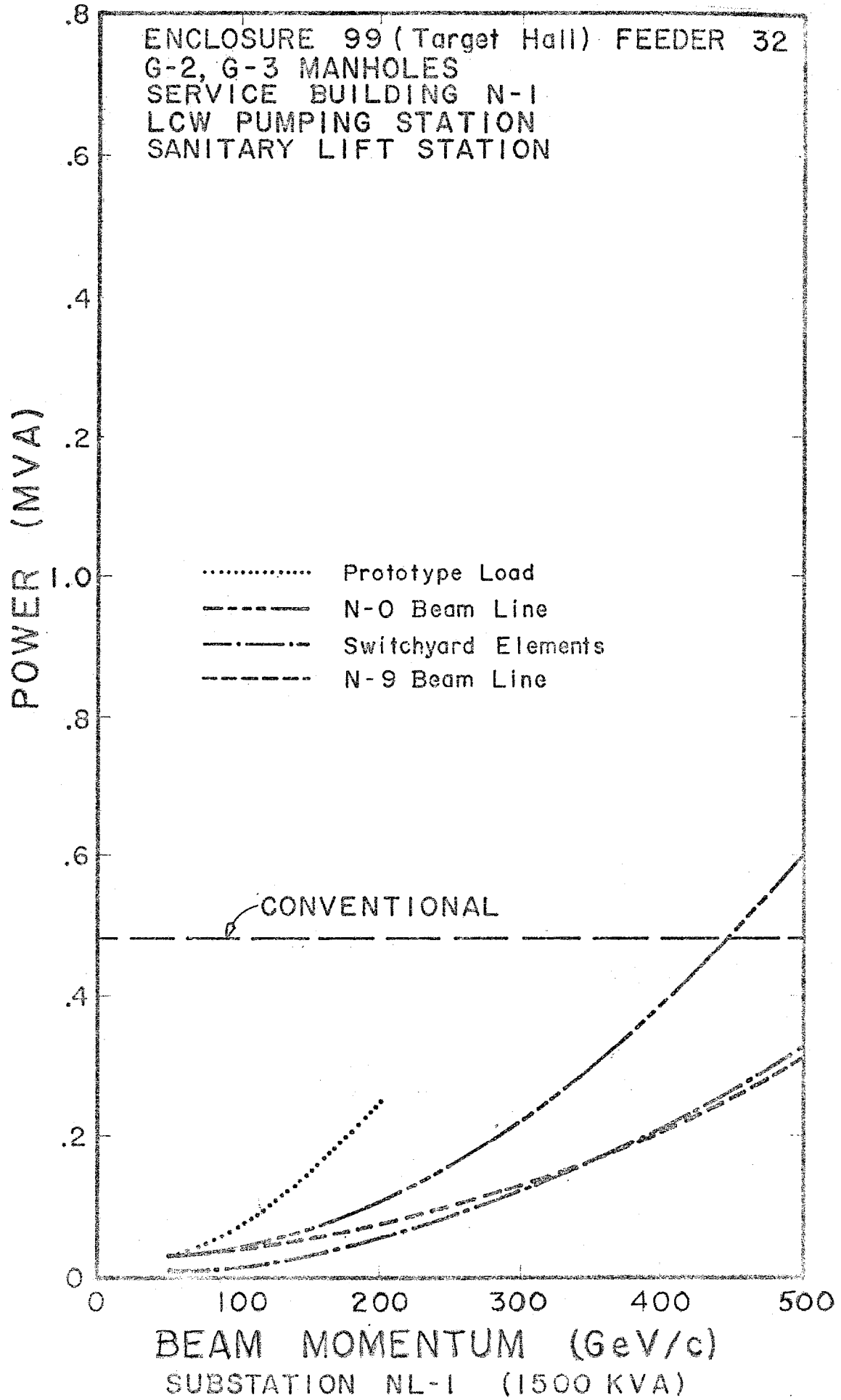
The curves labelled N-0, N-1, etc. refer to the N-0, N-1, etc. beam lines as specified in the beam line data sheets dated March 12, 1973. N-1' refers to the proposed increased-aperture version of the muon beam, N-1.

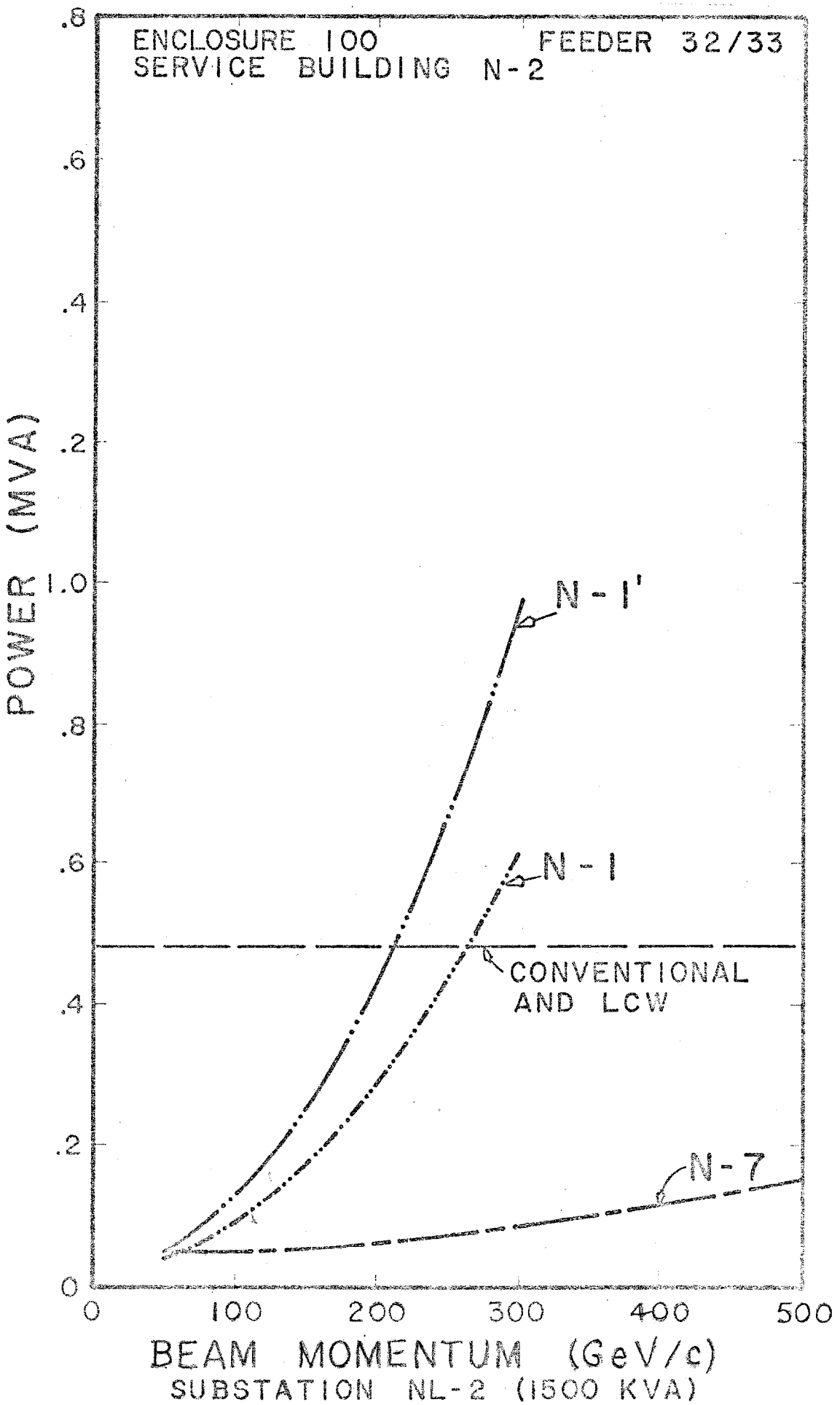
From the point of view of power, it is apparent that under certain conditions compromises in beam momentum and/or experimental equipment operating levels must be made if facilities are to be operated simultaneously.

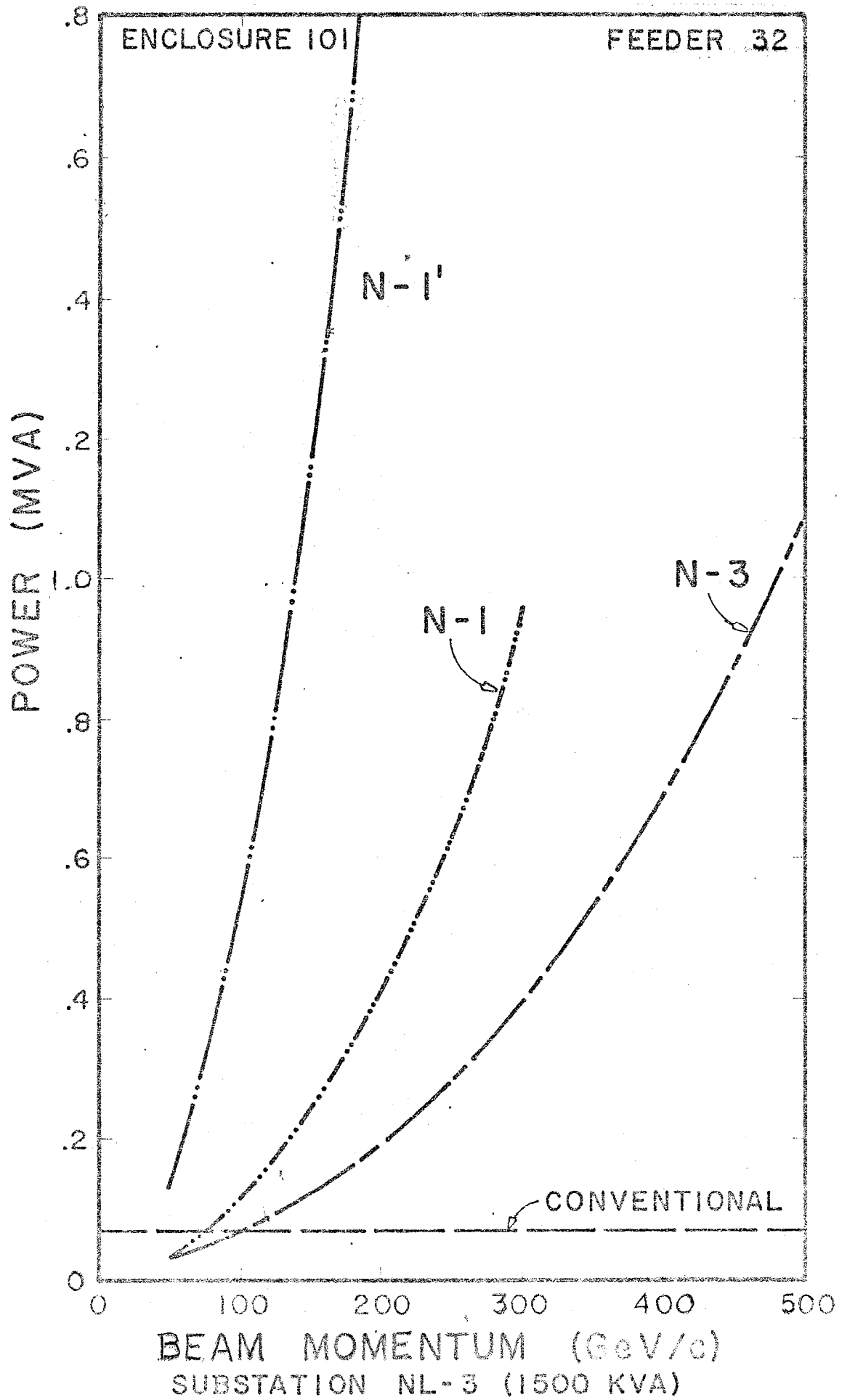


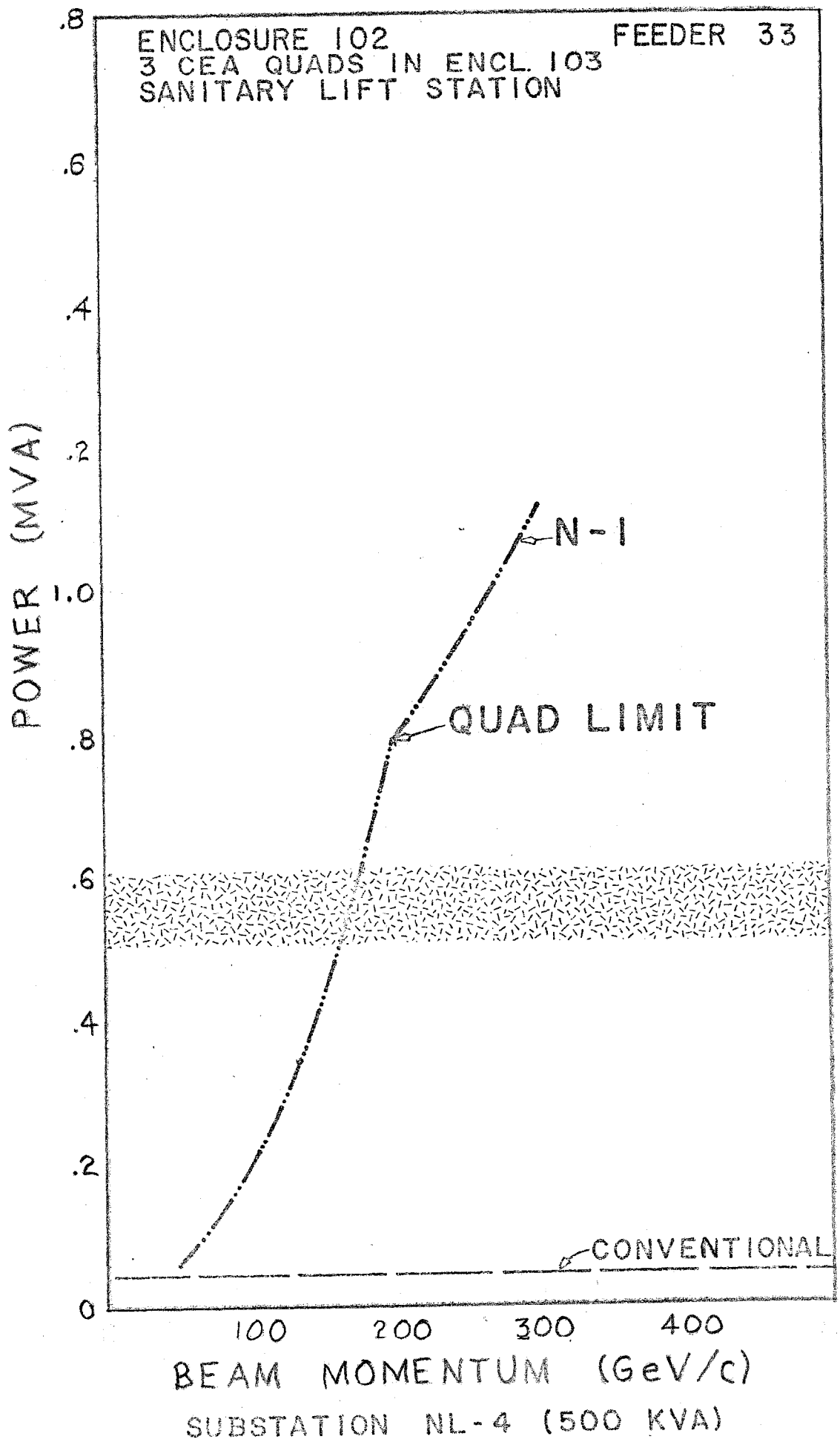
NEUTRINO LABORATORY 13.8 KV FEEDER AND SUBSTATIONS

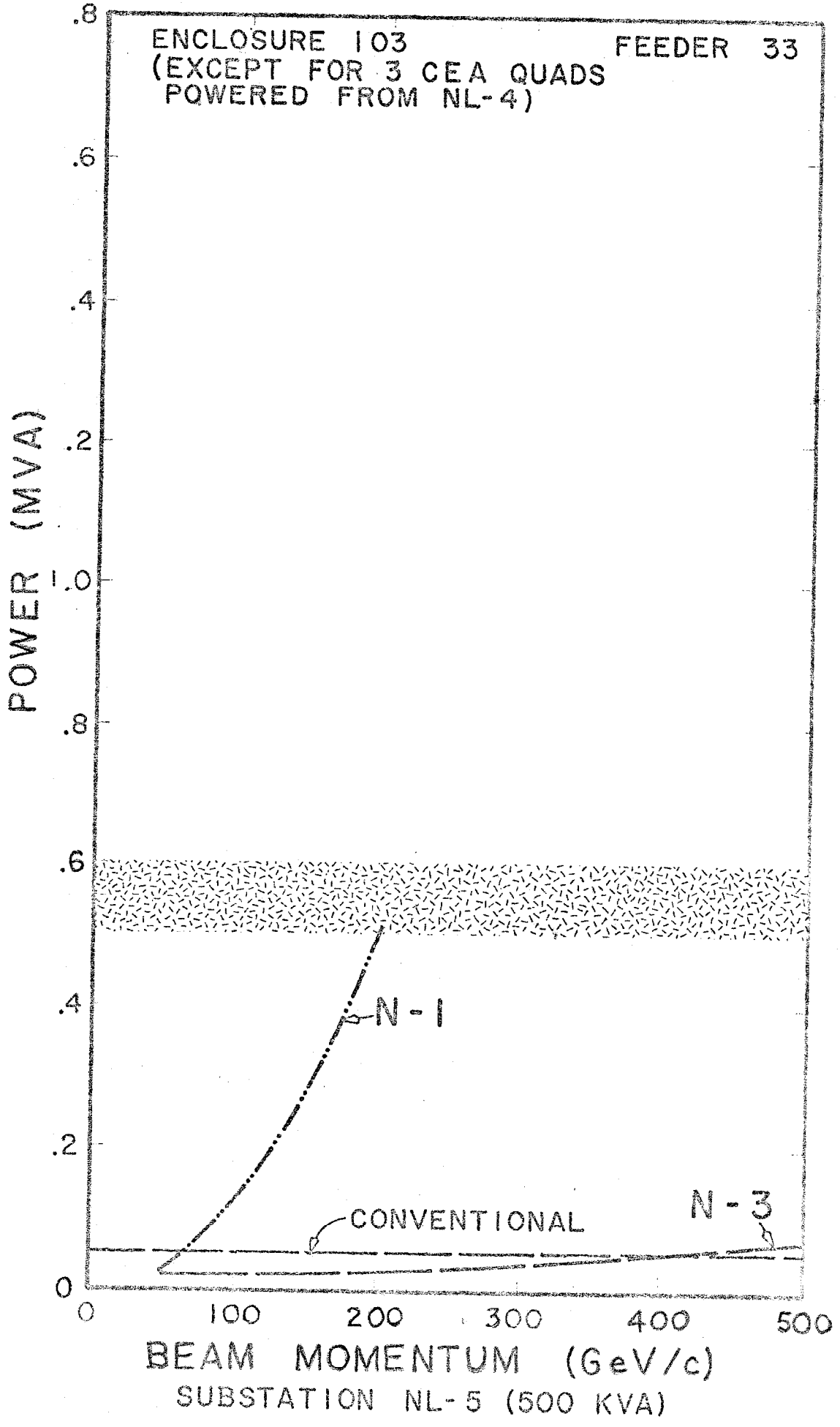
Figure 1

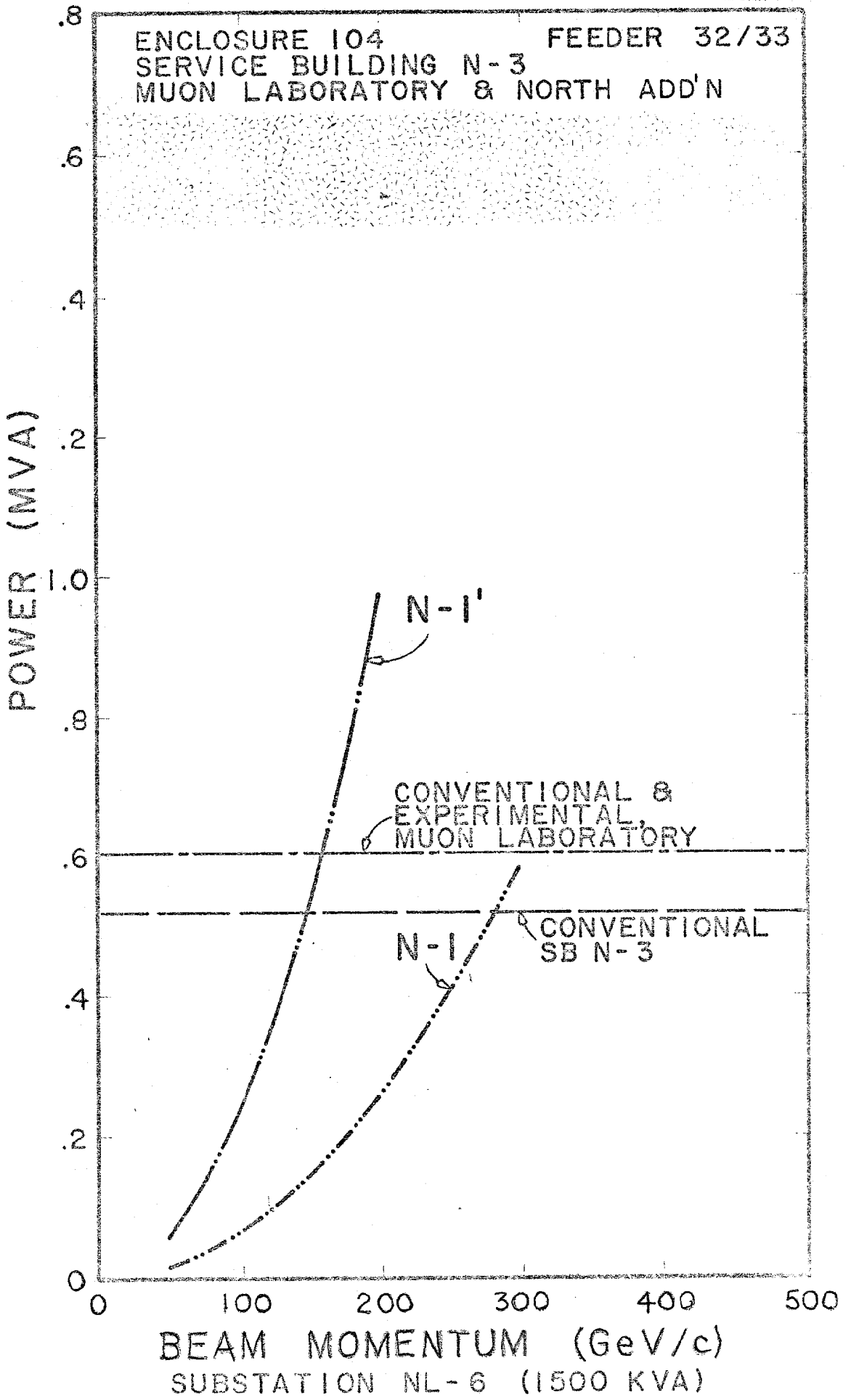

ENCLOSURE 99 (Target Hall) FEEDER 32
G-2, G-3 MANHOLES
SERVICE BUILDING N-1
LCW PUMPING STATION
SANITARY LIFT STATION
Prototype Load
N-0 Beam Line
Switchyard Elements
N-9 Beam Line
CONVENTIONAL
POWER (MVA)
.8
.6
.4
.2
1.0
.8
.6
.4
.2
0
0
100
200
300
400
500
BEAM MOMENTUM (GeV/c)
SUBSTATION NL-1 (1500 KVA)

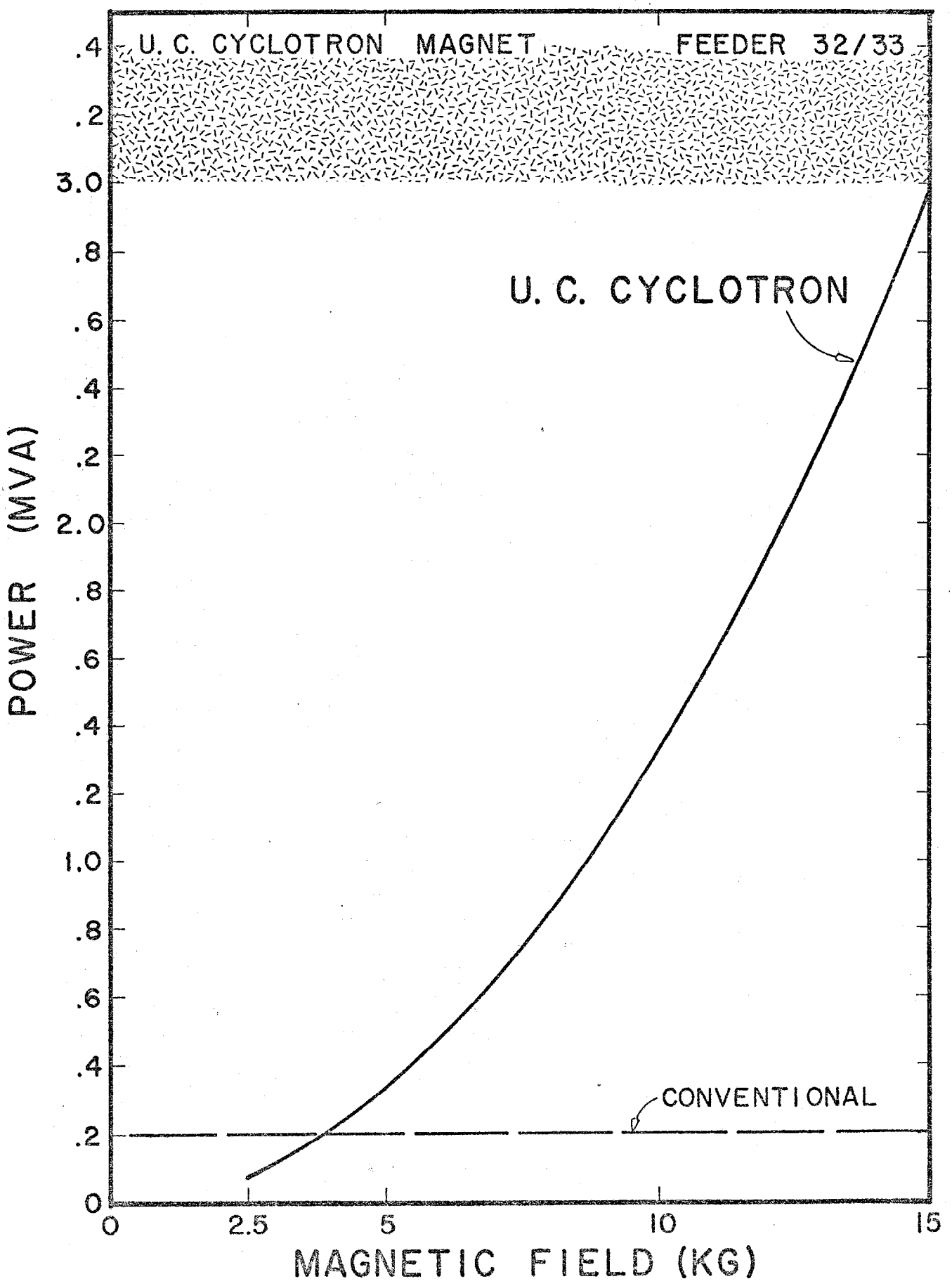

ENCLOSURE 100
SERVICE BUILDING N-2
FEEDER 32/33
POWER (MVA)
.8
.6
.4
.2
1.0
.8
.6
.4
.2
0
N-1'
N-1
CONVENTIONAL
AND LCW
N-7
0
100
200
300
400
500
BEAM MOMENTUM (GeV/c)
SUBSTATION NL-2 (1500 KVA)


ENCLOSURE 101
FEEDER 32
N-1'
N-1
N-3
CONVENTIONAL
POWER (MVA)
.8
.6
.4
.2
1.0
.8
.6
.4
.2
0
0
100
200
300
400
500
BEAM MOMENTUM (GeV/c)
SUBSTATION NL-3 (1500 KVA)

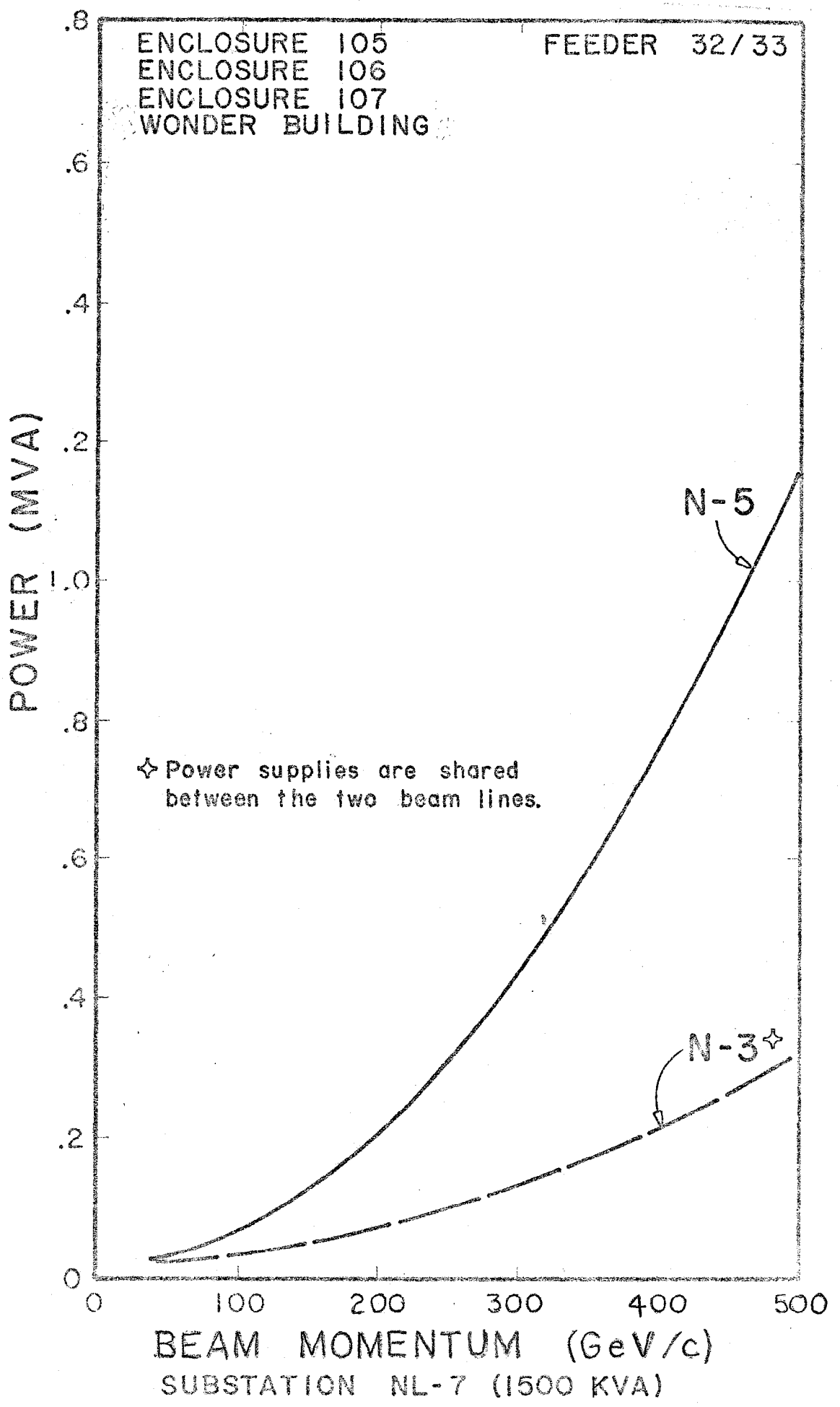

ENCLOSURE 102
3 CEA QUADS IN ENCL. 103
SANITARY LIFT STATION
FEEDER 33
POWER (MVA)
.8
.6
.4
.2
1.0
.8
.6
.4
.2
0
N-1
QUAD LIMIT
CONVENTIONAL
100
200
300
400
BEAM MOMENTUM (GeV/c)
SUBSTATION NL-4 (500 KVA)

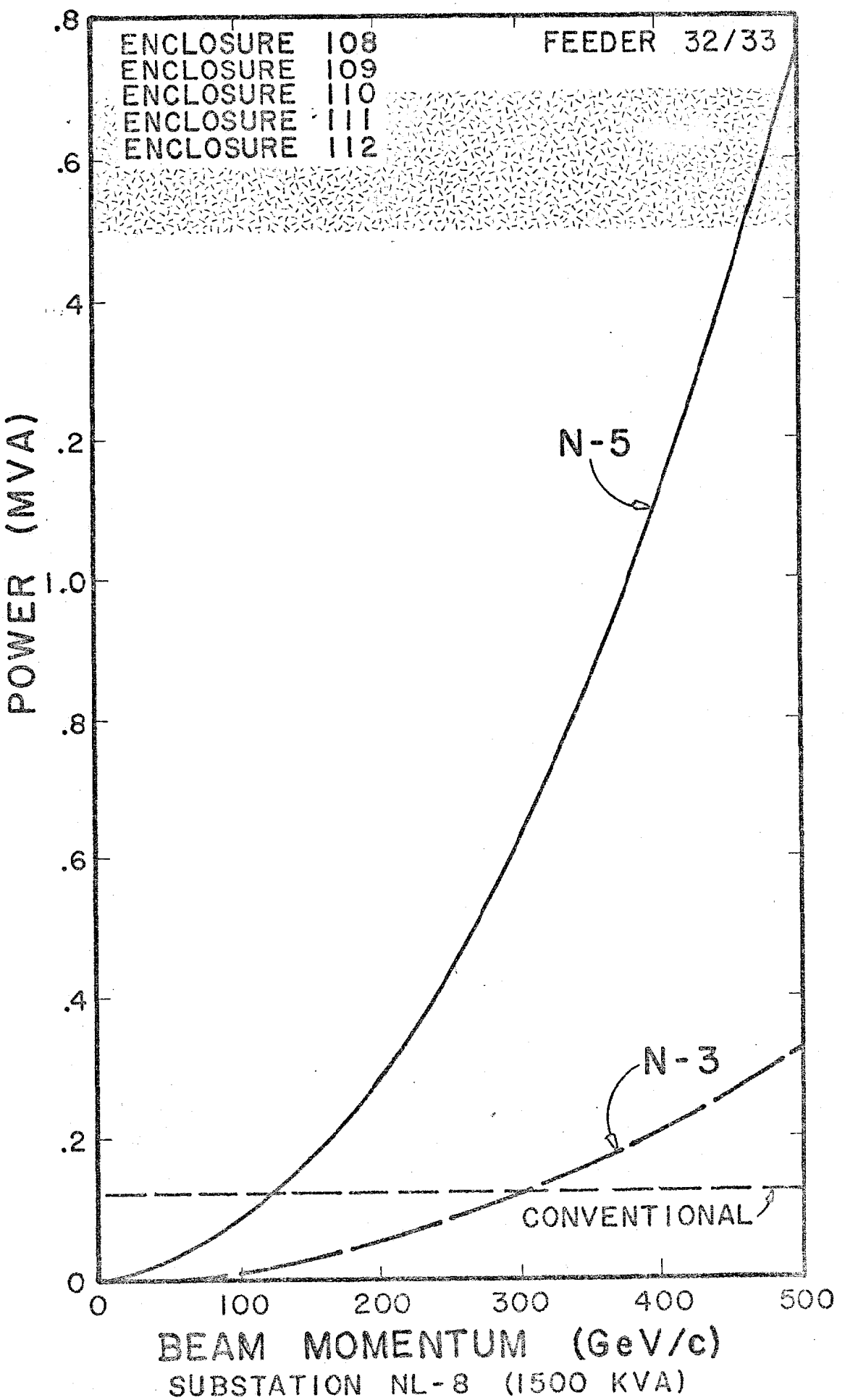

ENCLOSURE 103
(EXCEPT FOR 3 CEA QUADS
POWERED FROM NL-4)
FEEDER 33
POWER (MVA)
.8
.6
.4
.2
1.0
.8
.6
.4
.2
0
N-1
CONVENTIONAL
N-3
0
100
200
300
400
500
BEAM MOMENTUM (GeV/c)
SUBSTATION NL-5 (500 KVA)

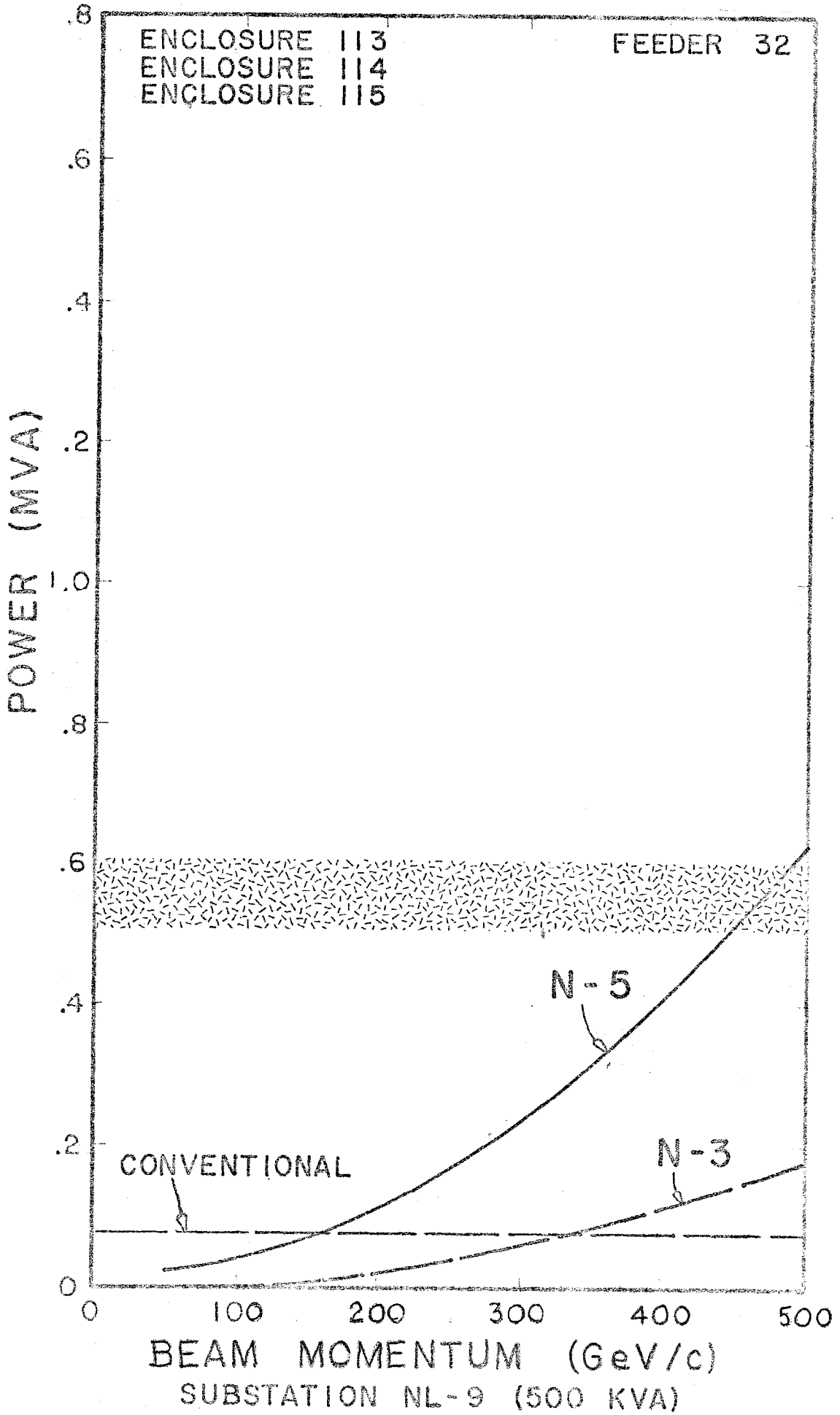

ENCLOSURE 104
SERVICE BUILDING N-3
MUON LABORATORY & NORTH ADD'N
FEEDER 32/33
POWER (MVA)
.8
.6
.4
.2
1.0
.8
.6
.4
.2
0
N-1'
CONVENTIONAL &
EXPERIMENTAL,
MUON LABORATORY
N-1
CONVENTIONAL
SB N-3
0
100
200
300
400
500
BEAM MOMENTUM (GeV/c)
SUBSTATION NL-6 (1500 KVA)

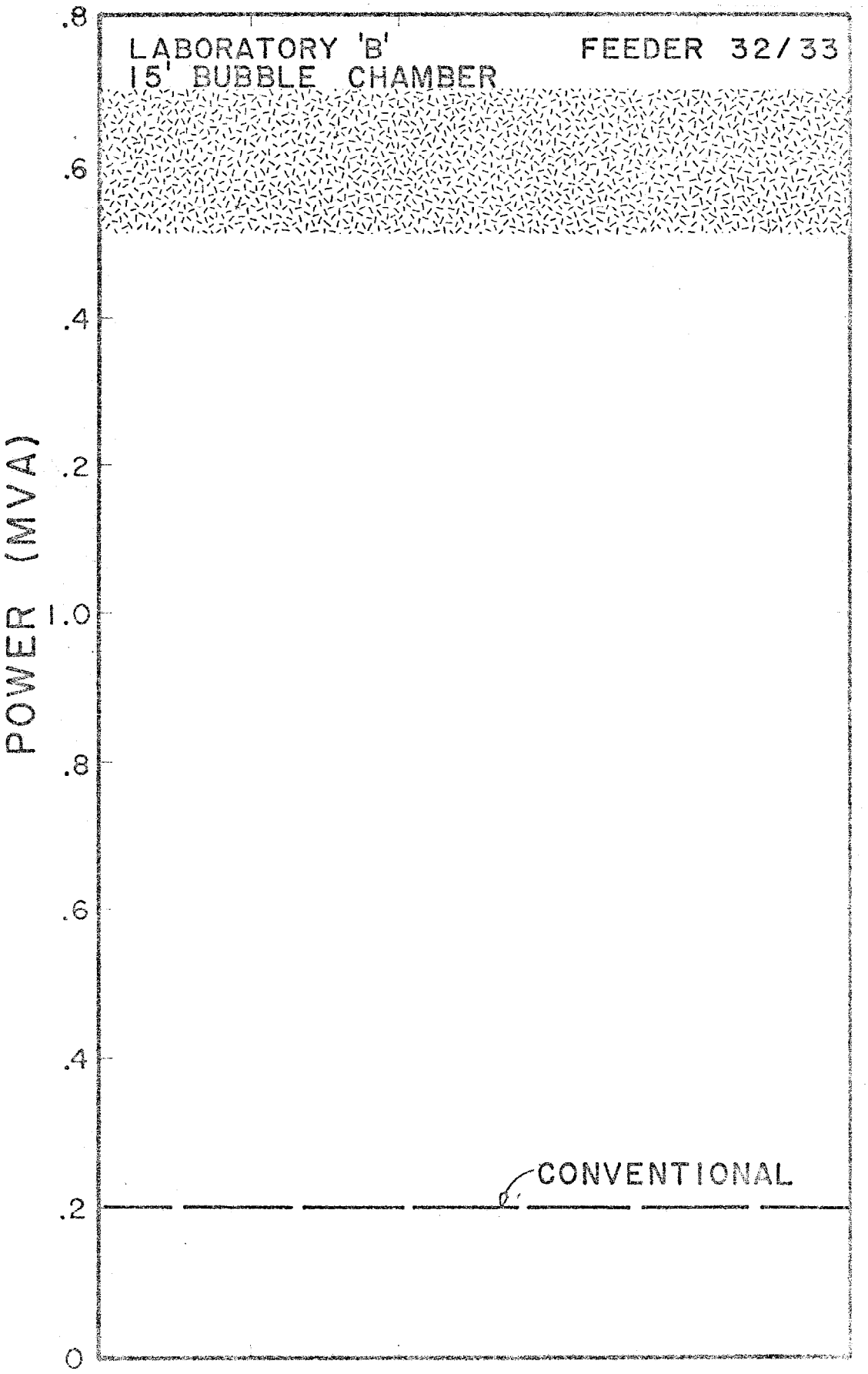


SUBSTATIONS NL-6A, NL-6B (2 x 1500 KVA)


ENCLOSURE 105
ENCLOSURE 106
ENCLOSURE 107
WONDER BUILDING
FEEDER 32/33
N-5
N-3✧
✧ Power supplies are shared between the two beam lines.
POWER (MVA)
.8
.6
.4
.2
1.0
.8
.6
.4
.2
0
0
100
200
300
400
500
BEAM MOMENTUM (GeV/c)
SUBSTATION NL-7 (1500 KVA)

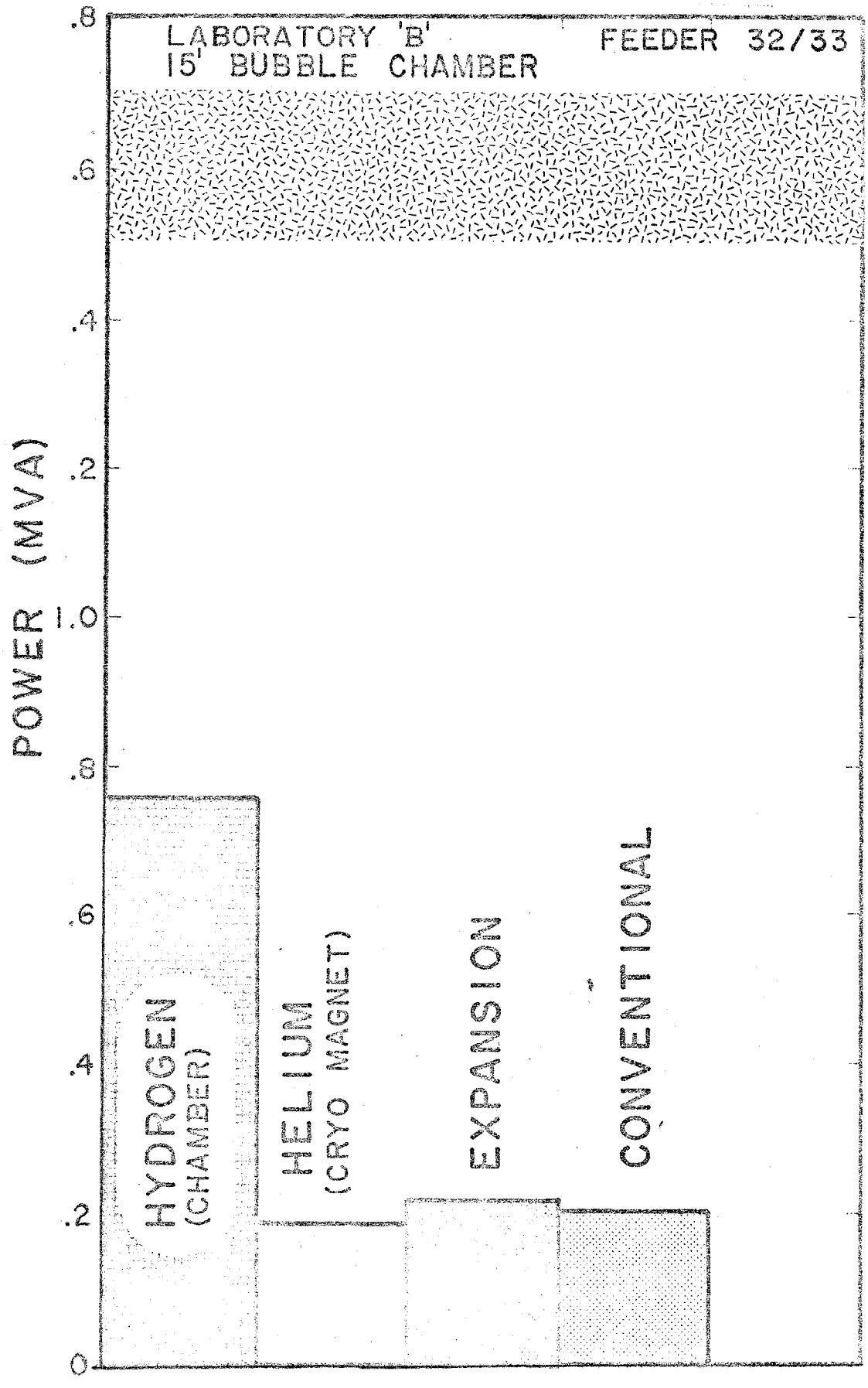

ENCLOSURE 108
ENCLOSURE 109
ENCLOSURE 110
ENCLOSURE 111
ENCLOSURE 112
FEEDER 32/33
N-5
N-3
CONVENTIONAL
POWER (MVA)
.8
.6
.4
.2
1.0
.8
.6
.4
.2
0
0
100
200
300
400
500
BEAM MOMENTUM (GeV/c)
SUBSTATION NL-8 (1500 KVA)


ENCLOSURE 113
ENCLOSURE 114
ENCLOSURE 115
FEEDER 32
POWER (MVA)
.8
.6
.4
.2
1.0
.8
.6
.4
.2
0
N-5
N-3
CONVENTIONAL
0
100
200
300
400
500
BEAM MOMENTUM (GeV/c)
SUBSTATION NL-9 (500 KVA)

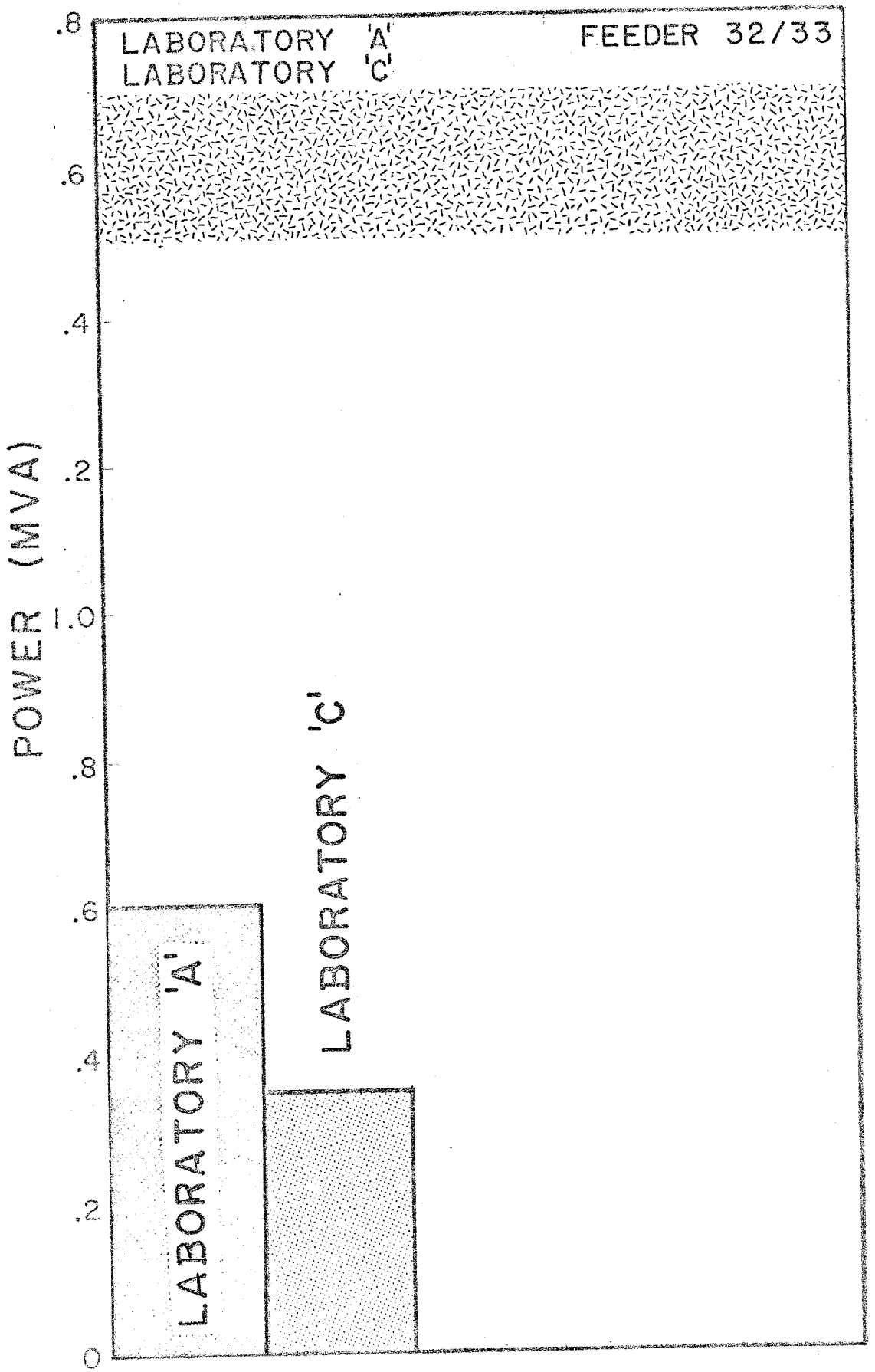


CONVENTIONAL SYSTEMS

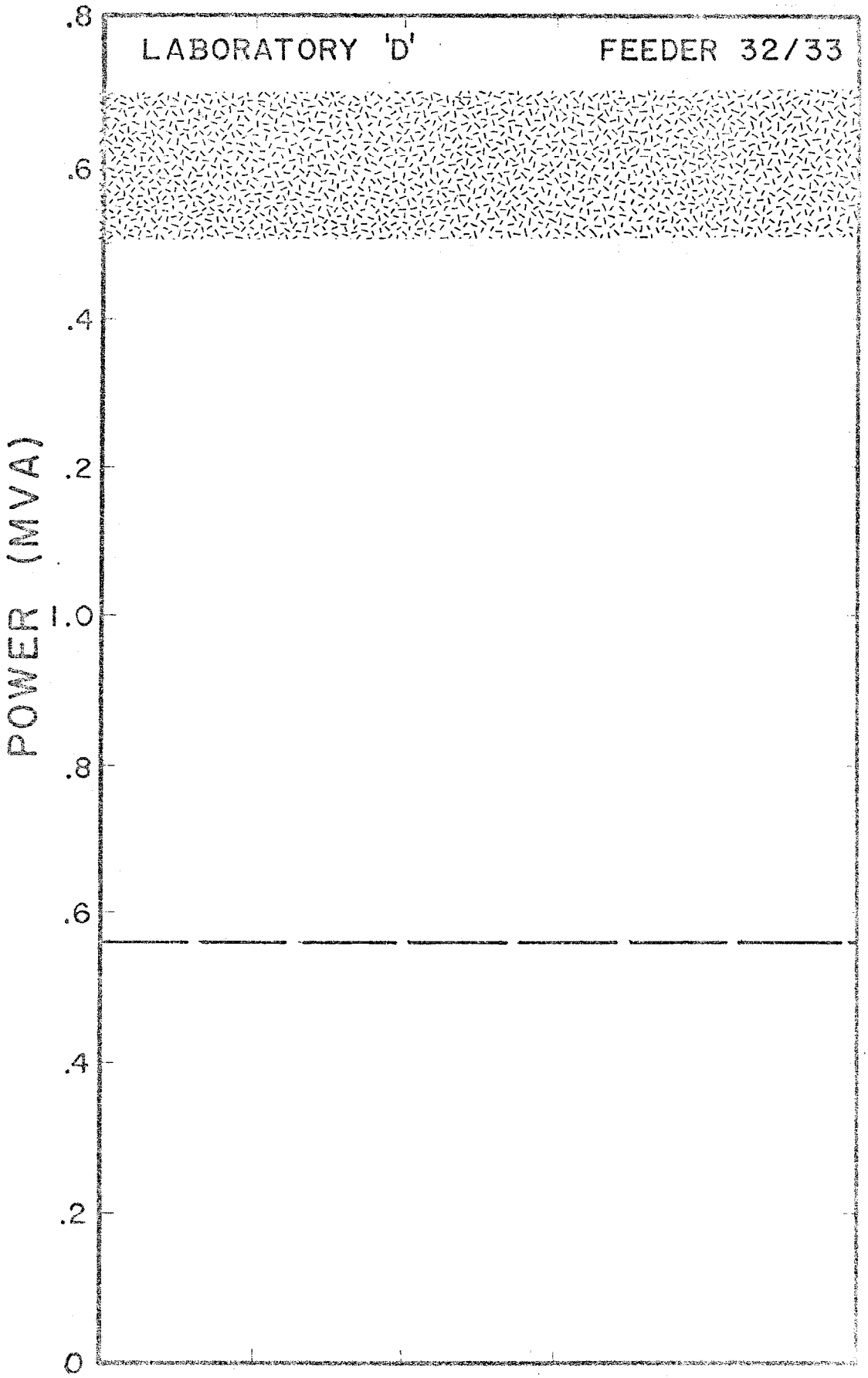
SUBSTATION NL-10 (1500 KVA)



SUBSTATION NL-II (1500 KVA)

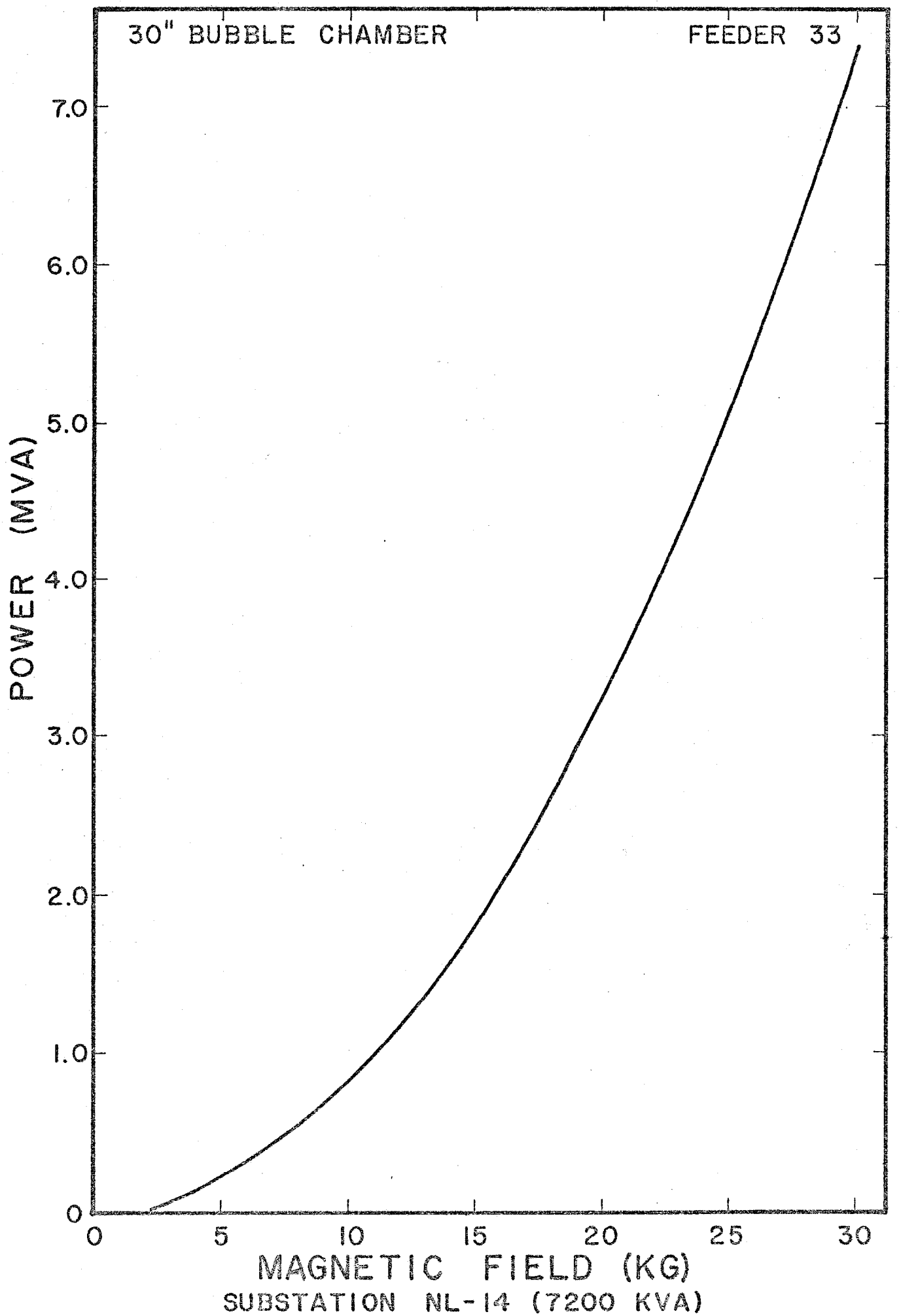


SUBSTATION NL-12 (1500 KVA)



CONVENTIONAL PLUS TECHNICAL SYSTEMS

SUBSTATION NL-13 (1500 KVA)


30" BUBBLE CHAMBER
FEEDER 33
POWER (MVA)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
0
5
10
15
20
25
30
MAGNETIC FIELD (KG)
SUBSTATION NL-14 (7200 KVA)

national accelerator laboratory

TM-296-C
2261

13.8 kV FEEDERS AND LOAD DISTRIBUTION IN THE NEUTRINO AREA

T. E. Toohig

November 1973

The electrical power distribution from the Master Substation to the Neutrino Area consists at present of two 13.8 kV feeders, Feeder 32 and Feeder 33, running the length of the area. Appropriate unit substations at various locations as detailed in Fig. 1 convert the 13.8 kV to voltages required for equipment. Table I lists the capability for switching between feeders for this configuration. In early 1974 these will be supplemented by a third feeder, Feeder 35 providing the distribution shown in Fig. 2. The feeders are rated for 7.0 MVA each as installed in the power ducts and loads are balanced between the feeders accordingly.

The attached graphs, NL-1 to NL-14, illustrate operating loads on the various substations under different conditions of beam settings and facility operation. An efficiency of 0.75 was used for the power supplies, and a power factor of 0.8 was used over-all in calculating the graphs. These numbers are derived from early operating experience and will probably have to be refined with time.

The curves labelled N-0, N-1, etc. refer to the N-0, N-1, etc. beam lines as specified in the current beam line data sheets.

From the point of view of power, it is apparent that under certain conditions compromises in beam momentum and/or experimental equipment operating levels must be made if facilities are to be operated simultaneously.

TABLE I

NEUTRINO AREA POWER DISTRIBUTION

1. Non-Switchable Power

1.1 Feeder 32

NL-1: SB-N1, G-2, G-3, NeuHall, Sanitary Lift Station

NL-3: 101

NL-9: 113, 114, 115

1.2 Feeder 33

NL-4: 102, 103

NL-5: 103

NL-8: 108, 109, 110, 111, 112

NL-14: 30-inch bubble chamber

2. Switchable Power

NL-2: SB-N2, 100

NL-6: SB-N3, 104, Muon Lab

NL-6A: U.C.Cyclotron, Muon Lab
NL-6B:

NL-7: 105, 106, 107, Wonder Bldg

* † NL-10:

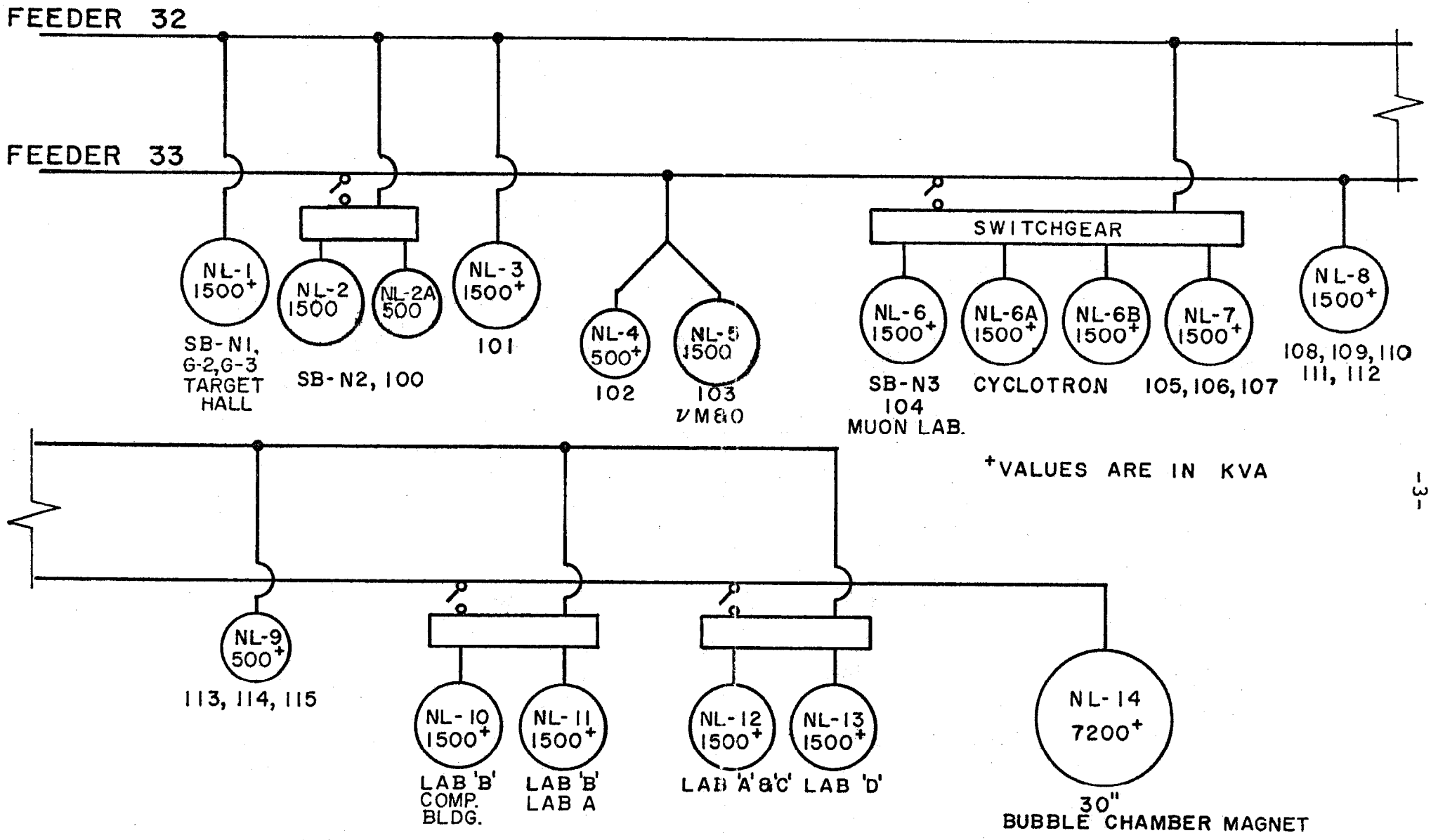
* † NL-11: Lab "B"

* † NL-12: Lab "A" and "C", Casey's Pond Pumping Station

* † NL-13: Lab "D"

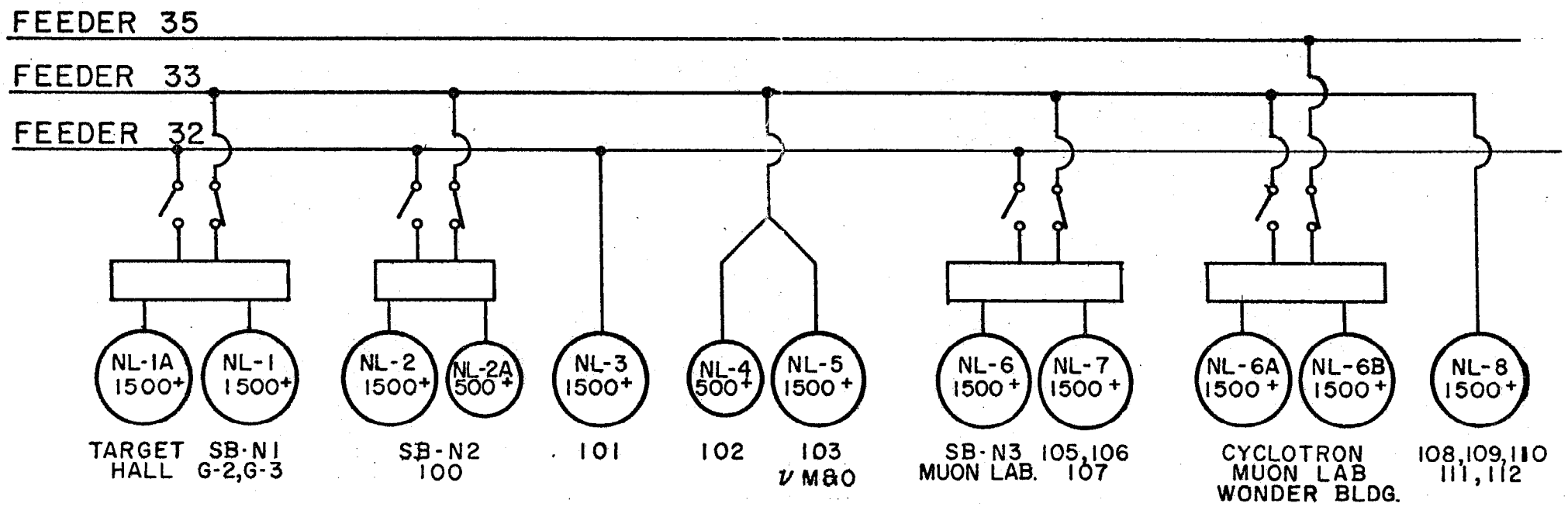
*Coupled to emergency power system

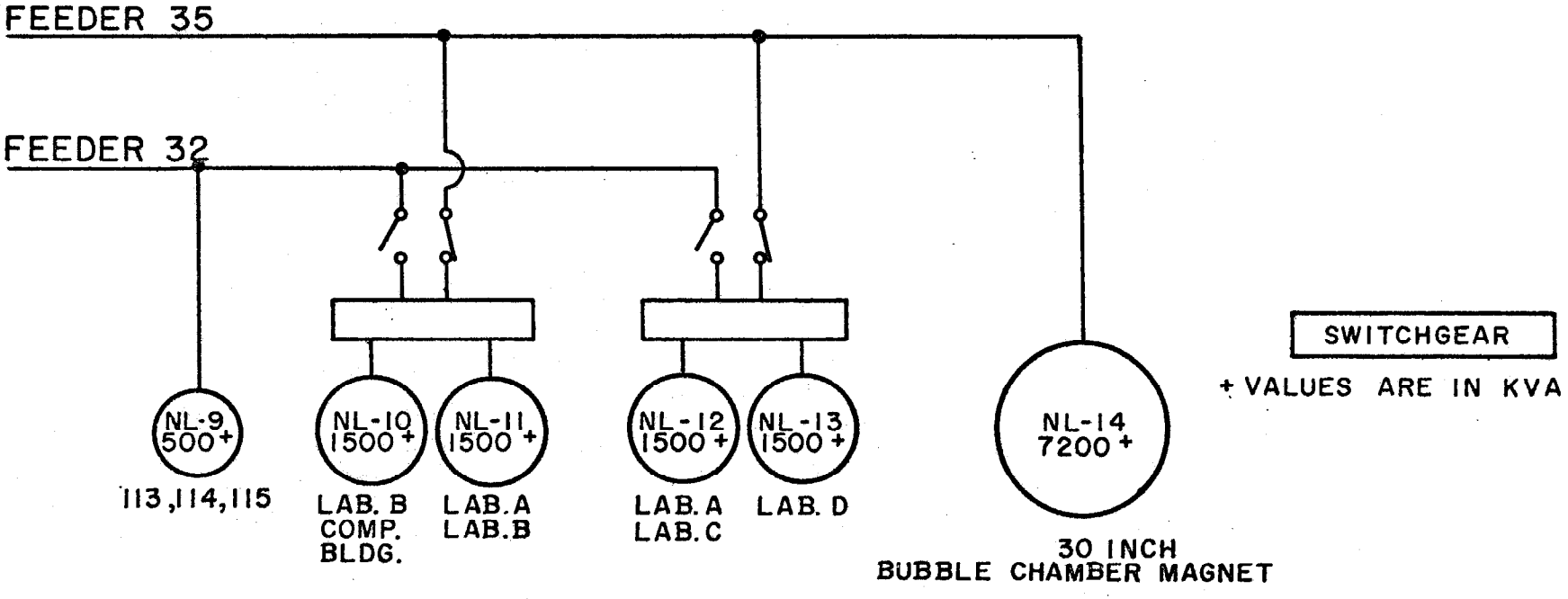
†Critical if 15-foot is cooling down



NEUTRINO LABORATORY 13.8 KV FEEDER AND SUBSTATIONS

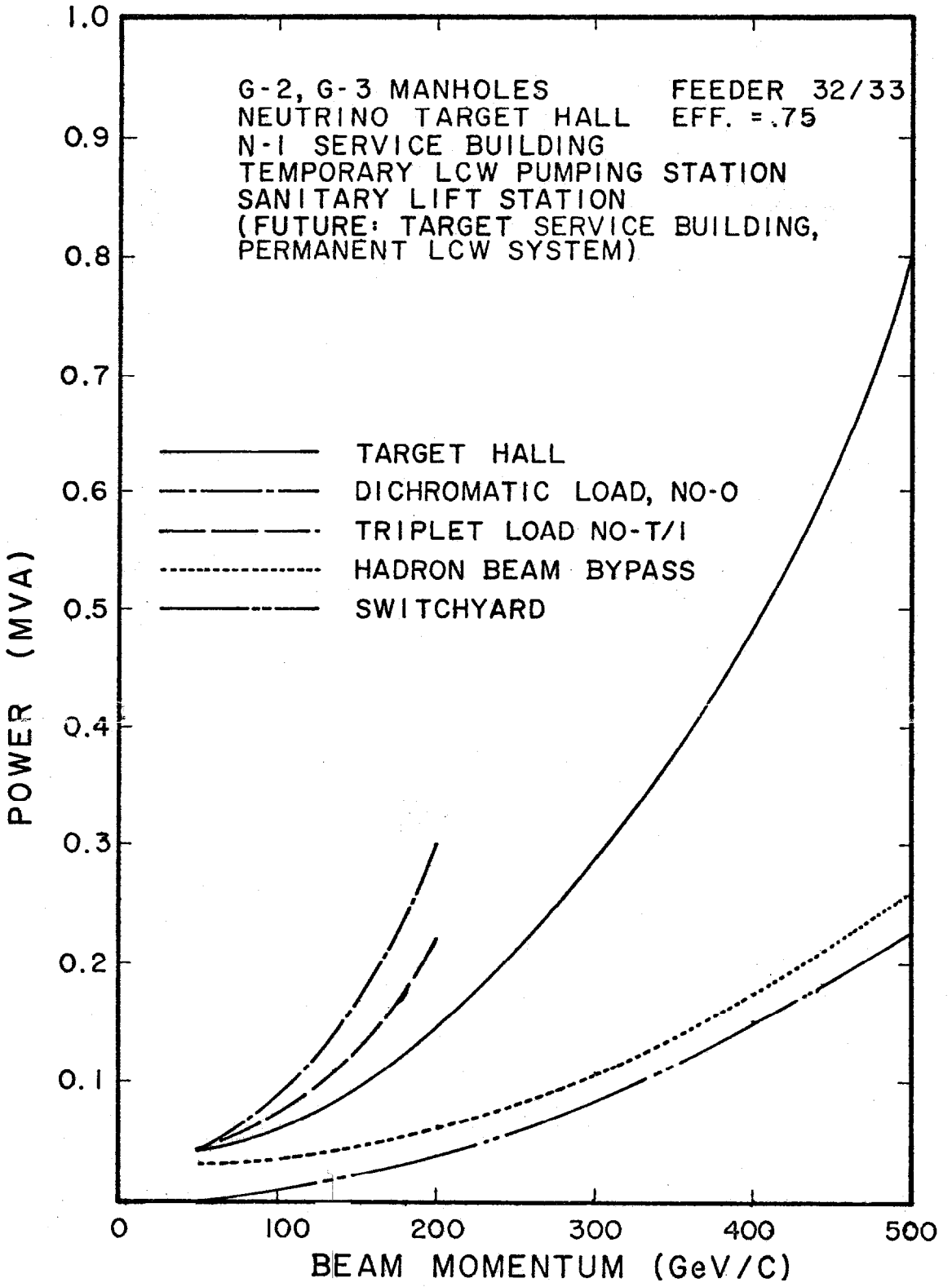
Figure 1



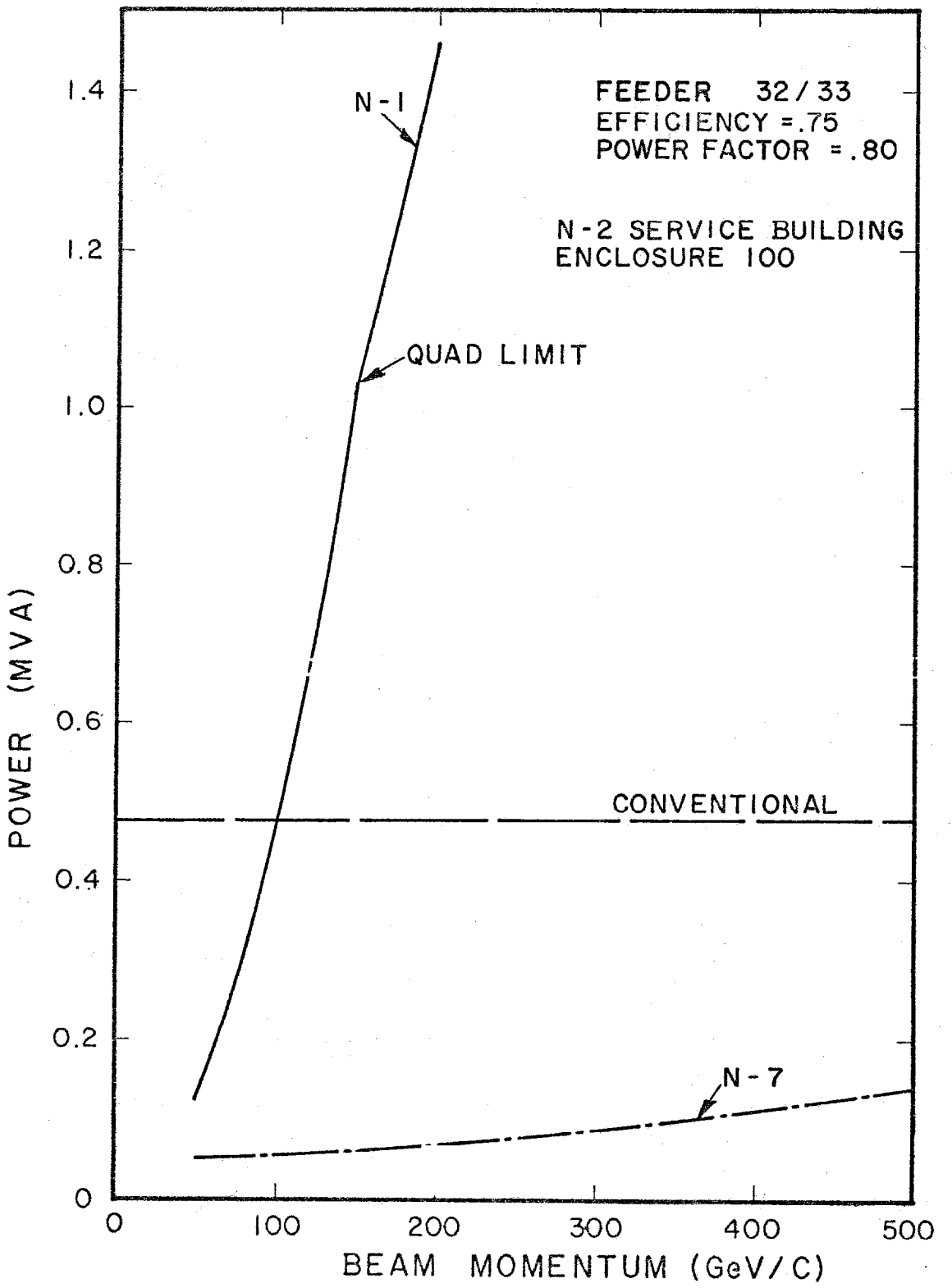


NEUTRINO LABORATORY 13.8 KV FEEDERS AND SUBSTATIONS

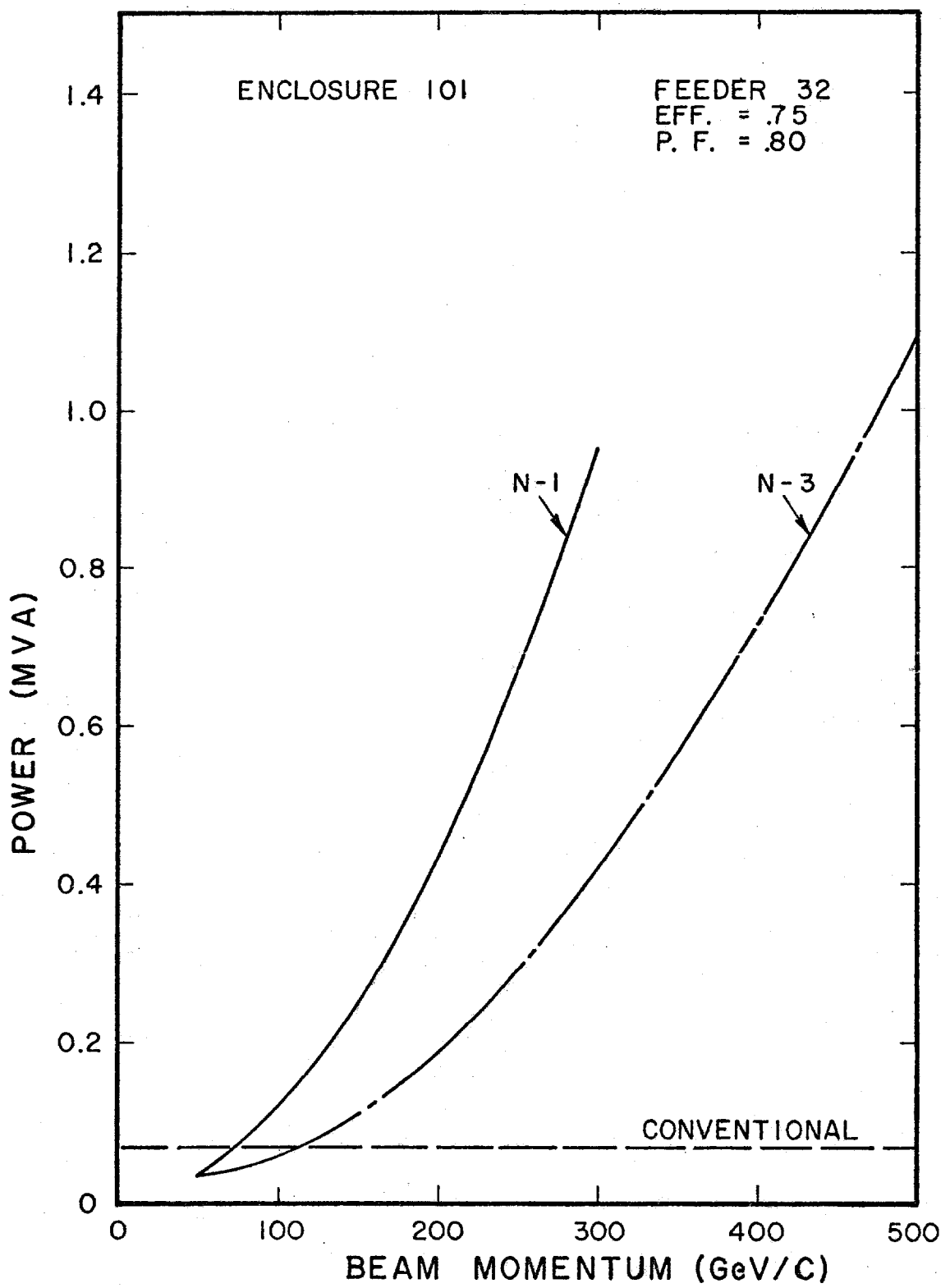
Figure 2



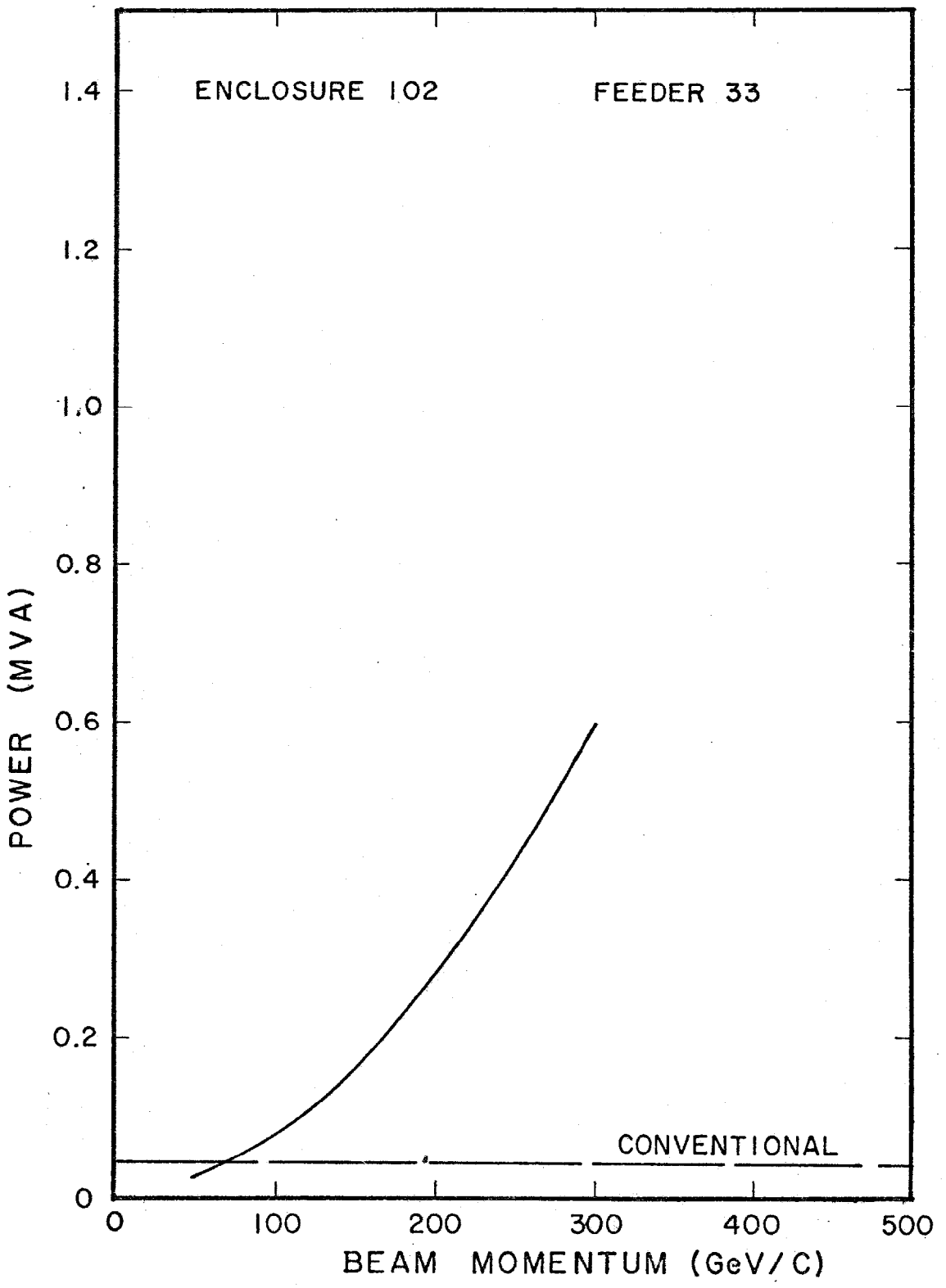
SUBSTATION NL-I (1500 KVA), NL-IA (1500 KVA



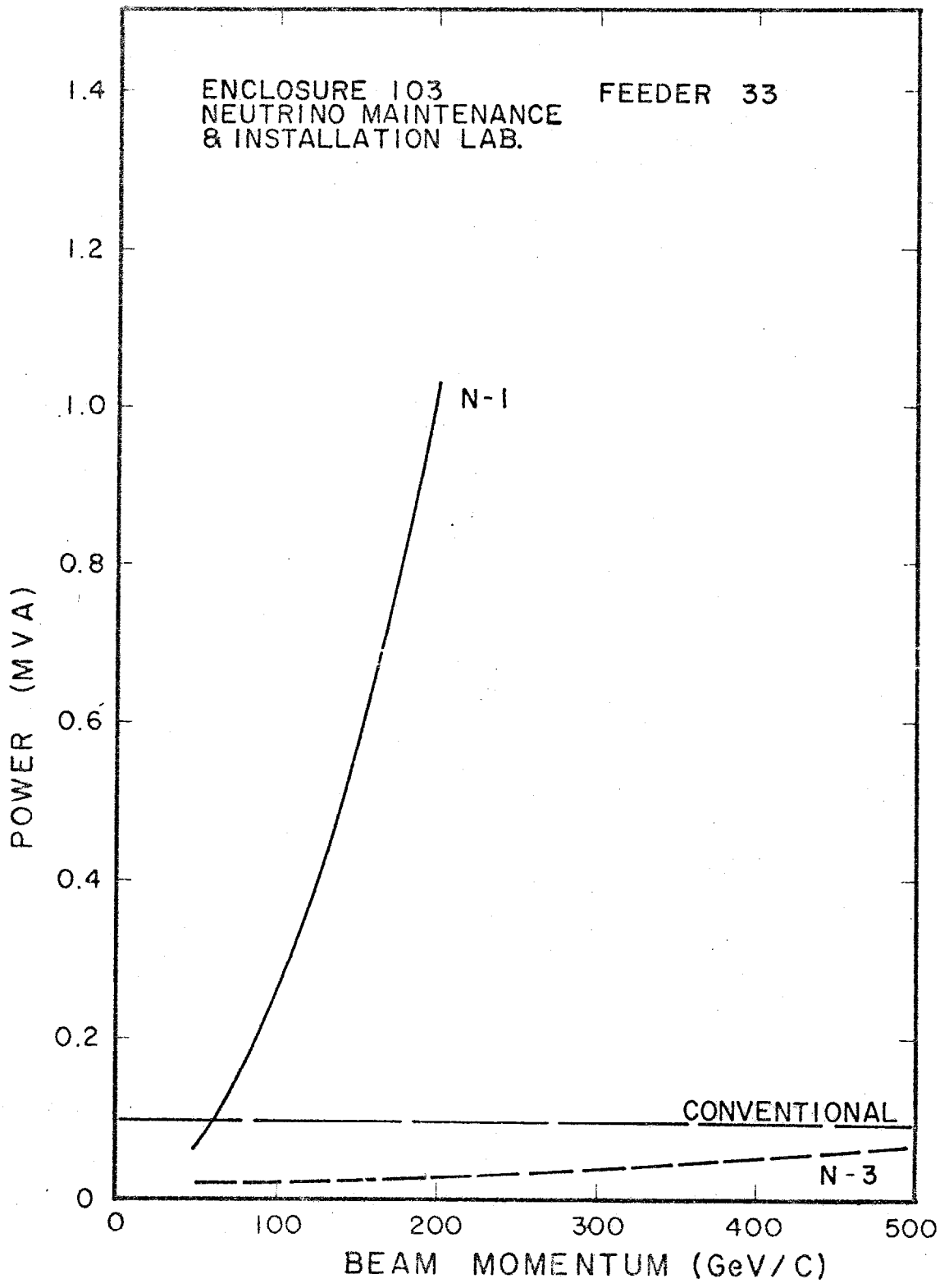
SUBSTATION NL-2(1500 KVA), NL-2A(500 KVA)



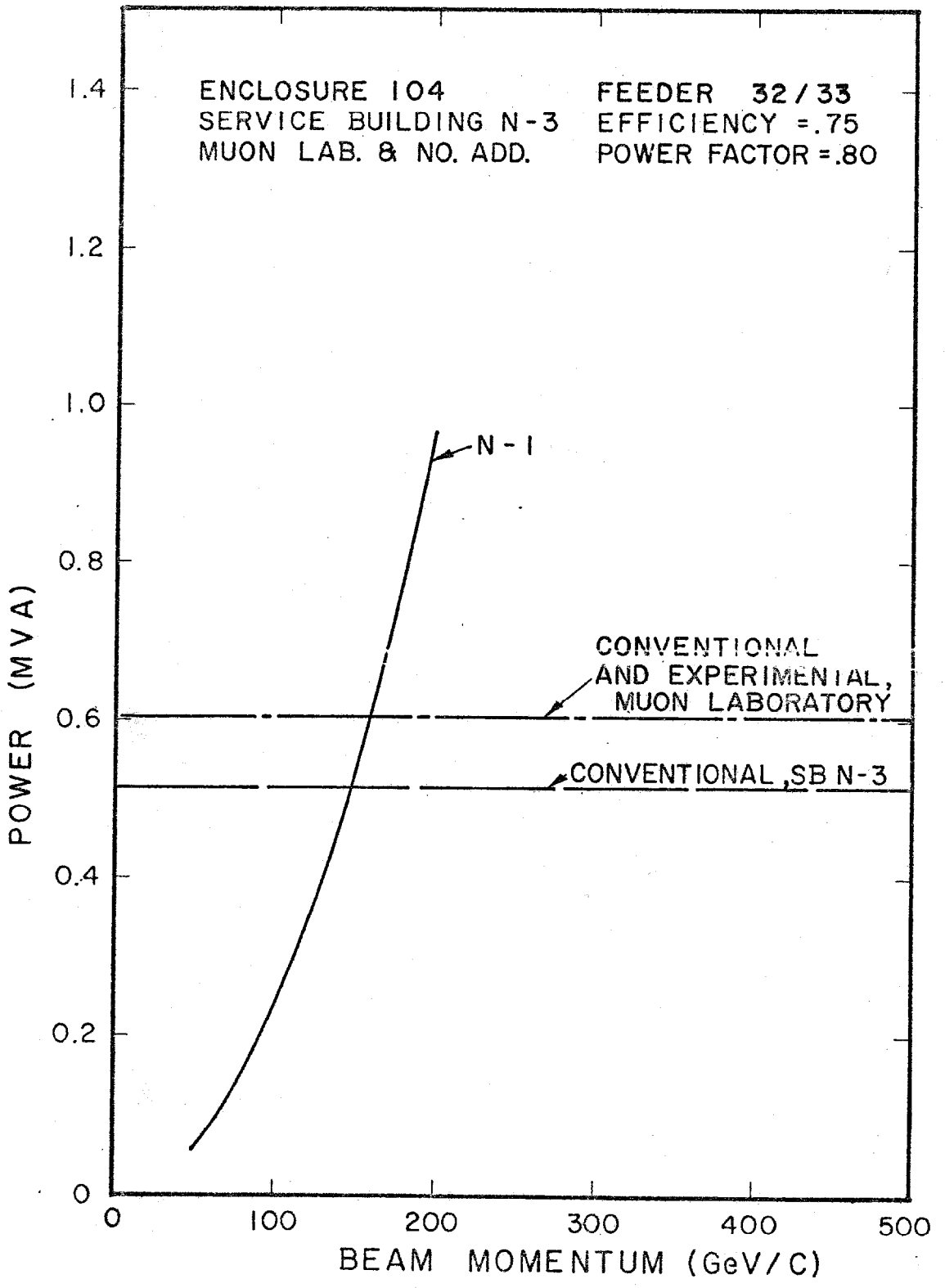
SUBSTATION NL-3 (1500 KVA)



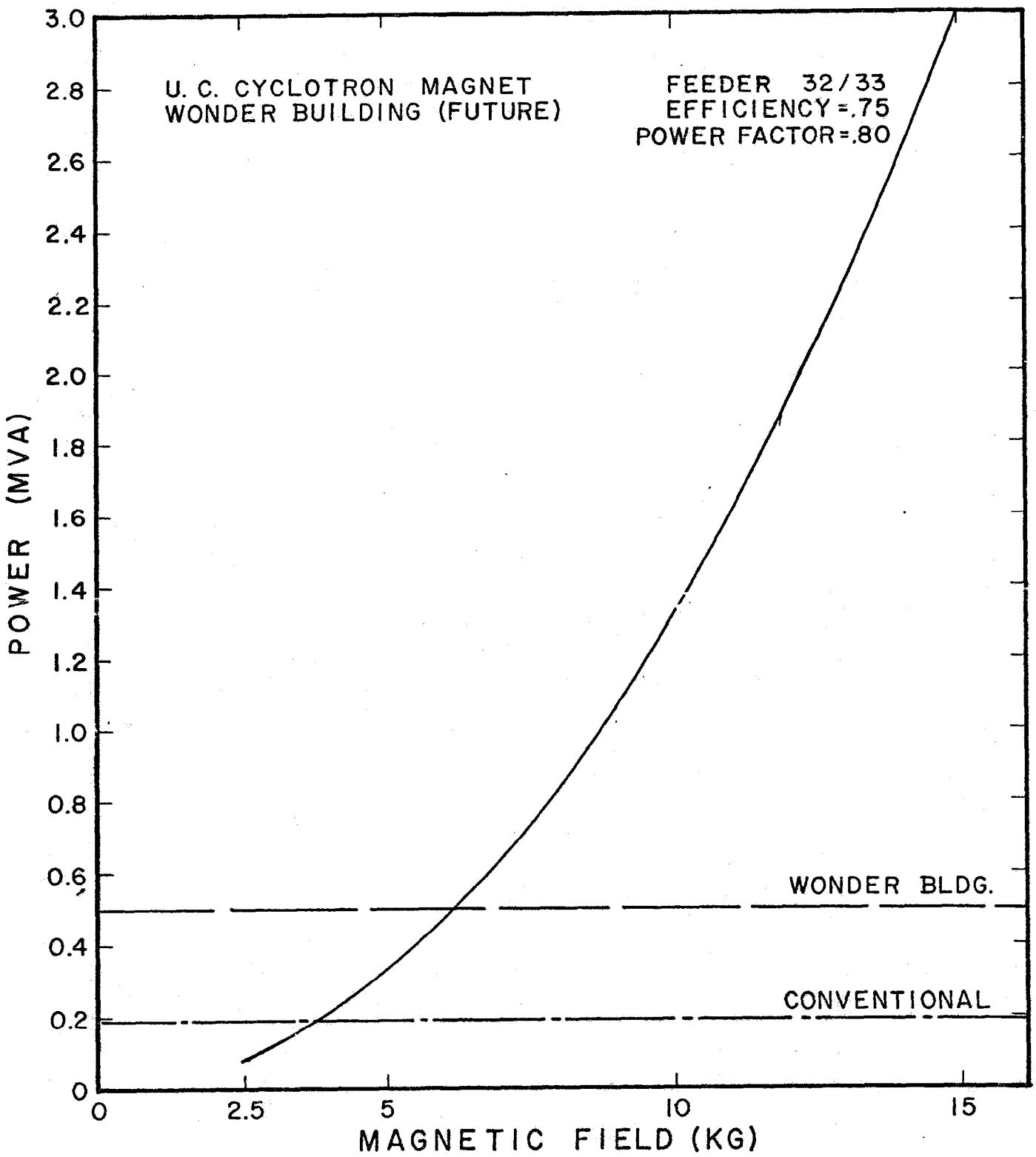
SUBSTATION NL-4 (500 KVA)



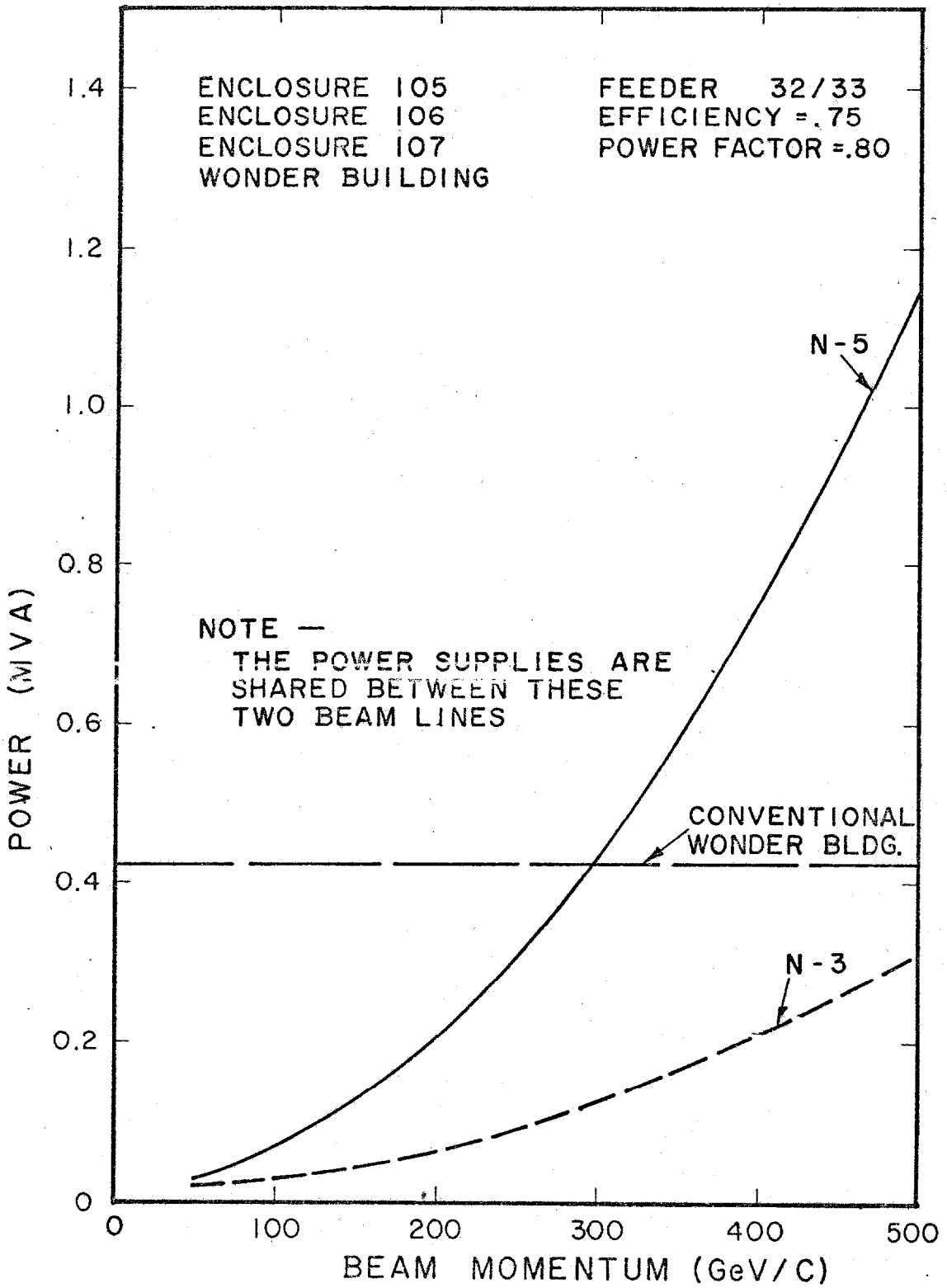
SUBSTATION NL-5 (1500 KVA)



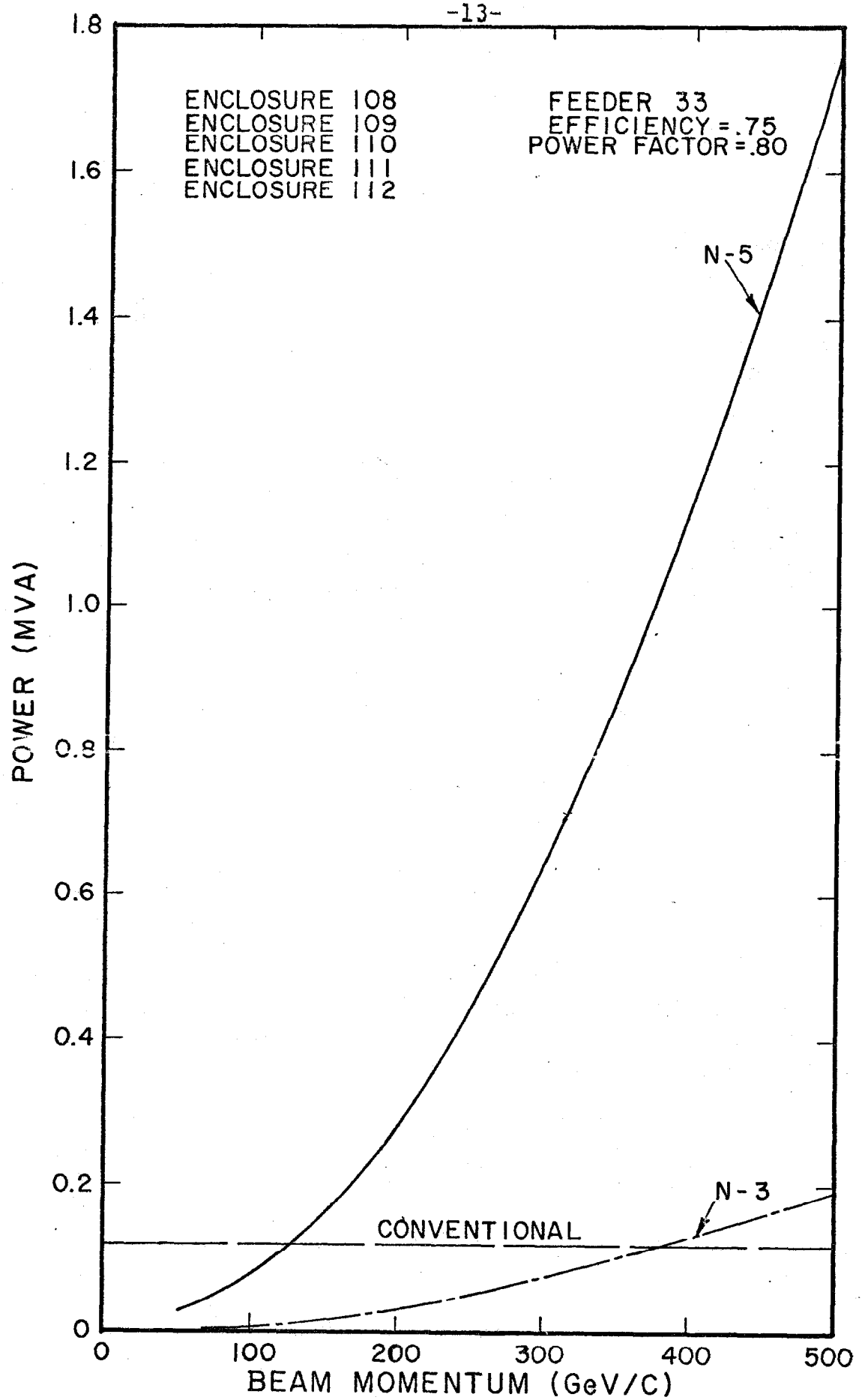
SUBSTATION NL-6 (1500 KVA)



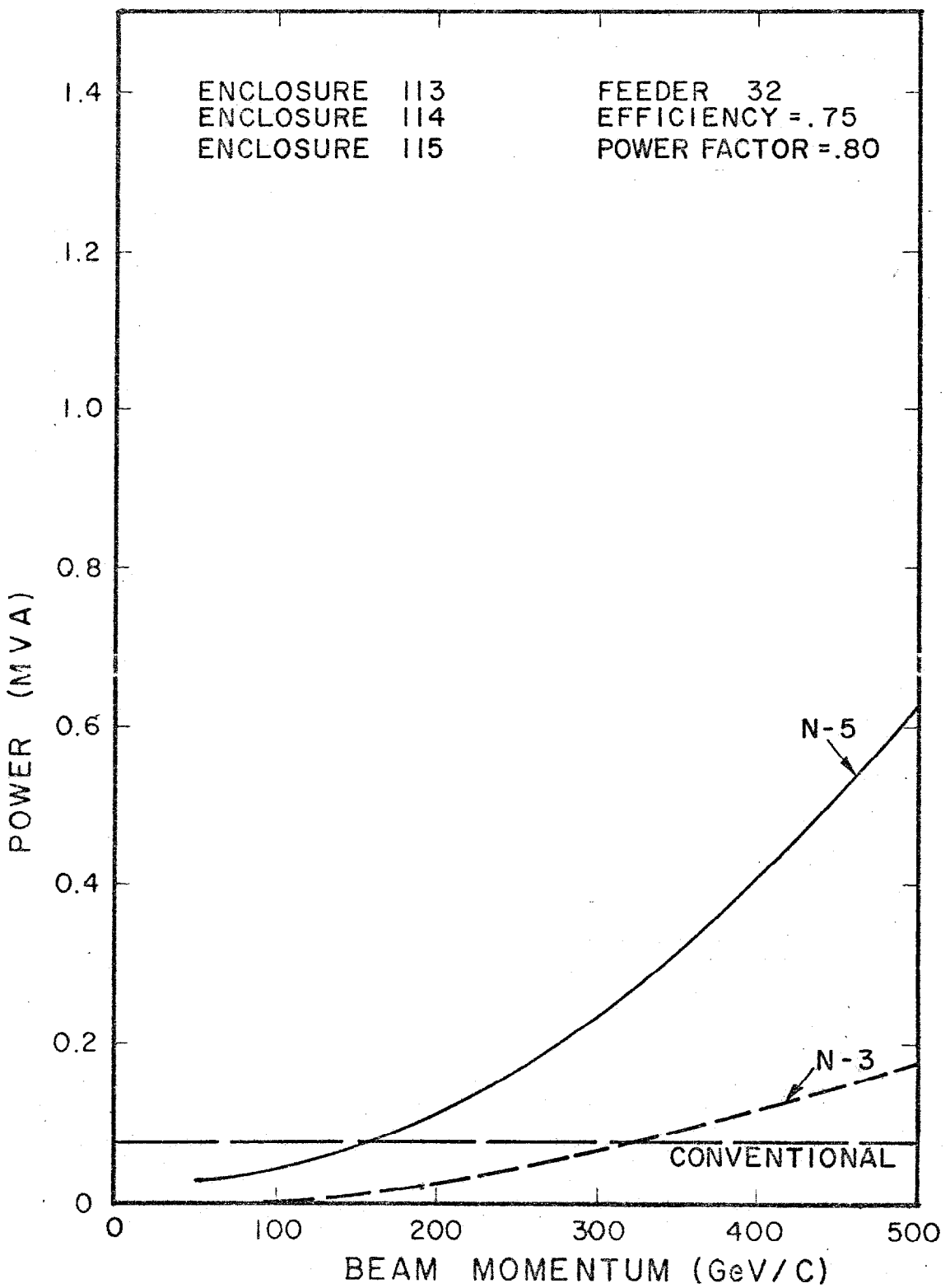
SUBSTATIONS NL-6A(1500 KVA), NL-6B(1500 KVA)



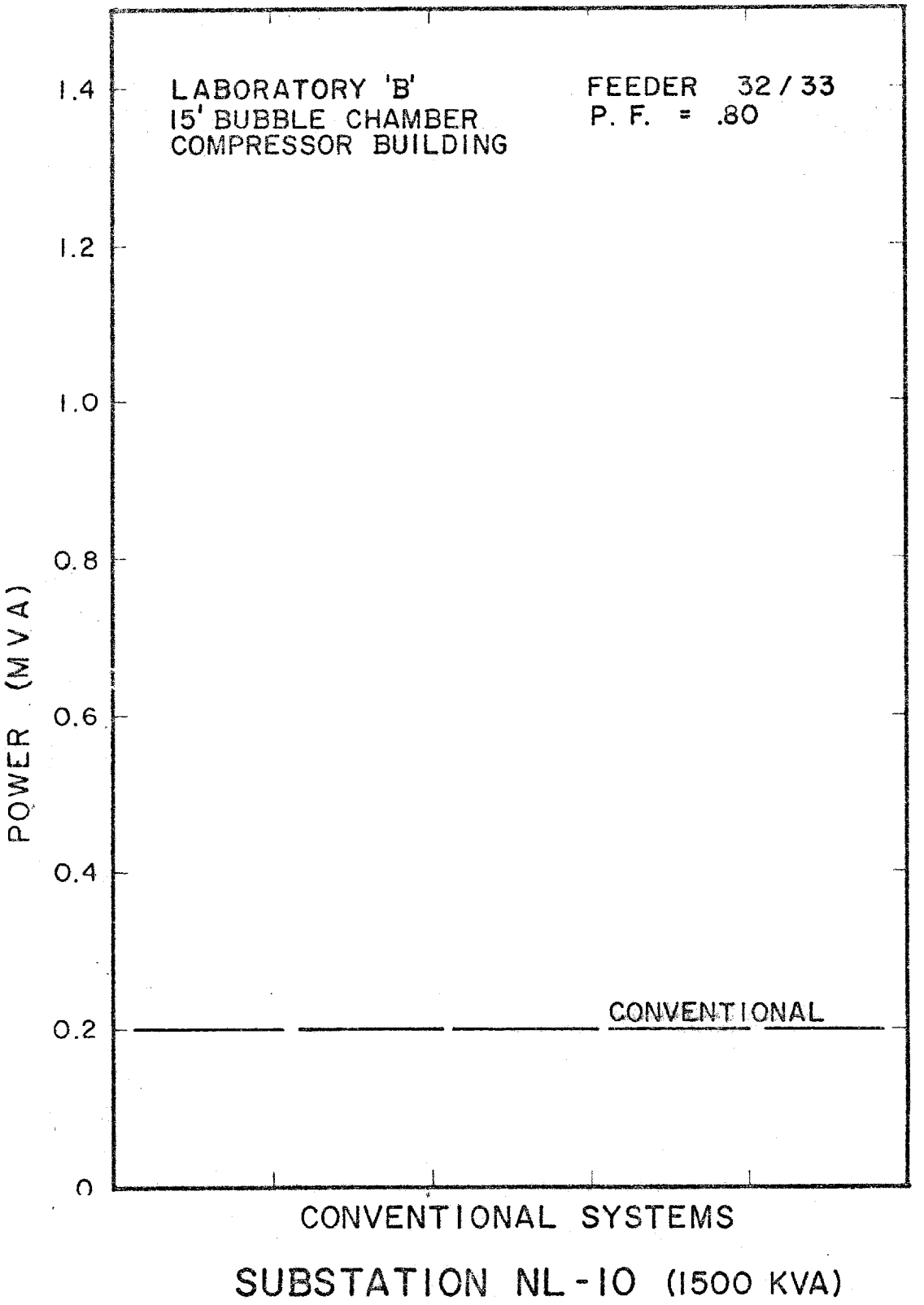
SUBSTATION NL-7 (1500 KVA)



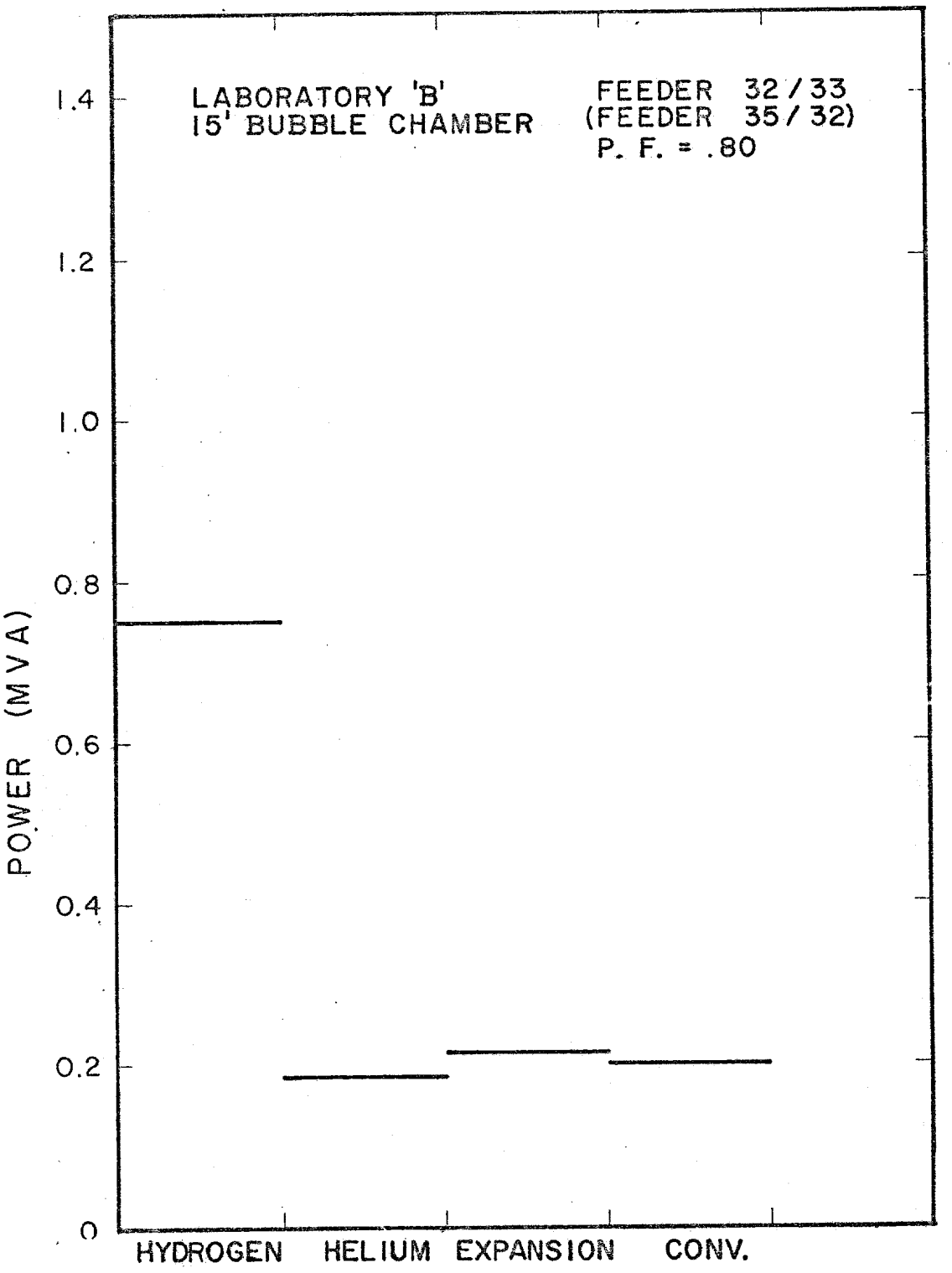
SUBSTATION NL-8 (1500 KVA)



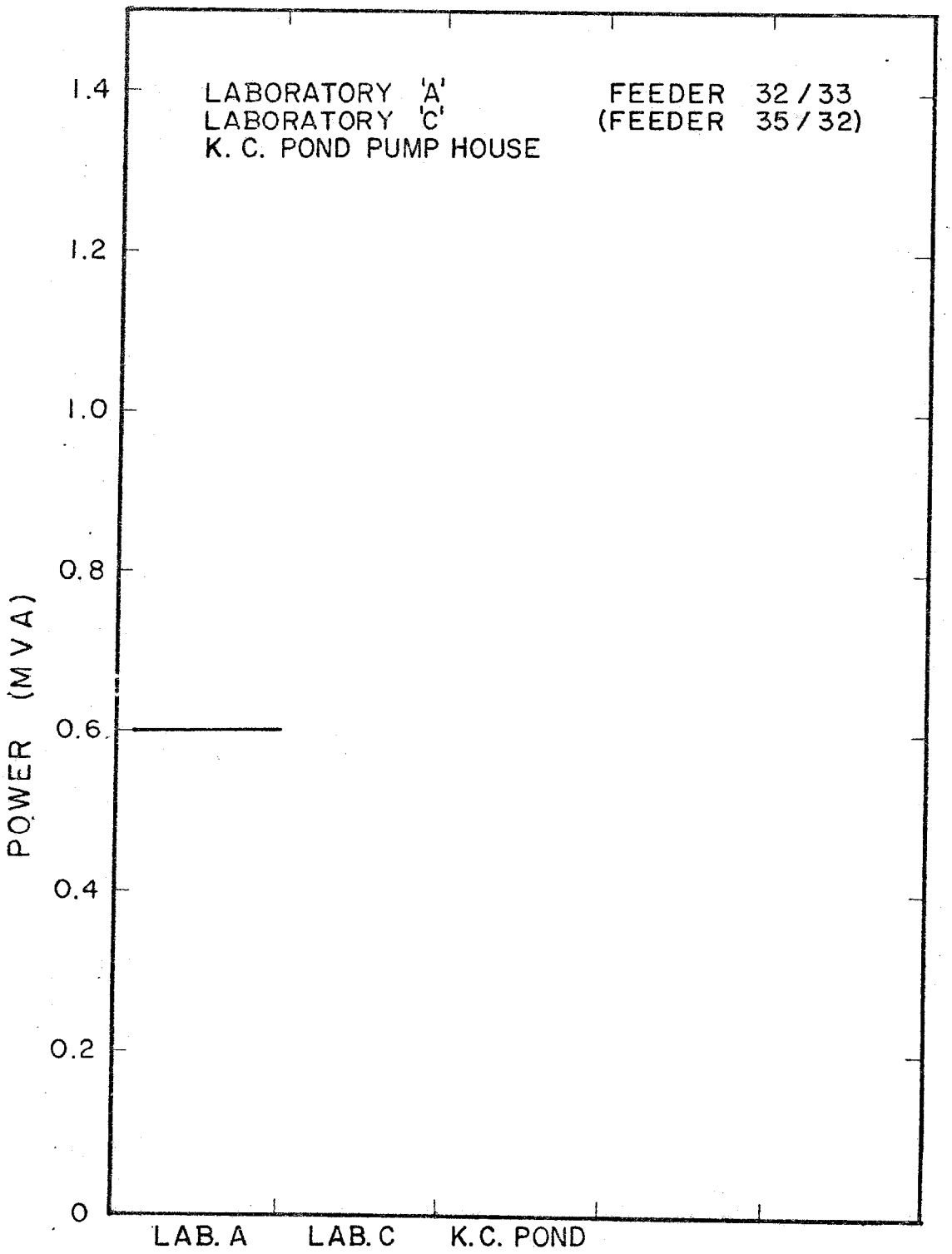
SUBSTATION NL-9 (500 KVA)



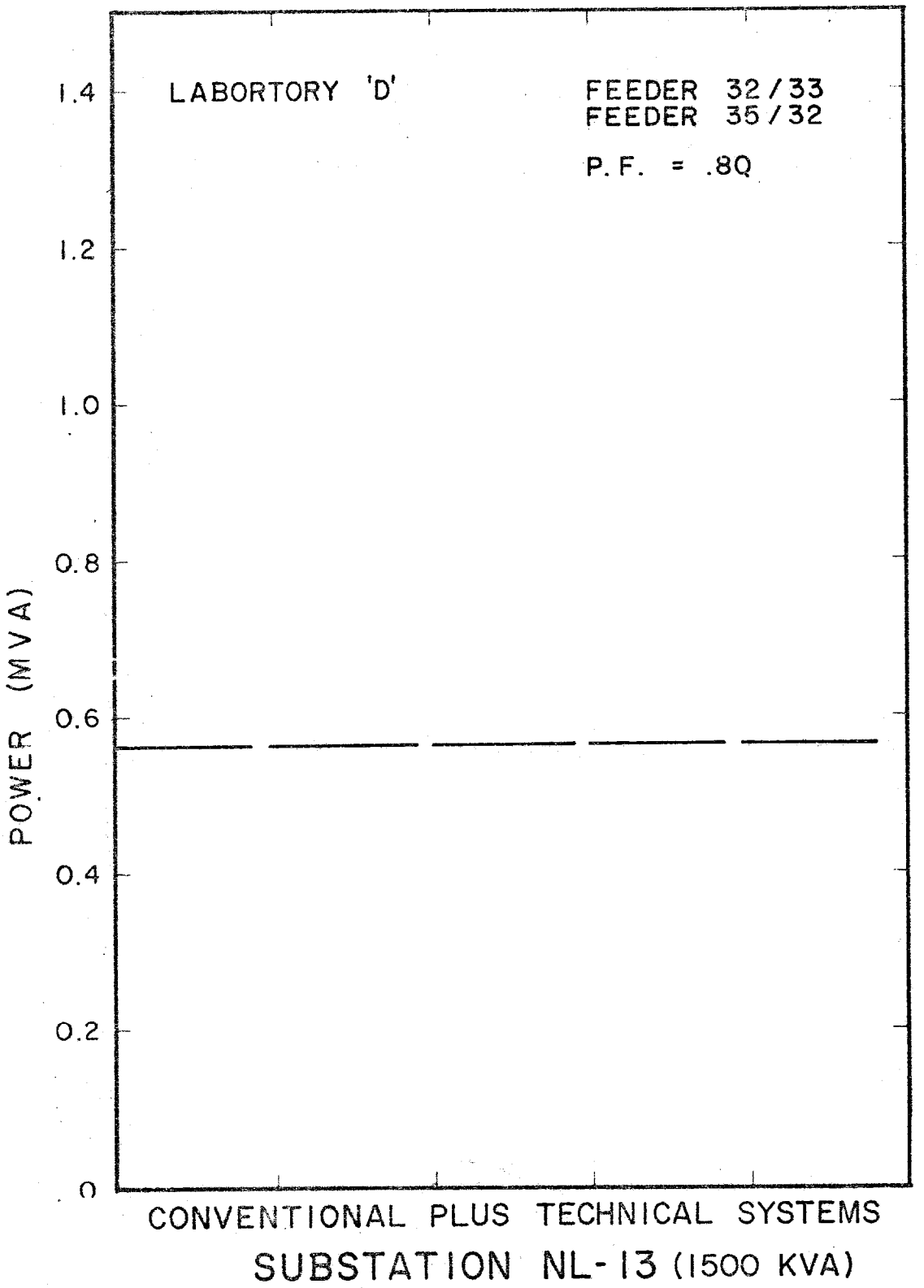
SUBSTATION NL-10 (1500 KVA)

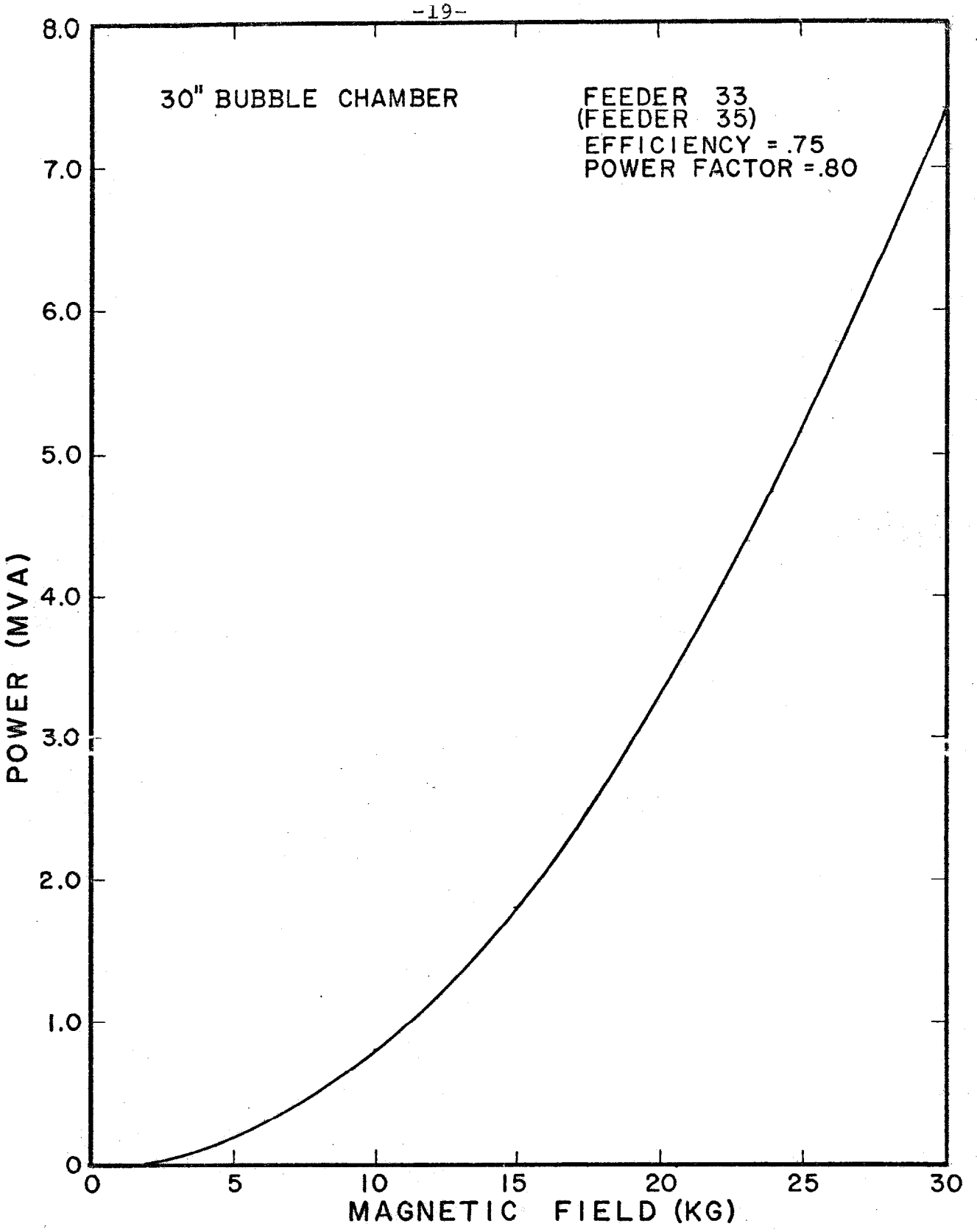


SUBSTATION NL-II (1500 KVA)



SUBSTATION NL-12 (1500 KVA)


LABORTORY 'D'
FEEDER 32/33
FEEDER 35/32
P.F. = .8Q
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
POWER (MVA)
CONVENTIONAL PLUS TECHNICAL SYSTEMS
SUBSTATION NL-13 (1500 KVA)



SUBSTATION NL-14 (7200 KVA)